



Name of Candidate:

Lixin Sun

Project Title:

**The METRO Framework: factors influencing the adaptability,
scalability and sustainability (ASaS) of complex health interventions
in low- and middle- income countries (LMICs)**

Name of Supervisor:

Andrew Booth

Name of Co-Supervisor:

Robert Akparibo

A thesis submitted for the degree of PhD in Public Health

Department of School of Health and Related and Research

Statement of Probity

I confirm that I shall abide by the University of Sheffield's regulations on plagiarism and that all written work shall be my own and will not have been PLAGIARISED from other paper-based or electronic sources. Where used, material gathered from other sources will be clearly cited in the text.

Date: 24/06/2024.....

Name (Print): Lixin Sun.....

Content

Abbreviations	7
Abstract.....	8
Chapter 1 Introduction	11
1.1 Chapter Overview.....	15
1.2 Background.....	15
1.3 Research Context	23
1.4 Structure of the thesis.....	25
1.5 Aims and objectives	26
1.6 Summary.....	29
Chapter 2 Systematic review of theoretical theories, models and frameworks of ASaS of complex health interventions.....	30
2.1 Introduction.....	30
Search Strategy	32
2.2 Method	33
Search terms	33
Inclusion and exclusion criteria.....	33
Data extraction and appraisal	35
Quality Assessment	36
Analysis	36
2.3 Results.....	39
Characteristics of included studies	39
The result of the quality assessment of the included studies.....	39
Theories, models and frameworks (TMFs) used.....	42
Adaptability, scalability and sustainability definitions and outcomes reported	42
Implementation and the relationship between adaptability, scalability and sustainability.....	43
2.4 Applicability and feasibility of the collected TMFs	54
2.5 Discussion	72
Similarities and differences between the TMFs	72
Have gaps in knowledge been addressed?	75
What inter-relationships have been demonstrated between factors influencing scalability, adaptability, and sustainability of the complex health interventions?	77
Lack of TMFs designed for LMICs	77
Strengths and Limitations	78
2.6 Summary.....	79
Chapter 3 Empirical systematic review	81
3.1 Introduction.....	81
3.2 Method	82
3.2.1 Search Strategy.....	82
3.2.2 Inclusion and exclusion criteria.....	85
3.2.3 Methodological quality assessment	87
3.2.4 Data Extraction and Synthesis.....	87
3.3. Result	90

3.4 Discussion	103
3.4.1 Similarities and gaps between definitions of adaptability, scalability and sustainability) and related findings in the empirical review	103
3.4.2 The complexity of influencing factors of adaptability, scalability and sustainability	105
3.4.3 The dynamics of influencing factors of adaptability, scalability and sustainability	107
3.4.4 Links and differences in the influencing factors found in theoretical and empirical systematic reviews	109
3.4.5 Limitations	112
3.5 Summary	113
Chapter 4 Research approach and methods	115
4.1 Chapter Overview	115
4.1.1 Research paradigm	115
4.1.2 Methodology	117
4.1.3 Justification for using mixed method as methodology	118
4.1.4 Delphi survey using mixed methods	119
4.1.5 The Delphi process	120
Consent	127
4.2 Delphi survey study phase	127
4.2.1 Study design	127
4.2.2 Description of Participants	132
4.2.3 Sampling and Recruitment	134
4.2.4 Data collection	136
4.2.5 Data analysis	141
4.3 Consensus meeting phase	146
4.3.1 Study design	146
4.3.2 Description of participants	148
4.3.3 Sampling and recruitment	149
4.3.4 Data collection of consensus meeting	149
4.3.5 Data analysis	150
4.4 Ethical considerations	151
4.4.1 Ethics approval	151
4.4.2 Informed consent	151
4.4.3 Privacy and confidentiality	152
4.4.4 Safety issues	153
4.4.5 Data storage and protection	154
4.5 Summary	155
Chapter 5 Delphi questionnaire survey round 1	157
5.1 The Expert Panel	157
5.2 The expert panel of first round of Delphi survey	159
5.3 The results of the first round	162
Adaptability	168
Theme 1 Context	168

Theme 2 Setting.....	175
Theme 3 Organizational attributes	182
Theme 4 Human resources.....	185
Theme 5 Provider factors	187
Theme 6 Recipient factors.....	189
Theme 7 Project Management processes.....	191
Theme 9 Embedding in communities	195
Scalability.....	196
Theme 1 Context.....	196
Theme 2 Setting.....	202
Theme 3 Organizational attributes	207
Theme 4 Human resources.....	210
Theme 5 Provider factors	214
Theme 6 Recipient factors.....	216
Theme 7 Project Management processes.....	218
Theme 9 Embedding in communities	222
Sustainability	224
Theme 1 Context.....	224
Theme 2 Setting.....	228
Theme 3 Organizational attributes	231
Theme 4 Human resources.....	233
Theme 6 Recipient factors.....	235
Theme 7 Project Management processes.....	237
Theme 8 Monitoring and supervision.....	240
Theme 9 Embedding in communities	245
5.3 The comparison of the influencing factors of the three concepts of ASaS.....	248
Theme 1 Context.....	248
Theme 2 Setting.....	248
Theme 3 Organizational attributes	249
Theme 4 Human resources.....	249
Theme 5 Provider factors	250
Theme 6 Recipient factors.....	250
Theme 7 Project Management processes.....	250
Theme 8 Monitoring and supervision.....	251
Theme 9 Embedding in communities	251
5.4 Summary.....	252
Chapter 6 Results from the Second Round of Delphi survey	252
Introduction.....	253
Expert Panel.....	255
6.1 Questionnaire Dissemination and Data Collection	257
6.2 Analysis of the Second Round of Delphi survey	258
6.3 Results.....	259
The degree of concentration of experts' comments	259
The degree of coordination of experts' comments	271

The modification of the influencing factors and themes	275
6.4 Summary	275
Chapter 7 The Results of the Third Round of Delphi survey	277
Introduction	277
Expert Panel	277
7.1 The Third Round of Delphi Questionnaire	280
7.2 Questionnaire Dissemination and Data Collection	281
7.3 Analysis of the Third Round of Delphi survey.....	281
7.4 Results.....	282
Influencing factors reaching the a priori consensus	283
Influencing factors not reaching the a priori consensus	294
Discarded influencing factors	301
7.5 Summary.....	311
Chapter 8 The Results of the Consensus Meeting.....	314
8.1 Introduction	314
Participants' information	315
8.2 Results from the Consensus Meeting	315
8.2.1 The discussion of the five influencing factors.....	316
8.2.2 The discussion of the nine themes	324
8.3 The Final themes and influencing factors	325
8.4 Summary.....	331
Chapter 9 Overall Delphi survey results	332
9.1 Introduction.....	332
9.2 Summary of the findings from the Delphi survey and consensus meeting.....	333
Linkages among factors in the Adaptability phase.....	338
Linkages among factors in the Scalability phase	343
Linkages among factors in the Sustainability phase.....	347
Differences and similarities in linkages between factors at different stages of the complex interventions process	349
9.3 Observations on the collected data	350
Changes in consensus rates.....	350
Assessment of inputs from experts from HICs and experts from LMICs	350
9.4 Summary.....	352
Chapter 10 The final framework	353
10.1 introduction to METRO framework	353
10.1.1 Introduction to the inner ring	358
10.1.2 Introduction to the outer ring	360
10.1.3 Order of Themes.....	361
10.1.4 The summary of the nine themes.....	362
10.2 A guide to using the METRO Framework.....	373
10.3 Summary.....	388
Chapter 11 Discussion	390
11.1 Summary of the framework.....	391
11.1.1 Non-linear Approach to Intervention Implementation.....	391

11.1.2 Comprehensive Integration of Influencing Factors	391
11.1.3 Emphasis on Stakeholder Relationships and Environment.....	392
11.1.4 Visual and Conceptual Clarity	392
11.1.5 Flexibility in Application	392
11.2 Comparison with other TMFs.....	393
Similarities	393
Differences.....	394
11.3 How this study will advance the implementation of complex health interventions in low- and middle-income countries	395
11.4 Who would use this framework?	397
11.5 What future research is needed?.....	398
11.6 Strengths and limitations	401
Strengths.....	401
Limitations	402
Chapter 12. Conclusion	407
The Contribution to Knowledge.....	409
Implications for practice.....	410
References	412
Appendix.....	435
Appendix 1: The BeHEMoTh search process	435
Appendix 2: The specific search terms and strategy of systematic review of TMFs	438
Appendix 3: The quality assessment of the included studies in the systematic review of TMFs	439
Appendix 4.....	452
Table 1: the basic information of included studies in theoretical systematic review	452
Table 2: The factors influencing the adaptability, scalability and sustainability of complex interventions in the included studies of theoretical systematic review	489
Table 3: the correlation between influencing factor mentioned in each included study and the three concepts of adaptability, scalability and sustainability	495
Appendix 5: Overview of frameworks and models used in the complex health interventions	507
Appendix 6: The search strategy of empirical systematic review	514
Appendix 7: Quality assessment form	516
Appendix 7a: CLEAR assessment form.....	516
Appendix 7b: Details of Quality Appraisal.....	519
Appendix 8.....	550
Table 1: the basic information of included studies in systematic review of empirical studies.....	550
Table 2: The factors influencing the adaptability, scalability and sustainability of complex interventions in the included studies of empirical systematic review.....	611
Table 3: the correlation between influencing factor mentioned in each included study and the three concepts of adaptability, scalability and sustainability	619
Appendix 9 The first round of Delphi survey questionnaire	642
Appendix 10 The second round of Delphi survey questionnaire	666

Appendix 11 The third round of Delphi survey questionnaire.....	706
Appendix 12 The results of the First round of Delphi survey.....	719
Appendix 13 The results of the second round of Delphi survey	724

Abbreviations

ASaS	Adaptability, scalability and sustainability
CDC	Centers for Disease Control and Prevention
CD	Communicable diseases
COM-B	Capability, Opportunity, Motivation and Behaviour
EBP	Evidence-based practice
EPIS framework	Exploration, Preparation, Implementation, Sustainment (EPIS) framework
LMICs	Low- and middle- income countries
MRC	Medical Research Council
NCDs	Non-communicable diseases
TMF	Theory, model and framework
USAID	The United States Agency for International Development

Abstract

Introduction: Complex health interventions are widely used in public health, clinical research, and education to tackle global health issues. Researchers and healthcare providers rely on theories, models, and frameworks (TMFs) to guide these interventions. However, there is a lack of a TMF specifically designed for low- and middle-income countries (LMICs). The factors influencing the adaptability, scalability, and sustainability (ASaS) are crucial but not comprehensively addressed in existing TMFs.

Objectives: This study aims to identify factors influencing ASaS in complex health interventions in LMICs and develop a theoretical framework to fill the research gap.

Method: The study began with a systematic review to gather ASaS factors from existing TMFs and practical implementations. A Delphi approach followed, using qualitative and quantitative methods across three rounds of Delphi questionnaire survey and consensus meeting. Sixty-two participants from diverse backgrounds, such as public health, hospitals, and NGOs, were recruited online through purposive sampling. Data were collected via structured questionnaires and consensus meetings and analyzed using SPSS for quantitative data and NVivo for qualitative data. The Prior consensus rate was not set for the first round due to the use of open-ended questions. For the second round, the prior consensus rate was set at 70%, and for the third round and the consensus meetings, it was set at 65%.

Results: The study identified nine themes (Project management processes; Context; Setting; Organizational attributes; Human resources; Primary stakeholders' factors; Secondary stakeholders' factors; Monitoring and supervision; Embedding in communities) and 51 factors influencing ASaS through systematic reviews and a Delphi survey, resulting in the preliminary Managing the Environment for Transferability, Relationships and Outcomes (METRO) framework.

Conclusion: The research presents the METRO framework for understanding ASaS factors in complex health interventions within LMICs, emphasizing context-specific strategies for successful implementation. This framework encapsulates findings from both literature and expert experience and would benefit from further, empirical validation within LMICs.

Acknowledgements

I would like to thank my supervisors, Professor Andrew Booth and Dr. Robert Akparibo, and also my pre-supervisor, Dr. Katie Sworn for their advice and support throughout my PhD. They gave me direction when I was confused and encouragement when I felt nervous or anxious.

I would also like to thank the experts involved in this PhD project. Their views and comments in the questionnaire and in the consensus conference are of great significance to this project.

I would like to give thanks to my supportive family. I am fortunate to have parents and my wife who have always supported me.

Finally, I would like to reiterate my thanks to all of you mentioned above again, without your continued help and support, I would not have been able to complete this accomplishment.

Chapter 1 Introduction

The field of health interventions has experienced substantial growth in recent years, emphasizing the creation of diverse strategies to combat various diseases[1]. This is particularly evident in low- and lower-middle-income countries (LMICs), where health interventions are often complex due to their multifaceted approaches[2]. These approaches typically include direct measures like vaccination, handwashing, and treatment adherence to control communicable diseases[2].

However, the effective translation of these strategies into actionable plans in LMICs presents a significant challenge[3]. These countries often grapple with limited economic resources, inadequate healthcare infrastructure, and a high dependency on external assistance, all of which complicate the implementation of complex health interventions[4].

To tackle these challenges, a growing number of complex intervention studies are now conducting process evaluations. The process evaluation assumes a pivotal role in shaping and executing intricate interventions by facilitating the evaluation of fidelity and the quality of intervention execution, elucidating the causal mechanisms involved, and pinpointing contextual factors linked to alterations in outcomes[5].

For example, if an intervention that was expected to be effective does not show positive results at the end of the study, it may be that the intervention itself is ineffective or it may be due to other study-related reasons, such as problems with the study design, problems with the implementation of the intervention, or failure to attract a sizeable enough target participants[6]. Through process evaluation, researchers can better analyze and understand the challenges encountered during the implementation of complex health interventions.

However, relying on researchers and practitioners to analyze and summarize each complex health intervention every time is highly time-consuming and labor-intensive.

This is especially burdensome for low- and middle-income countries (LMICs), where it significantly increases both economic and personnel costs. To alleviate this pressure, implementation science researchers have sought to design guidelines to provide researchers who are unfamiliar with the specifics of an intervention with an initial implementation plan, thought process, and key considerations.

In this context, many theories, models, and frameworks (TMFs) for complex health interventions have been developed and gained widespread recognition and application. For example, the Consolidated Framework for Implementation Research (CFIR) focuses on factors influencing the intervention process, and the Exploration, Preparation, Implementation, and Sustainment (EPIS) framework provides comprehensive guidance on both the processes and factors involved in implementing interventions[7, 8].

Against this backdrop, researchers and healthcare providers often rely on TMFs to guide their work such as CFIR framework[9] and RE-AIM framework[10] as these models can, to some extent, enable practitioners to make better use of the limited resources available to them and cope with the obstacles that may arise[11]. For example, Bergeron et al underscores the importance of economic evaluations in determining the most efficient ways to deploy limited resources for maximum health impact[12]. By applying TMFs to understand and evaluate the cost-effectiveness of different health interventions, practitioners can make informed decisions that improve the allocation of scarce resources[12].

Although many excellent theories, models, and frameworks (TMFs) have been designed and widely applied, the implementation of complex health interventions in LMICs still faces significant challenges. These difficulties may stem from the fact that most of the existing frameworks and measures for determining implementation factors and outcomes have originated in high-income nations[13]. Also, a study

indicated that although the number of frameworks related to program sustainability is increasing, these frameworks are rarely applied and evaluated in low- and middle-income countries or vulnerable communities within high-income countries. The primary reason for this phenomenon is the unique challenges faced by these countries and regions in terms of community and workplace capacities[14]. From the personal experience, the researcher encountered significant challenges while working on several community-based hypertension prevention and control projects in China. One major difficulty was the lack of suitable TMFs tailored to the local context. For instance, cultural factors led some patients to refuse medication, complicating the intervention efforts. This experience highlighted the critical need for a TMF that is specifically designed for LMICs. This realization has been a driving force behind pursuit of the researcher to develop a TMF that addresses these unique challenges.

Consequently, it cannot be assumed that these current TMFs are also suitable for resource-limited settings[15]. In other words, it is essential to assess the extent to which current TMFs address the complexities of health interventions comprehensively, particularly their adaptability across different countries with varying levels of resources and healthcare systems. This emphasizes the necessity of developing tailored guidelines that accurately reflect the adaptive needs of interventions in low- and middle-income countries, ensuring that the TMFs are relevant and effective in addressing the unique health challenges specific to these environments[16].

Implementation science experts have recognized the issue of limited availability of TMFs in low- and middle-income countries (LMICs). To address this problem, some researchers have made modifications and adaptations to existing mature TMFs to better suit the needs of LMICs. For example, the MRC framework underwent a significant update in 2021 to reflect new research and practice developments[17]. Also, the study of Means et al. have added 11 new concepts to the "Comprehensive Framework for Implementation Research," such as strategic policy adjustment,

perceived sustainability, and scalability[18]. These enhancements are designed to improve the framework's applicability in LMICs.

Furthermore, a systematic review aimed at evaluating and suggesting optimizations for the Consolidated Framework for Implementation Research (CFIR) highlighted its potential for enhanced utility in LMIC settings[18]. The limitations are (i) **Applicability and Scope of CFIR in LMICs**: The review discovered that although the majority of CFIR constructs were applicable in LMICs, the framework frequently extended beyond its initial scope, especially regarding the functionality of health systems in these regions. (ii) **Introduction of a New Domain - "Characteristics of Systems"**: To improve CFIR's relevance in LMIC contexts, the study recommended the introduction of a new domain, "Characteristics of Systems," which focuses on broader health system and geopolitical factors [14]. (iii) **Systemic Determinants and Customized Approaches**: This domain is designed to identify the systemic determinants that affect the scalability and sustainability of implementation in LMIC environments, advocating for a customized approach to meet the unique implementation challenges in such settings.

Consequently, based on the current literature review of the CFIR framework, it is clear that existing TMFs require adjustments when applied in LMICs[18].

These findings collectively suggest that while existing theoretical frameworks like CFIR, TDF, and NPT offer structured approaches to implementation research, their application in LMICs may require thoughtful adaptation and contextualization. Researchers and practitioners should consider local health systems, resource constraints, and cultural factors when applying these frameworks to ensure their interventions are both effective and sustainable in LMIC settings.

Despite the existence of a few TMFs designed for LMICs, these frameworks are often tailored to specific regions within LMICs. For instance, the IHI framework[19] is

specifically designed for Africa, and the Conceptual Framework of Sustainability of Interventions[20] is tailored for sub-Saharan Africa. There is a notable absence of a TMF that is broadly applicable across all LMICs.

All these findings support that policymakers and practitioners implementing health interventions in LMICs may face some difficulties in utilizing TMFs, as the existing TMFs may not be fully applicable to the specific contexts and needs of these countries.

Therefore, this study aims to reduce the time, resources, and financial costs required by researchers or practitioners to adapt these models and frameworks by providing a customized framework specifically designed for the LMIC context.

1.1 Chapter Overview

In this section, a brief introduction will be given to the background of this study, which includes the definition of complex interventions, the concept of the theoretical theories, models, and frameworks (TMFs) for complex interventions, the current definition of adaptability, scalability and sustainability (ASaS), and the purpose of this study.

1.2 Background

Overall, this thesis focuses on the factors that influence the adaptability, scalability and sustainability of complex interventions. Conventionally

“complex interventions defined as interventions with several interacting components, they present a number of special problems for evaluators, in addition to the practical and methodological difficulties that any successful evaluation must overcome”[21].

Complex interventions are increasingly recognized for their utility in addressing multifaceted challenges across diverse fields, each characterized by its unique complexities and requiring tailored approaches.

In healthcare and public health, Craig et al. emphasize the design, evaluation, and implementation of complex interventions to enhance health outcomes and mitigate disease spread[22]. Education sees such interventions blending pedagogical strategies, curriculum development, and technological integration to meet diverse learning needs, as explored by Reed et al. highlight the role of complex interventions in environmental conservation, focusing on stakeholder engagement and adaptive management[23]. In the realm of agriculture and food systems, Klerkx et al. advocate for systemic approaches that facilitate the co-evolution of technology, practices, and institutional frameworks[24]. Murray et al. delve into technology and digital health, discussing the transformative potential of digital health interventions for healthcare delivery[25]. Lastly, in urban planning and development, McCann and Ward address the transference of policy and planning ideas, underscoring the need for adaptation to local conditions[26].

The introduction of the evaluation framework by the Medical Research Council (MRC) in 2000 marked a significant milestone in the field of public health[17]. This framework provided a structured approach to designing and implementing complex health interventions, facilitating their widespread adoption in public health, clinical research, and education to reduce the global health burden[27].

Based on the sequential process outlined in the MRC framework, the implementation of a complex health intervention typically progresses through several stages including develop intervention/identify intervention, feasibility, evaluation, and implementation. In addition, the framework identifies some core factors that are essential to influence the success of these processes including consider context, develop, refine, and (re)test

programme theory, engage stakeholders, identify key uncertainties, refine intervention, and economic considerations[17]. Both the MRC framework and some mature TMFs such as previous mentioned EPIS framework and CFIR framework frequently highlight three key concepts during these stages: adaptability, scalability, and sustainability. Adaptability is often emphasized in the early stages of the intervention, while scalability and sustainability become more prominent in the later stages.

For example, the Exploration, Preparation, Implementation, Sustainment (EPIS) framework provides a relatively comprehensive and detailed description of the implementation process for complex health interventions[28]. It delineates four clearly defined stages that are in sync with and provide guidance for the implementation process. These stages encompass the identification of various levels within both the outer system and inner organizational contexts. They also encompass bridging and innovation factors that revolve around the interaction between these external and internal contexts and the innovation or practice being put into action.[28]

During the Exploration phase, diverse stakeholders contemplate the emerging or pre-existing health needs of the target groups. They strive to pinpoint the most suitable Evidence-Based Practices (EBP) to address these needs. Subsequently, they make a determination regarding the adoption of the identified EBP.

In the Preparation phase, the primary goals involve recognizing potential barriers and facilitators to implementation within the external and internal contexts. Further assessment of the necessity for adaptation is carried out, along with the development of a comprehensive plan to leverage implementation facilitators and address potential barriers.

The Implementation phase marks the initiation of EBP usage within the system and/or organization(s).

Finally, in the Sustainment phase, the structures, processes, and support systems in both the outer and inner contexts are sustained. This is done to ensure the continued delivery of the EBP, whether with or without some modifications, in order to realize the resultant public health impact of the implemented EBP.

More importantly, a study conducted by Sarma [29] describes how the process of implementing complex interventions can be divided into three domains including: evidence efficacy to effectiveness trial, scaling-up, sustainability. In the initial phase of the study, researchers aim to understand how the intervention can be adapted, improved or reinvented to meet local circumstance and needs[8]. If a complex intervention is shown to be 'effective', it is then considered in a larger context and enters a phase of scaling up. When the intervention is shown to be effective in this larger context, it has the ability to be sustained in a real-world practice setting[29]. Therefore, these three concepts—adaptability, scalability, and sustainability—are identified as critical in this study due to their integral role throughout the entire implementation process of complex health interventions.

- **The definition of adaptability**

Adaptability in health research is reflected in diverse levels[8]. Several studies highlight the importance of culture in their definitions of adaptability. For example, Teal and Street [30] define the concept as follows:

“Adaptability in health care means being skilled at integrating a patient's cultural values or beliefs into any encounter with the awareness and ability to adapt behaviours to maximize the patient’s comfort, reconcile misunderstandings, and be responsive to the patient’s needs”.

Weller et al, 2011[31] define adaptability as

“Adaptability means there will be sufficient cooperation and communication to minimise the risk of harm to the patient.”

Furthermore, Hamel, C.,[32] provides a more detailed definition showing below:

“Adaptation is conceived as the process of making a program fit a specific context or setting either by modifying it (for instance by reordering, delaying, or emphasizing components), changing the manner or intensity of delivering the program components, or adapting the program to cultural or language sensibilities. The degree to which an intervention can be adapted, tailored, refined, or reinvented to meet local needs. “

Among the definitions of adaptability mentioned above, Hamel, C.'s explanation is particularly notable for its comprehensiveness and relevance to the specific challenges faced in the implementation of complex health interventions. Consequently, this study adopts Hamel's definition as the definition of adaptability.

- **The definition of scalability**

Similarly, diverse definitions were cited for the concept of scalability.

Scalability is defined by the World Health Organisation (WHO) as

“deliberate efforts to increase the impact of health service innovations successfully tested in pilot or experimental projects so as to benefit more people and to foster policy and programme development on a lasting basis”[33]

In the study of Waddington,[34] scaling up is defined as “doing something in a big way to improve some aspect of a population’s health” in the health sector.

Also, Milat, A.J. developed the initial definition of ‘scalability’, which is shown below:

“The ability of a health intervention shown to be efficacious on a small scale and

or under controlled conditions to be expanded under real world conditions to reach a greater proportion of the eligible population, while retaining effectiveness” [35].

Among the definitions of scalability mentioned above, Milat, A.J. has provided a clear and comprehensive definition of scalability, therefore, this study adopts it.

- **The definition of Sustainability**

Scheirer and Dearing[36] defined sustainability as the

“continued use of intervention components and activities for the continued achievement of desirable health outcomes within the population of interest.”

Also, the United States Agency for International Development (USAID) defined sustainability as

“the capacity to maintain program services at a level that will provide ongoing prevention and treatment for a health problem after termination of major financial, managerial and technical assistance from an external donor” [37].

Additionally, Shediak-Rizkallah and Bone[38] conceptualised sustainability broadly as “the maintenance of health benefits over time”. Specifically, Shediak-Rizkallah and Bone[38] developed one widely accepted definition, which described sustainability across three components:

“(1) continued benefits to those who received health services when the program started and to new participants when the supporting funds are discontinued; (2) continued implementation of a program activities in an organization following the discontinuation of the program financial support; and (3) community empowerment to improve their health by continuing the activities of a finished program. Together, these measures, they argue, allow one to plan for “what is to be sustained, how or by whom, how much and by when”

Among the definitions of sustainability mentioned above, this study adopts USAID's definition since it is clear and concise.

The definitions of LMICs and ASaS is shown in Table 1.

Table 1: The definitions of key concepts in this study

Concepts	Definitions
Adaptability	“Adaptation is conceived as the process of making a program fit a specific context or setting either by modifying it (for instance by reordering, delaying, or emphasizing components), changing the manner or intensity of delivering the program components, or adapting the program to cultural or language sensibilities. The degree to which an intervention can be adapted, tailored, refined, or reinvented to meet local needs.” [32]
Complex interventions	“complex interventions defined as interventions with several interacting components, they present a number of special problems for evaluators, in addition to the practical and methodological difficulties that any successful evaluation must overcome”[21].
Low- and middle-income countries	“Based on the World Bank Atlas method, as for the current 2022 fiscal year, low-income economics are defined as those with a GNI per capita of \$1,045 or less in 2020; lower middle-income economics are those with a GNI per capita between \$1,046 and \$4,095; upper middle-income economics are those with a GNI per capita between \$4,096 and \$12,695”[39]
Scalability	“The ability of a health intervention shown to be efficacious on a small scale and or under controlled conditions to be expanded under real world conditions to reach a greater proportion of the eligible population, while retaining effectiveness”[35].
Sustainability	“the capacity to maintain program services at a level that will provide ongoing prevention and treatment for a health problem after

	termination of major financial, managerial and technical assistance from an external donor”[37].

Note: (1) While arriving at a definition of each of these concepts was one objective of the subsequent literature review work tentative definitions are presented in advance to orientate the reader to the three concepts

(2) References: definition of LMICs[39]; definition of adaptability[32]; definition of scalability[35]; definition of sustainability[37]

However, to date, no studies have been found to explore the influencing factors of all the three concepts, ASaS, of complex interventions, although several studies have been conducted to explore the influencing factors of one or two concepts of these three.

However, as mentioned in the section 1.1, most of these frameworks are generic frameworks rather than customized frameworks for LMICs. The requirement for researchers to dedicate significant time and effort to adapt existing theories, models and frameworks (TMFs) for use in low- and middle-income countries (LMICs) highlights a critical gap in the current research infrastructure. Consequently, the development of a TMF specifically tailored for LMIC contexts and concerned with ASaS would enable researchers to allocate less time and resources to making these adaptations. This approach suggests a strategic shift towards creating TMFs that inherently accommodate the unique challenges and resource constraints of LMICs, thereby streamlining the research process and enhancing the efficiency and effectiveness of health interventions in these settings.

Consequently, the overall aim of the first year was to conduct one theoretical review and a further empirical systematic review to explore the influencing factors concerned with ASaS in complex health interventions and to explore the relationships among these factors.

1.3 Research Context

The main area of this research is complex health interventions, which is a subfield of implementation science. To date, there is no consensus upon the definition of implementation in health care research. The concepts 'implementation', 'diffusion', 'adoption', 'embedding', and 'normalization', which express similar meanings and are often used interchangeably[40, 41]. Typically, implementation is defined as

“efforts or activities planned to apply (new or changes to) practices in a specific setting. The implementation process involves all activities that occur between making a decision to adopt and the time that an intervention becomes part of the organisational routine, ceases to be new or is abandoned.”[42]

Furthermore, the process of implementing an intervention is frequently

“characterised as an active, dynamic, iterative, multifaceted and complex process.”[43].

Furthermore, the situation in LMICs is more complex compared to countries with HICs[44]. Specifically, compared to HICs, LMICs are more likely to encounter diverse health challenges such as infectious diseases, chronic diseases, malnutrition, maternal and child health, mental health issues, etc.[44-46]. These challenges require comprehensive interventions to address different populations and health needs.

In addition, LMICs often suffer from significant health inequalities, with a large proportion of the population not having access to adequate health services. And, LMICs typically have higher population densities, while healthcare facilities, human resources, and financial resources are often inadequate compared to HICs. These

issues call for more complex and integrated health interventions to provide more comprehensive, effective and sustainable health services that contribute to improving people's quality of life and health status. Therefore, a framework designed for LMICs is becoming increasingly important in low- and middle-income countries.

Based on several well-developed and validated TMFs, the three core concepts ASaS (adaptability, scalability and sustainability) are found to be widely used as core components in these TMFs. For example, the MRC framework mentioned the concept of adaptability in the 'develop intervention' and 'identify intervention' phases, and mentioned the concepts of scalability and sustainability in the "implementation" phase.

Also, in terms of EPIS framework[28], it mentioned the concept of adaptability in the Exploration phase, and mentioned the concepts of scalability and sustainability in the Implementation phase and Sustainment phase respectively. Consequently, this study focuses on the exploration of the influencing factors of ASaS of complex health intervention in LMICs, and aims to provide a framework that will include these three important components within a single framework that is particularly sensitive to issues encountered by LMICs, informed by these with contextual knowledge and experience.

In order to meet these gaps, as a result, the initial phase of this PhD project involves a comprehensive systematic review of the existing TMFs in health interventions (Chapter 2). Specifically, this review aims to collate factors mentioned within TMFs that influence any of the three core concepts of adaptability, scalability, and sustainability (ASaS). This step will assess the current applicability and feasibility of these TMFs within LMICs, identifying specific gaps this research seeks to address. By evaluating how these frameworks account for factors affecting ASaS, the review will

highlight areas where existing TMFs may fall short in LMIC contexts, guiding the development of more suitable frameworks.

The second task of this project extends to a systematic review of existing empirical studies. This is undertaken with the objective of further exploring factors that impact the concepts of ASaS within the actual process of health interventions. By examining empirical evidence, this task aims to uncover how these ASaS factors manifest and influence health interventions in real-world settings, particularly within LMICs. This empirical exploration provides a deeper understanding of the practical challenges and opportunities for enhancing adaptability, scalability, and sustainability in health interventions, directly informing the development of a refined or novel TMF tailored for LMICs. The third task is to conduct a Delphi survey and consensus meeting to collect the data, and further to develop a framework to meet the gaps identified from the previous Chapters.

1.4 Structure of the thesis

Chapter 1 provides the background of this thesis and the rational of conducting this thesis. It mainly focuses on the definition and development of complex interventions, along with the current definitions of adaptability, scalability and sustainability (ASaS).

Chapter 2 present findings of a systematic review of the TMFs. The aim of this section is to systematically review the TMFs of ASaS of complex interventions along with the influencing factors of ASaS in the LMICs. The analysis of previous theoretical TMFs and the strengths and weaknesses of previous studies help this study to select the appropriate research methodology and assist this study to explore the influencing factors of ASaS of complex interventions and the development of subsequent theoretical TMF.

Chapter 3 presents the findings of a systematic review, which explores influencing factors of complex and further verifying the influencing factors mentioned in the theoretical systematic review.

Chapter 4 describes the research methodology and methods, including the Delphi approach adopted.

Chapter 5 presents the findings of the first round of the Delphi survey.

Chapter 6 presents the findings of the second round of the Delphi survey.

Chapter 7 presents the findings of the third round of the Delphi survey.

Chapter 8 presents the findings of the consensus meeting.

Chapter 9 summarizes the overall findings of the Delphi survey.

Chapter 10 provides the guidance of the how to use METRO framework.

Chapter 11 presents a general discussion of this study. Including the summary of the METRO framework, the comparison with other TMFs, how this study will be used in the future, and the strengths and limitations of this study.

Chapter 12 summarises the preceding chapters and contains recommendations for future research in this area.

1.5 Aims and objectives

This study has two main aims:

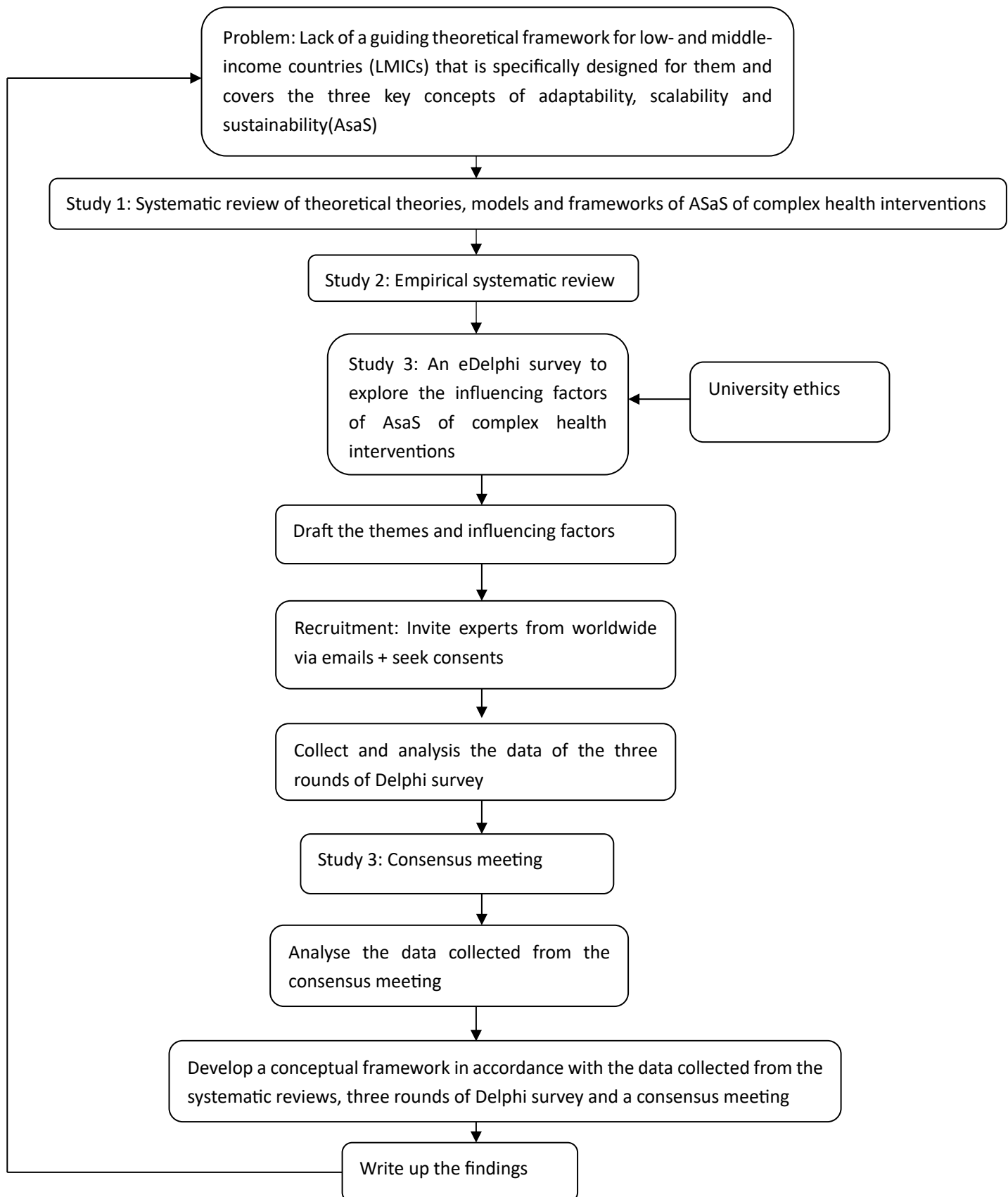
- To explore the common influencing factors of three core concepts, namely adaptability, scalability and sustainability, in relation to complex health interventions in LMICs.
- To develop a framework describing the factors influencing of the ASaS for guiding complex health interventions in LMICs.

Research aims are developed to address the gaps identified in the systematic review present in chapter 2 and 3.

In order to achieve the aims, the following objectives are set:

1. To analyse and define adaptability, scalability and sustainability (ASaS) in the context of complex interventions;
2. To explore the factors influencing adaptability, scalability and sustainability of complex health interventions in LMICs;
3. To explore the relationships among the factors influencing the adaptability, scalability and sustainability of complex health interventions in LMICs;
4. To develop a framework covering the factors influencing adaptability, scalability and sustainability of complex health interventions in LMICs.

The overall design of the PhD study is shown in the Figure 1 below.

Figure 1 Overall design of the PhD study

1.6 Summary

In summary, this project explores the factors influencing the ASaS of complex health interventions in LMICs and further develop a framework to describe these factors. In the next two chapters, they will respectively describes the collection of results of TMFs of ASaS of complex interventions along with the influencing factors of ASaS in the LMICs, and the results of characteristics of influencing factors of ASaS of complex interventions from the perspective of empirical research.

Chapter 2 Systematic review of theoretical theories, models and frameworks of ASaS of complex health interventions

This chapter systematically reviewed the theories, models, and frameworks (TMFs) of adaptability, scalability and sustainability (ASaS) of complex interventions along with the influencing factors of ASaS in the Low- and Middle-income Countries (LMICs).

2.1 Introduction

Theories, models and frameworks are used extensively to advance the science of implementation of complex health interventions (CHIs) [47-49], to guide the design and implementation of complex interventions, and to help in assessing their quality. The resultant models can also be used to elucidate causal mechanisms between influencing factors and to identify contextual factors associated with changes in outcomes [47, 48, 50]. In turn, TMFs offer a lens for the exploration of the complex fields of public health, health policy and social care [47].

To date, no literature has sought to collate and review common features of included TMFs across all three ASaS components or to document differences between component models.

Generally, a theory is defined as:

“a set of inter-related concepts, definitions and propositions that present a systematic view of events or situations by specifying relations among variables, to explain and predict the events or situations[51, 52].

Simply put, theories, are closely related to models[53]. Specially, theories are characterized as combining the explanatory alongside the descriptive, and models are defined as theories with a narrowly defined scope of explanation [52]. A framework is described as

“a structure, overview, outline, system or plan consisting of various descriptive

categories including concepts, constructs or variables, and the relations between them that are presumed to account for a phenomenon” [52, 54].

Compared with theories and models, frameworks do not seek to be explanatory; rather than *describe* the internal relationships of concepts, they simply *present* the concepts[52]. However, despite some diverse characteristics, the terms “theory”, “model” and “framework” (TMF) are frequently used interchangeably in relation to CHIs.

Consequently, the aim of this review is to conduct a systematic review of theoretical frameworks concerned with at least one of the three concepts of ASaS (adaptability, scalability and sustainability), to deconstruct the constituent theories, and then to analyse the influencing factors within these conceptions. Justification for this approach recognizes two perspectives: (i) This study collected the factors influencing all three concepts of adaptability, scalability, and sustainability (ASaS). The reason is that TMFs represent diverse contexts and levels; some TMFs are developed for the whole world and others are designed for some specific areas within LMICs such as the previously mentioned IHI framework[19] and the Conceptual Framework of Sustainability of Interventions[20], with influencing factors that differ across regions such as differences in culture. Identifying and summarizing these diverse factors was critical to the subsequent Delphi questionnaire to ensure that a comprehensive list of influences could be provided for expert assessment and reference (ii) the methodologies of included studies play a positive role in shaping subsequent primary studies. During the construction process of TMFs, some included studies used a systematic review approach to gather information and qualitative methods (e.g., in-depth interviews) to collect relevant influencing factors and opinions on model construction. These methods are important inspiration and guidance for subsequent model construction.

Specifically, the objectives of this review are:

1. To explore definitions of adaptability, scalability, and sustainability.
2. To identify the factors listed in the published studies
3. To identify published theoretical studies concerned with at least one of the concepts of sustainability, scalability and adaptability of complex health intervention-related frameworks and to assemble and explore relevant models and frameworks;
4. To explore inter-relationships between factors influencing scalability, adaptability, and sustainability of the complex health interventions;
5. To appraise the methodological quality and reporting quality of the included literature.

Search Strategy

Systematic review methods were employed to collect TMFs. Specifically, the BeHEMoTh procedure (named as a mnemonic from the component elements Behaviour of Interest, Health context, Exclusions and Models or Theories) was used as a systematic approach by which to collect theoretical frameworks[47]. The BeHEMoTh procedure offers auditability and transparency when identifying published TMFs. Specific features of the BeHEMoTh search process are attached in Additional file 1. The search begins with a structured BeHEMoTh question. First, the researcher reviewed TMFs identified from a initial search in order to construct a systematic search procedure for retrieving ASaS related TMFs via Google Scholar [Step 1a]. In addition with Google scholar, four more databases, PubMed, MEDLINE, CINAHL and Web of Science, were systematically searched using the same search strategy, in a process similar to a conventional systematic review search [step 1b]. Titles and abstracts were screened for TMFs using a spreadsheet with each additional instance being added to a pre-identified list of TMFs generated in step 1 [step 2]. TMFs retrieved from step 2, together with those found through scoping via Google Scholar [step 3]. Searching of

source references for these TMFs was used to reveal cited studies of the first ten pages [step 4a and step 4b].

2.2 Method

Search terms

Search terms across the four databases and Google Scholar were organized within five search term groups including the three ASaS concepts (1. Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion; 2. Adaptable OR Adaptability OR Replicability* OR Fidelity* OR Adoption; 3. Scalability OR Scalable OR Scaling up OR Scale out OR expansion), complex interventions (4. complex NEAR3 intervention* OR complex NEAR3 treatment* OR complex NEAR3 training OR complex NEAR3 system* OR adaptive system); and terms relating to theories (5. Theor* OR models* OR Framework* OR Heuristic* OR Lens OR Paradigm*). For specific search terms and strategy see Appendix 2. Design of the search strategy, in searching for the ASaS concepts individually rather than for their intersect, recognises that not all TMFs involve all three factors of ASaS with many involving one or two factors.

Inclusion and exclusion criteria

Identified publications were imported to Endnote 9 software and duplicates were deleted. Specific inclusion criteria for factors that influence ASaS of CHIs are shown in Table 2.

Table 2: Eligibility criteria:

	Inclusion Criteria	Exclusion criteria
Intervention type	Studies relate to implementation or implementation science or complex health interventions including at least one model or framework	Studies do not relate to implementation or implementation science or complex health interventions
Publication type	- Reviews - Books - Journal articles - Gray literature	- editorials - commentaries - poster presentations - protocol papers
Study type	- conceptual papers - theoretical papers - reviews - concept analysis - Case study - Qualitative study evaluation with conceptual elements - Quantitative study evaluation with conceptual elements - Method papers	- Qualitative study or evaluation without conceptual elements - Quantitative study or evaluation without conceptual elements
Types of models and frameworks	significantly modified or updated an older framework;	- statistical models - disease models

	inductive formulation of a new framework from two or more older frameworks;	reports of an existing framework without modification
Discipline	Health or health related education or international development or health-related social services	None human science
Study outcomes	No limitation	
Publication dates	Subsequent to first MRC guideline on complex interventions (2000)	
Publication language	English	Not English

Data extraction and appraisal

The titles and abstracts were screened, and the full text papers of potentially relevant studies were obtained. Subsequently, the researcher independently assessed all full text papers for eligibility. An initial data extraction form was modified and adopted after revision. A single researcher independently extracted: (1) Study identification: year of publication, authors, name of study and name of the theories, models and frameworks; (2) Methods: study design, and study context; (3) any TMFs used; (4) Purpose of the theories, models, and framework; (5) Theories, models, and frameworks: definition, conceptual model, framework; (6) factors influencing ASaS of CHIs and inter-relationships between these concepts. These tables are shown in Additional file 3.

Quality Assessment

Quality assessment criteria for assessing reports of TMFs are not common. Only three papers were identified that either develop or utilize criteria for assessing theories [55-57] These papers were used to compile a set of quality assessment criteria as shown below:

- 1) Is the methodology identified and justified?
- 2) Was a theoretical lens or perspective used to guide the study, with a reference provided?
- 3) Is the theory, model, or framework described?
- 4) Is the theory, model, or framework easily linked with the problem?
- 5) If a theory, model, or framework is used, are the concepts adequately defined?
- 6) Are the relationships among concepts clearly identified?
- 7) Are the influencing factors of concepts clearly identified?
- 8) Are the relationships among influencing factors clearly described?

Quality assessments were undertaken by a single reviewer, quality assessment judgements are reported in Appendix 3.

Analysis

Given that the literature relating to TMFs derives from multiple disciplines, the researcher decided to use a narrative synthesis approach, which allows for synthesis of diverse types, designs and contexts for studies [58-60].

First, collected TMFs were categorized against a pre-existing classification: (1) Process models; (2) Determinant frameworks; (3) Classic theories; (4) Implementation theories; (5) Evaluation frameworks [52] (Table 3).

Table 3: Classification of Models used in Implementation Science

Type of model	Description	Example(s)
(1) Process models;	Operationalize steps followed when embedding evidence-based practice. Represent idealised step-by-step, sequential, and linear interpretation of implementation and typically depict each developer's experience from implementing projects	Stetler Model[61] and Iowa Model[62]). Knowledge-to-action Framework [63]/ Quality Implementation Framework [64]
(2) Determinant frameworks;	Typically describe variables associated with implementation outcome. Generally, do not depict causal relationships. Operate at multiple levels: individuals, institutions, etc. In development process, they are based on implementation barriers and contributing factors identified from original research. Additionally, they partially incorporate each developer's implementation experience [65]. Some aggregate multiple frameworks [8, 66].	(Cochrane et al., 2007[67])
(3) Classic theories;	Borrowed by implementation science from classical theories from psychology, sociology and organisational science. Essentially, 'passive' - primarily explain, rather than guide, occurrence of change.	Include organizational theory[68], behavioural theories[69], and diffusion of innovation[70].
(4) Implementation	Adapted from classical theories,	COM-B (Capability,

theories;	specifically for implementation	Opportunity, Motivation and Behaviour) [71] and Normalization Process Theory[72]).
(5) Evaluation frameworks	Developed specifically to inform evaluation of outcomes from complex interventions.	RE-AIM [73] and PRECEDE-PROCEED model[74]

To effectively analyze the factors influencing the adaptability, scalability, and sustainability (ASaS) of complex health interventions (CHIs), this review integrates insights from multiple frameworks. Initially, the EPIS (Exploration, Preparation, Implementation, Sustainment) model was utilized, categorizing influencing factors into four key dimensions: Outer Context, Inner Context, Intervention Characteristics, and Bridging Factors. However, a more comprehensive understanding was needed, as the EPIS model alone did not fully capture the complexity of these factors.

To address this, features from the CFIR (Consolidated Framework for Implementation Research) and insights from the NASSS (Non-adoption, Abandonment, Scale-up, Spread, and Sustainability) framework and the Dynamic Sustainability Framework (DSF) were integrated. This meta-model enhancement involves expanding the descriptions within each EPIS dimension to cover additional critical elements found in these other frameworks.

Specifically, within the Inner Context, the organizational characteristics were elaborated to reflect deeper organizational dynamics affecting CHIs. In the Outer Context, the Sociopolitical Context was added, acknowledging its crucial influence on intervention outcomes. Further, the Intervention Characteristics were detailed more extensively to capture the nuanced nature of the interventions themselves.

This enriched model aims to provide a robust analytical framework that better reflects the complex interplay of factors influencing the ASaS of CHIs. By adopting this meta-model, the study offers a comprehensive theoretical foundation that underpins the examination of these complex interventions, paving the way for more targeted and effective implementation strategies in diverse settings.

2.3 Results

Characteristics of included studies

The flowchart of the search results (Fig. 2) shows that the search identified 9763 studies. Following removal of duplicates and application of eligibility criteria, only 37 papers remained for inclusion in the review. 25 studies provide generic TMFs that are not specific to whether they are used in HICs or LMICs [8, 10, 28, 29, 33, 36, 57, 68, 73, 75-90] worldwide. A further seven included TMFs [91-97] that were developed for high-income countries and only 5 studies [19, 20, 98-100] were designed for LMICs.

The basic information of included studies is shown in the Appendix 4

The result of the quality assessment of the included studies

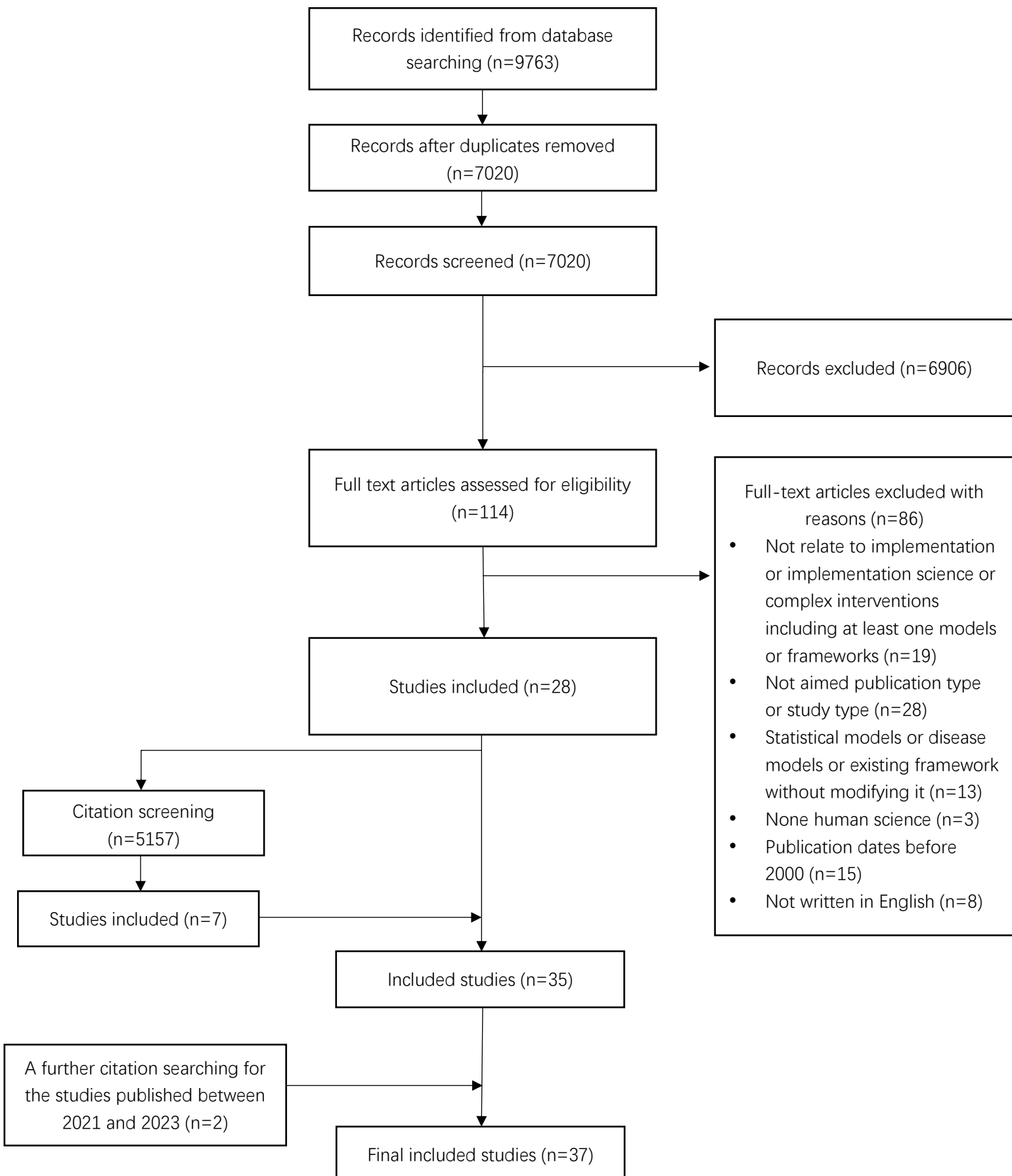
The evaluation of the implementation science frameworks utilized in the reviewed studies reveals a high level of methodological rigor and theoretical coherence. Each study meticulously identified and justified their methodologies, ensuring a robust foundation for their research. The use of theoretical lenses to guide the studies, accompanied by appropriate references, anchors the research in established theoretical traditions, thereby enhancing its credibility.

The theoretical frameworks were consistently well described and directly linked to the research problems, ensuring their relevance and practical utility. Additionally, the

concepts within these frameworks were clearly defined, which is essential for accurate interpretation and application of the research findings. The relationships among concepts were also clearly identified, facilitating a deeper understanding of the interactions and influences within the frameworks.

However, some gaps were noted in the identification and description of influencing factors and their interrelationships. While the majority of studies addressed these aspects comprehensively, a few studies did not fully elaborate on the influencing factors or their interconnections. Addressing these gaps in future research will further enhance the robustness and applicability of implementation science frameworks, particularly in the context of low- and middle-income countries where unique challenges and dynamics exist.

Overall, the quality assessment indicates a strong foundation in the reviewed studies, with opportunities for further refinement in understanding and describing the complexities of influencing factors and their relationships within implementation science frameworks.

Figure 2: PRISMA diagram of article selection

Theories, models and frameworks (TMFs) used

Categorising these according to the five categories of Per Nilsen's schema (Table 3) reveals that 14 of the 37 TMFs are process models, 13 are determinant frameworks, one is classic theory, one is implementation theory, and eight are evaluation frameworks (See Appendix 5).

Adaptability, scalability and sustainability definitions and outcomes reported

All 37 included studies reported at least two out of the three concepts of ASaS, and the specific concepts involved in each study. Of the 37 studies, 12 studies [8, 28, 33, 36, 68, 75, 86, 92, 99-102] mentioned all these three concepts.

• Adaptability

22 of the 37 included studies mention adaptability using such terminology as adaptability, adaptation, local adaptation, adapting, complex adaptive system, and feasibility. Definitions of adaptability mainly emphasize adaptation of interventions to fit with the local context and population[103].

• Scalability

27 studies described scalability using the terminology of scalable, scale up, diffusion, dissemination, spread, expanding. Key to scalability is the idea of expanding implementation of CHIs to reach a wider target population[75].

• Sustainability

29 of 37 studies mentioned sustainability with terminology relating to sustaining, sustainable, sustainability, normalization, sustainably, sustainment, and maintenance. Sustainability describes “a situation in which the delivery of an intervention and the behavior change implied can be maintained over time, with intended benefits being achieved continuously and adaptations conducted as relevant”.[103]

Implementation and the relationship between adaptability, scalability and sustainability

Diverse TMFs support authors frequently seek to demonstrate a relationship between the three ASaS concepts and the implementation process. Of the included TMFs, 27 TMFs explicitly mention whole process of implementation of CHIs; while the remaining ten do not emphasize the whole process of intervention implementation. The terminology used to describe the process of CHIs development varied. According to the EPIS model [28, 91], the pathway of a CHI is divided into four phases: exploration, preparation, implementation, and sustainment. During exploration and preparation, adaptability is important in determining whether the CHI can be conducted effectively with affordable cost[29].

Sarma's framework[29] describes three domains: i: evidence – efficacy to effectiveness; ii: Scaling-up; iii: sustainability. Domain i comprises intervention sources, evidence strength and quality, relative advantages, adaptability and complexity. Therefore, this framework suggests that implementation of a complex intervention requires validation of its effectiveness and adaptability, followed by scaling-up, and subsequent sustainability, with the process being non-linear.

Moreover, the MRC framework[88] describes the four phases of development, feasibility and piloting, evaluation, and implementation. The first three steps require that the implementation team identify/develop a framework, conduct a pilot study and evaluate effectiveness and cost effectiveness. One cited reason is to explore the adaptability of the target intervention. The implementation phase then emphasizes the vital role of dissemination and long-term follow-up.

To delve deeper into the influencing factors mentioned in the literature, this study initially adopted the EPIS framework to systematically categorize and summarize these factors. The EPIS framework divides influencing factors into four dimensions: Outer Context, Inner Context, Intervention Characteristics, and Bridging Factors. Building on the foundation of the EPIS framework, this research further elaborated on certain factors. Specifically, in the dimension of Inner Context, the description of Organizational Characteristics was expanded. In the dimension of Outer Context, an important factor, the Sociopolitical Context, was added. Moreover, this study also provided a more detailed explanation of Intervention Characteristics. This approach aims to understand the various factors

affecting implementation outcomes more comprehensively through meticulous analysis, thereby providing a solid theoretical foundation for subsequent research.

Despite the fact that these 37 TMFs (Theories, Models, and Frameworks) are related to at least one or two ASaS (Assessment, Support, and Sustainability) concepts, the influencing factors collected are relevant to all three ASaS aspects. This is because these factors are mentioned across various TMFs. To be specific, if a factor is mentioned in different TMFs, and these TMFs collectively address all three concepts of Adaptability, Scalability, and Sustainability (ASaS), then this factor will be considered as related to all three ASaS concepts and will be included as an influencing factor for ASaS. The influencing factors of ASaS of CHI obtained from this review are shown in the Table 4

Table 4. The influencing factors of adaptability, scalability and sustainability of complex interventions

Outer Context	Inner Context
• Sociopolitical context • Ethical • Legislation • Norms or regulations • Policies • Religion • Interorganizational Networks • Funding • Client Advocacy • Leadership	• Organizational characteristics • Absorptive capacity • Organization readiness • Structure • Values or visions • Working environment • Tension for change • Organization culture • Credibility and reputation • Structure • Readiness for change • Absorptive capacity • Individual adopter or provider characteristics • Ability or capacity • Race

	• Spoken language • Training or education • Views • Tension for change • Individual culture • Leadership • Staffing • Supervision, monitoring and evaluation
Intervention characteristics • Physical environment • Access to resources • Project champions • Stakeholder Involvement • Communication among healthcare workers and participants • Advanced support systems or tools • Technology advance or environment • Geographical factors • Time-cost	Bridging factors • Community function • Purveyors/Intermediaries

72

73 Of the collected TMFs, the EPIS (Exploration, Preparation, Implementation, Sustainment) model and
74 CFIR framework particularly emphasize the influencing factors of complex interventions. Therefore, it
75 seems appropriate to use a meta-model with the EPIS framework as the key guidance, complemented
76 by the CFIR framework, to demonstrate factors that influence the ASaS of CHIs. However, the EPIS
77 framework mainly categorizes the influencing factors into outer context, inner context, intervention
78 characteristics, and bridging factors, but does not elaborate on links between these factors and ASaS.
79 In addition, the EPIS framework does not fully cover the totality of influencing factors found across
80 such frameworks as CFIR, NASSS framework, and the dynamic sustainability framework (DSF).
81 Therefore, the EPIS framework was revised to meet the requirements of this study.

82

83 The four categories: outer context, inner context, intervention characteristics, and bridging factors.
 84 Basically, outer context refers to the external factors that influence the implementation of an
 85 intervention such as policy, funding, community norms, and socio-political context. The inner context
 86 pertains to the internal environment of the organization where the intervention is being implemented
 87 such as organizational culture, leadership, staff attitudes, and available resources. Intervention
 88 Characteristics focuses on the features of the intervention itself. Bridging factors refer to the processes
 89 and mechanisms that link the outer and inner contexts. Influencing factors within these four
 90 categories are not entirely independent. While some factors may, in some cases, relate predominantly
 91 to one or two of the ASaS concepts, all factors are interrelated, interacting and, ultimately, influence
 92 implementation of CHIs.

93

94 **Outer context**

95 **Sociopolitical context**

96 18 studies demonstrate how sociopolitical factors influence ASaS of complex interventions [33, 68, 78,
 97 80, 82, 85, 87, 89-95, 98-100, 104], and further impact health status and close persistent gaps in health
 98 care[105]. Sociopolitical context influences participants throughout the entire intervention.
 99 Specifically, one study described religion[98]; 2 studies described ethics [82, 97]; eight studies
 100 emphasized legislation[68, 78, 82, 87, 95, 98, 99, 104]; eight studies mentioned norms or
 101 regulations[20, 76, 78, 81, 90, 95, 97, 98]; 15 studies recognized that policies[8, 19, 20, 36, 76, 78,
 102 80-82, 87, 91, 92, 95, 97, 99] are key within complex interventions.

103

104 Sociopolitical factors are strongly linked to funding. In fact, an internal correlation exists between
 105 funding and other factors. For example ,training , materials, and health services all require
 106 funding[106].

107

108 In addition, the legislature can formulate policies and laws to allocate and guide the use of funds. For
 109 example, legislators can encourage uptake of specific complex interventions to promote children's
 110 health through extra/specific budget [91].

111

112 Policy is another CHI-related influencing factor. Policies creating negative finances can make it difficult
 113 to scale up and sustain policy-related interventions when finances are positive this can increase the
 114 motivation to adopt and adapt CHIs[20]. Different religious beliefs and ethical standards may exist
 115 across different countries, cities, and communities. Religious practices or local beliefs may act as
 116 either a facilitator or a barrier to the implementation of CHIs[107].

117

118 Sociocultural factors encompass common traditions, habits, patterns and beliefs which are
 119 throughout implementation of CHIs within a population group.[19, 78, 80-82, 87, 91, 93, 95, 98, 108].

120

121 **Interorganizational Networks**

122 Interorganizational networks bridge full-scale relationships across organizations [109]. Specifically,
 123 Interorganizational Networks refer to structured arrangements involving multiple organizations that
 124 collaborate to achieve shared goals. These networks facilitate the exchange of resources, knowledge,
 125 and information across organizational boundaries, enhancing overall performance and innovation
 126 capabilities[110]. Their importance is evident regardless of organisational structure[8]. Inter-
 127 organisational communication enable CHIs to be better adapted to local contexts and potentially
 128 sustained on a wider scale, be maintained and delivered effectively with lower cost due to the hybrid
 129 of resources[111].

130

131 High-quality inter-organisational communication results in a good working atmosphere, smooth
 132 collaboration, rapid feedback of information, clear tasks and strong cohesion between staffs[70]. Also,
 133 inter-organisational networks, (emphasizing) links, cooperation and competition with other
 134 organisations or governments, are powerful in the adaption of complex interventions[112, 113].

135

136 For example, collaboration between hospitals and organisations facilitates communication, enhances
 137 collaboration[114] and cross-organisational learning[115], and joint decision-making[116, 117]. It also
 138 enables the pooling of scarce resources [118, 119] allowing treatment for less accessible group [120],
 139 as well as reducing costs of transferring patients between health services or from duplication of

care[121]. In addition, sharing results with other organisations offers the potential for follow-up expansion and continuation.

Funding

One key challenge is the difficulty of securing long-term constant funding. Whether developing a new intervention or updating and integrating existing services, funding is essential to the effectiveness and sustainability of CHIs[91]. Generally, funding for projects is supported by the state, local government, or related organizations. Nineteen of the identified models or frameworks emphasize fiscal support prioritized in implementation[8, 20, 28, 33, 36, 68, 76-79, 81, 82, 87, 91, 95, 96, 98, 99, 104]. Conversely, insufficient financial support make CHIs unsustainable at the exploration stage[122]. In addition, sufficient fiscal support can facilitate such factors as staff training, supervision, and monitoring, particularly in LMICs who are in shortage of medical services and resources[20]. For example, in the COVID-19 epidemic, the main challenges to introducing new vaccines not only included the cost of purchase but also the cost of transport and cold chain, and the labour costs of community workers, especially in LMICs[123]. These may therefore prevent effective interventions from being delivered on a large scale in the long term.

Client Advocacy

Client advocacy is defined as:

“support or marketing for system change based on consumer needs, priorities and/or demographics”.[28]

Three of the 37 studies identify client advocacy as an important influencing factor [28, 36, 91]. During implementation client advocacy assists healthcare workers, participants and their families in navigating the healthcare system [124]. Specifically, for participants without fully understanding medical procedures or the healthcare system, complex medical processes can constitute a barrier to care. Good client advocacy enable/accustom participants to understand health services and negotiate medical care services, insurance issues, administrative and legal tasks. At the national level, client

168 advocacy can be beneficial in promoting good policy and a positive socio-political environment[91].
 169 At the local or community level, the main role of client advocacy is to promote service levels, as well
 170 as equity[91].

171

172 **Leadership**

173 16 of the 37 studies emphasize leadership [8, 19, 20, 28, 68, 78, 79, 83, 85-87, 91, 92, 97-99]. Specific
 174 subgroups may offer either approval or conflict. Strong leadership can promote effective use of
 175 resources while encouraging personnel to work towards a common goal, which facilitates the
 176 adaptation, expansion, and sustainability of complex health interventions in the areas where they are
 177 implemented[28].

178

179 **Inner context**

180 **Organizational characteristics**

181 Organizational characteristics constitute
 182 “structures or processes that take place and/or exist in organizations that may influence the process
 183 of implementation”. [28, 33, 36, 76, 83, 84, 91-93, 95, 104]

184 Organization characteristics covers ten influencing factors including absorptive capacity [8, 19, 20, 33,
 185 36, 79, 80, 83, 87, 91-93, 97, 99, 104], organization readiness [33, 68, 91-93], structure[8, 76, 78, 81,
 186 83, 87, 90, 92, 93, 99, 104], values or visions [78, 80, 83, 86, 87, 92, 99], working environment [8, 28,
 187 33, 36, 76, 84, 91, 92, 95, 97], tension for change[8, 90, 92, 94], organization culture [8, 78, 83, 86, 91,
 188 98], leadership[8, 19, 20, 28, 78, 79, 83, 85-87, 91, 92, 97-99], credibility and reputation[86]. The ASaS
 189 of complex interventions very much depend upon the characteristics of the organisation.

190

191 When an organisation possesses superior knowledge/skills, the ability to absorb new knowledge, and
 192 mechanisms to assist knowledge sharing, together with good measures to facilitate the uptake of new
 193 knowledge, it is more likely to implement CHIs sustainably, scalarly and effectively[125, 126].
 194 Additionally, adaptation of the complex intervention to the structure, values and authority of an

organisation helps to scale up and sustain the CHIs over time. Also, culture (the organisation's normative beliefs and shared expectations) as well as leadership, all influence complex interventions[104, 127, 128]. For example, CHIs may fail, even when work tasks, structures and behaviours remain largely constant, because the culture and beliefs within the organisation do not match the needs of CHIs.

Structure

Organisations with strong organisational power may be likely to implement CHIs because they have stronger leadership and more frequent communication than those with weak or decentralised organisational structures[129].

Readiness for change

In addition, strong organisations are prepared and aware of possible encountered changes and can adjust their strategies and approaches of working in time to enable CHIs to be carried out well. Readiness for change is related to other factors including organisational culture, and individual attitudes [128, 130-132].

Absorptive capacity

During the exploration and preparation phases of a CHI, an organisation's absorptive capacity (the ability to identify, assimilate, transform, and use external knowledge, research and practice[133]), readiness for change and receptive environment exert a significant impact on the adaptability of CHIs. For example, when organizations encounter difficulties in implementing CHIs, a leader may emphasise the need for input from their team and to learn new methods or techniques, therefore team members feel valued and motivated to learn, absorb and try new methods and techniques[8].

220 **Individual adopter or provider characteristics**

221 Organisational change begins with individual behavioural change[8]:

222 “Individuals are carriers of cultural, organizational, professional, and individual mindsets, norms,
223 interests, and affiliations.”[104]

224 Therefore, individual adopter or provider characteristics are important in the adaptation, scaling up
225 and sustainment of CHIs[91]. Individual adopter or provider characteristics include participants’
226 personal characteristics, age, race/ethnicity, education, training, foundation subjects, professional
227 experience, adaptability, personal values and goals, and personal character creative ability.

228

229 Fourteen included studies emphasise how the CHI is accepted and scaled-up by participants and
230 health care workers[8, 28, 33, 76-79, 84, 89, 92, 94, 95, 97, 98]. In parallel to the organisational level,
231 individual ability or capacity[8, 19, 78, 87, 92, 94, 97, 104], training or education[33, 76, 78, 79, 83,
232 92, 93, 97], and tenacity for change[8, 92, 94] constitute important factors. CHIs are more easily
233 adapted and diffused when led by experienced and leaders [8, 19, 20, 28, 78, 79, 83, 85-87, 91, 92,
234 97-99] with common visions or views[8, 78, 92, 94, 97, 100, 104]. In addition, race [78, 91], spoken
235 language [78, 91, 93] and individual culture [78, 94, 97, 99] are considered to be vital influencing
236 factors. Specifically, when there is a high degree of fit between the norms and values of the individual,
237 organisation and CHIs, individuals may find that they achieve higher efficacy when implementing
238 CHIs[104].

239

240 **Leadership**

241 As mentioned above, 16 of the 37 included studies emphasize leadership [8, 10, 19, 20, 28, 68, 78, 79,
242 83, 85-87, 91, 92, 97-99].

243

244 **Staffing**

245 CHIs require sufficient, well-trained healthcare workers. Fourteen of the 37 studies list staffing as an
246 important factor in their TMFs.[28, 68, 76-80, 86, 87, 91-93, 97, 104]. Job candidates may be selected

so that their knowledge, skills, competencies, and attitudes [134] match the requirements of the CHI. For example, in sub-Saharan Africa substitution of trained health care workers by community workers with minimal or no training, impacts upon adaptability and spread[20]. Also, the social-political context of some sub-Saharan countries has weakened already fragile health systems, thereby limiting adaptability and future sustainability[20]. Conversely, high staff turnover presents a further obstacle to sustained implementation[77, 135]; irregular rotation of doctors and nurses within a rural area contributes to a lack of care, thereby affecting the continued effectiveness of a CHI[136].

As previous mentioned, insufficient funding poses a challenge to staffing. When health workers supporting CHIs are paid little or no money, attrition, dropouts and frequent turnover of staff impact on adaptability and spread[20]. When health staff are scarce, it triggers staff overload, leading to a decline in the quality of health services and further exacerbating staff turnover, leaving the further spread of interventions severely compromised[20]. Therefore, these non-linear, interdependent influencing factors interact to determine implementation of complex interventions.

Supervision, Monitoring and evaluation

Supervision, monitoring and evaluation refers to the collection, storage, analysis and use of data to assess whether complex interventions are achieving their intended objectives, and further influences improvement, policy development and advocacy of complex intervention[137]. Nine of the 35 studies argue for the vital role of monitoring and evaluation in providing an effective approach by which to assess the effectiveness of complex interventions[20, 68, 83, 86, 87, 91, 92, 98, 104].

Sustained monitoring and support during implementation, especially during the sustainment phase, impacts on the scalability and sustainability of CHIs[91]. Supervision, monitoring and support enable staff to effectively achieve predetermined intervention objectives. Insufficient data collection poses a major barrier to monitoring that may result in a lack of feedback on the effectiveness of the intervention[91].

275 **intervention characteristics**

276 The characteristics of the intervention itself is also an important factor. Specifically, the physical and
 277 community environment, the cost of the intervention and access to resources (9 studies)[8, 20, 68,
 278 77, 81, 92, 93, 97, 99] and the source of funding all exert a direct impact. Additionally, the guidance
 279 and assistance of project champions (11 studies) [20, 33, 77, 79, 80, 83, 87, 90, 91, 97, 100],
 280 stakeholder involvement (11 studies) [20, 28, 75, 85, 91, 92, 96-100], and supervision (6 studies)[20,
 281 76, 86, 87, 93, 97], can facilitate complex interventions. Project champions are committed to
 282 supporting and promoting the implementation of CHI, along with a strong belief in the value of
 283 carrying out CHIs[138].

284

285 Additionally, effective communication among healthcare workers and participants[28, 33, 78, 80, 87,
 286 90, 92, 93] (6 studies), advanced support systems or tools (9 studies)[19, 28, 33, 68, 76, 79, 80, 91, 95]
 287 and technology advance or environment(8 studies)[33, 68, 78, 87, 92, 97, 98, 104] facilitate the
 288 sustainment of CHIs. The included frameworks attest to how the characteristics of the CHI decide
 289 whether an intervention can be adapted, scaled-up and sustained[8, 33, 73, 79, 89, 92, 94].

290

291 Finally, geographical factors (5 studies)[68, 79, 82, 95, 97] and time-cost (4 studies)[68, 77, 78, 90] are
 292 also important influencing factors. Although researchers hope that CHIs can be adapted and
 293 conducted as quickly as possible, it takes time for both healthcare providers and participants to adapt
 294 to new interventions[116]. Also, when interventions change significantly within a short period of time,
 295 the lack of sufficient time to adapt to the intervention and adjust to relevant cultural factors prevent
 296 staff and participants from adopting a new CHI[139].

297

298 **Bridging factors**

299 Factors influencing the inter-relationship of outer and inner context are described as “bridging factors”
 300 in the EPIS framework. Bridging factors include community engagement[20, 28, 33, 36, 68, 77, 81, 85,
 301 87, 95, 97, 98] and Purveyors/Intermediaries[28].

302

303 **Community function**

304 13 of the 37 studies stress the importance of the community [20, 28, 33, 36, 68, 77, 81, 85, 87, 95,
305 97-99]. Development of complex interventions within a community may be facilitated when they
306 utilise existing community resources, available structures and staff, reducing dependence on external
307 funding [20]. For example, community members were proud to participate in a project to improve
308 malaria prevention through insecticide-treated mosquito nets and thereby contribute to disease
309 control within their community. Consequently, the project was speedily adapted, replicated and
310 scaled-up locally[140].

311
312 The community function is also affected by socio-political factors[141]. If the visions that underpin
313 the policy are inconsistent with community objectives, the policy hinder spread and sustainability
314 even where the community possesses powerful leadership, project champions and sufficient
315 resources [141, 142].

316

317 **Purveyors/Intermediaries**

318 Purveyors/Intermediaries (Organizations or individuals providing support or consultation for
319 implementation and/or training in the innovation) take on a critical bridging role for key processes in
320 the implementation of CHIs[28]. Purveyors, who may be individuals, groups or communities, aim to
321 facilitate the effective and sustainable implementation of CHIs[143]. Intermediaries provide
322 consultancy and training services to governments, organisations, etc., and also develop and
323 implement different health-services and projects for them[143]. They also provide monitoring,
324 support, quality improvement and evaluation services at the end of the project[143].

325

326 **2.4 Applicability and feasibility of the collected TMFs**

327 This study employs the Theoretical Quality Tool, adapted from Hean et al. [144], to rigorously assess
328 the applicability of various Theoretical Models and Frameworks (TMFs) in the context of Low- and
329 Middle-Income Countries (LMICs). Overall, 27 [8, 10, 19, 20, 28, 29, 33, 36, 57, 73, 75-88, 90, 91, 96,
330 98, 145] of the 37 studies describe macroscopic TMFs and nine studies [68, 89, 92-95, 97, 99, 100]

331 describe TMFs for specific relevant interventions. The detailed outcomes of this assessment are
332 presented in the Table 5. The summary table highlights the applicability and feasibility of TMFs in
333 LMICs.

334
335 Of the 37 TMFs reviewed (two studies identify EPIS), seven demonstrate high applicability and
336 feasibility, readily integrating into LMIC healthcare environments without necessitating significant
337 overhauls. For example, models like the AIDED and NPT are readily implementable in LMICs due to
338 their practicality and context-sensitive design. They integrate seamlessly into existing healthcare
339 systems, offering solutions without the need for extensive system overhauls, crucial in resource-
340 limited environments. Twenty-five TMFs require adaptations to align with the local conditions of
341 LMICs, entailing modifications to fit cultural, economic, and healthcare infrastructure nuances. For
342 example, the EPIS framework, CFIR framework, PRISM Model and Chronic Care Model, though broadly
343 applicable, need customization to fit the unique cultural, economic, and healthcare infrastructures of
344 LMICs.

345
346 For the remaining five TMFs, their inherent theoretical complexity and the fact that some were
347 specifically designed for High-Income Countries (HICs) pose significant barriers to adoption in in Low-
348 and Middle-Income Countries (LMICs). This finding highlights an important disconnect between their
349 foundational assumptions and the practical realities of healthcare systems in LMICs. The specific
350 information of the applicability and feasibility of the collected TMFs is shown in the Table 5.

Table 5. The applicability and feasibility of the collected TMFs

Highly Applicable and feasible TMFs	Name of the TMFs	Name of the Study	Applicability	Feasibility
1	DSF (Dynamic Sustainability Framework)	The Dynamic Sustainability Framework: Addressing the Paradox of Sustainment Amid Ongoing Change	Applicability: This framework (DSF) is potentially suitable for LMICs due to its focus on continuous adaptation and learning, aligning with the diverse healthcare challenges in these regions.	Feasibility: DSF's feasibility in LMICs depends on factors such as each region's healthcare infrastructure, cultural factors, and resource availability. Its emphasis on ongoing learning, adaptation, and tailoring interventions to local contexts is critical for addressing specific needs and conditions in LMIC environments.
2	AIDED Model	A model for scale up of family health innovations in low-income and middle-income settings: a mixed methods study	Applicability: This model offers a practical approach for scaling up family health innovations in LMICs, focusing on adapting to local contexts and engaging user groups, crucial for addressing the challenges in these regions.	Feasibility: It emphasizes developing support systems and effectively spreading innovation, involving essential concepts like assessing the landscape and tailoring innovations to user needs. This approach is designed to overcome barriers to scaling up in LMICs, making it feasible for application in diverse healthcare environments.
3	NPT (Normalization Process Theory)	Normalisation Process Theory: a framework for developing,	Applicability: This Theory (NPT) aids in implementing complex health interventions in LMICs by focusing on their integration	Feasibility: NPT concepts such as coherence, cognitive participation, collective action, and reflexive monitoring are crucial for facilitating intervention adoption. These principles enhance

		evaluating and implementing complex interventions	into routine practices. It addresses challenges of assimilating these interventions within existing systems and cultural contexts, making it highly applicable in LMICs.	the feasibility of NPT in LMICs, considering socio-organizational factors and the need for interventions to resonate with local healthcare environments.
4	A Proposed Framework for Success	Scaling Up Global Health Interventions: A Proposed Framework for Success	Applicability: This framework is designed to guide the implementation of new health programs, policies, or interventions in LMICs, considering their unique challenges and requirements, making it suitable for these contexts.	Feasibility: A tailored approach for LMICs, drawing on literature and expert interviews, underscores its feasibility in these unique settings. Key aspects enhancing feasibility include simplicity of interventions, local engagement, using state and non-state actors, political will, and incorporating research into implementation, as evidenced in successful health interventions across various LMICs.
5	Theory of Change (ToC)	Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions	Applicability: This approach, successfully piloted for mental health projects in LMICs, is adaptable to the varied local conditions in these settings. Its emphasis on stakeholder engagement and identifying causal pathways makes it highly relevant for designing, implementing, and evaluating	Feasibility: Success of the ToC in LMICs depends on effectively customizing it to local conditions and ensuring active stakeholder participation. While it is adaptable and useful, challenges like significant stakeholder involvement and genuine ownership of ToC maps must be addressed to ensure its feasibility.

			complex interventions in LMICs.	
6	Conceptual framework of sustainability of interventions implemented in SSA	Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and conceptual framework	Applicability: The study focus on challenges of sustaining health interventions in Sub-Saharan Africa (SSA), emphasizes the importance of sustainability for both communicable and non-communicable diseases in LMICs. It provides insights relevant to regions with similar challenges.	Feasibility: While addressing sustainability in SSA, the study faces limitations in resource availability, healthcare workforce, and system strength. Its primary focus on sustainability in SSA may not fully encompass all relevant concepts for broader LMIC contexts, indicating a need for a more comprehensive understanding of LMICs' diverse needs.
7	IHI Framework for Going to Full Scale	A Framework for Scaling Up Health Interventions	Applicability: This framework has proven practical in LMICs, particularly in African health initiatives. Its stages effectively address the critical aspects of scaling up health interventions in the resource-varied and infrastructurally challenging contexts of LMICs.	Feasibility: Comprehensive coverage of all phases, from initial setup to full-scale implementation and sustainability, demonstrates its feasibility in LMICs, accommodating their diverse healthcare environments and operational challenges.
TMFs Requiring Adaptation				
1	PRISM Model	A Practical, Robust Implementation	Applicability: This framework (DSF) is suitable for LMICs due	Feasibility: Feasibility in LMICs hinges on factors like healthcare infrastructure, cultural context,

		and Sustainability Model (PRISM) for Integrating Research Findings into Practice	to its emphasis on continuous adaptation and learning. It aligns to the diverse healthcare challenges in LMICs, focusing on adapting and improving health interventions. DSF's adaptability makes it relevant for various regional health concerns.	and resource availability in each region. Its principles of ongoing learning, adaptation, and fitting interventions to local contexts require consideration of these specific regional needs and conditions.
2	Chronic Care Model (CCM)	Factors influencing the implementation of chronic care models: A systematic literature review	Applicability: The model's effectiveness in LMICs depends on its alignment with the specific health challenges and infrastructures of these regions. While it broadly covers various chronic diseases and settings, indicating a comprehensive approach, its relevance varies based on the unique healthcare contexts in different LMICs.	Feasibility: Implementing CCM in LMICs requires meticulous planning and is influenced by factors at multiple healthcare levels. Its adaptability and feasibility in LMICs hinge on the region-specific healthcare needs, infrastructure, and resource capabilities.
3	EPIS Framework	Advancing a Conceptual Model of Evidence-Based Practice Implementation in	Applicability: The conceptual model is broadly relevant for LMICs, particularly when tailored to address their unique cultural and systemic	Feasibility: The model's feasibility in LMICs involves consideration of local resources and capacities, given its complexity and the multiple phases of exploration, adoption, implementation, and sustainment. Effective

		Public Service Sectors	differences. It encompasses crucial aspects like local needs and the sociopolitical environment, underscoring its adaptability for diverse LMIC settings.	application in LMICs demands a deep understanding of local contexts and resource constraints.
4	Triple C Model	Implementation of sustainable complex interventions in health care services: the triple C model	Applicability: The model focuses on sustainable complex interventions in healthcare, is well-suited to LMICs, especially when adapted to local contexts. Its stages of consultation, collaboration, and consolidation emphasize key aspects like stakeholder engagement and teamwork, aligning with the needs in LMICs.	Feasibility: This model's simplicity and practical approach make it feasible for LMICs, particularly in settings constrained by resources. Its emphasis on clear communication and sustainable practices is critical for the success of healthcare interventions in these resource-limited environments.
5	NASSS Framework	Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to	Applicability: This framework, designed for health and social care technologies, has potential applicability to LMICs. Its broad design covers key areas such as health conditions, technology,	Feasibility: Feasibility in LMICs depends on local contexts, resources, and healthcare needs. Its development, informed by empirical case studies and a hermeneutic literature review, makes it adaptable to the diverse settings and challenges characteristic of LMICs.

		the Scale-Up, Spread, and Sustainability of Health and Care Technologies	adopters, and the wider context, offering concepts likely beneficial for LMICs, especially in informing technology design and implementation planning.	
6	A comprehensive conceptual framework for implementation science	Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting	Applicability: This framework provides well-defined concepts that suggest clarity and potential usability in LMICs. It effectively connects components essential for identifying, scaling up, and sustaining effective interventions, indicating relevance for LMICs.	Feasibility: While framework is clear and has proven effective in programs like those in Bangladesh, its adaptation to specific LMIC contexts may require further clarification, ensuring it meets local needs and conditions.
7	EPIS Framework	Systematic review of the Exploration, Preparation, Implementation, Sustainment (EPIS) framework	Applicability: Focus on inner and outer context factors, innovation factors, and bridging factors, suggests potential adaptability to diverse settings, including LMICs. Its comprehensive approach to different implementation stages and context factors make it broadly	Feasibility: Feasibility of applying to LMICs depends on the specific contexts and available resources in these regions. While it covers factors crucial for implementing EBPs, the review doesn't explicitly confirm inclusion of all useful concepts for LMICs, indicating a need for further assessment in these unique settings.

			relevant.	
8	The systems transformation framework (STF)	The Power of the Frame: Systems Transformation Framework for Health Care Leaders	Applicability: Adaptability and relevance for LMICs, particularly in structuring healthcare leadership and change management, are evident. However, it lacks a specific focus on LMIC contexts, suggesting a need for further contextualization.	Feasibility: While concepts are broadly applicable to healthcare systems, their direct relevance and practical implementation in LMICs might require adaptations. This is due to varying healthcare challenges and resource constraints characteristic of LMICs.
9	A Proposed Framework for Success	Scaling Up—From Vision to Large-Scale Change: A Management Framework for Practitioners	Applicability: This field-tested framework, applicable across various sectors, aligns well with the challenges of scaling up interventions in LMICs. Its comprehensive approach, encompassing strategic planning, change management, resource allocation, and momentum maintenance, is aptly suited for these regions.	Feasibility: Given its proven applicability in different sectors, principles and methodologies show promise for effective implementation in LMICs, considering their specific challenges and needs in healthcare and resource management.
10	CFIR framework	Fostering implementation of health services	Applicability: The CFIR offers a comprehensive and pragmatic approach, making it adaptable	Feasibility: Includes wide range of relevant concepts for LMICs, including its adaptability to local social, economic, and cultural contexts,

		research findings into practice: a consolidated framework for advancing implementation science	for LMICs. Its flexibility and thorough consideration of both internal and external factors in implementation align well with the diverse challenges of health service implementation in LMICs.	supporting its feasibility in these varied settings, guiding effective management of health service implementation processes.
11	the Context and Implementation of Complex Interventions (CICI) framework	Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework	Applicability: The CICI framework's comprehensive approach and focus on socio-economic and cultural contexts make it suitable for application in LMICs. It addresses a broad spectrum of factors vital for the success of complex interventions in these diverse environments.	Feasibility: Given its emphasis on context, the CICI framework is relevant and feasible for LMICs, providing a guide for effectively handling the unique challenges and complexities of health service implementation in these settings.
12	Conceptual framework for sustainability of public health programs	An Agenda for Research on the Sustainability of Public Health Programs	Applicability: Suggestions are adaptable for LMICs, focusing on sustainability of health interventions, particularly maintaining benefits post-funding. This aspect is highly relevant for LMICs, where sustaining health initiatives is a critical concern.	Feasibility: For effective application in LMICs, must consider specific resource limitations and health system dynamics prevalent in these regions. Comprehensive approach to addressing sustainability highlights feasibility in LMICs, considering their unique healthcare environments.

13	Framework of Dissemination in Health Services Intervention Research	Interventions in Organizational and Community Context: A Framework for Building Evidence on Dissemination and Implementation in Health Services Research	Applicability: This framework emphasizes adapting health interventions to diverse community settings in LMICs, focusing on the importance of community-based approaches given the varied resources and cultural contexts. It covers understanding multi-layered community dynamics and the diffusion of new practices.	Feasibility: Including essential elements like contextual factors, diffusion stages, and intervention outcomes, tailored to unique challenges in LMICs, making it a feasible approach for health interventions in these regions.
14	A Person-Focused Model of Care	A Person-Focused Model of Care for the Twenty-First Century: A System-of-Systems Perspective	Applicability: The model, integrating physical, mental, and social health aspects using a system-of-systems approach, is suitable for LMICs. It addresses multi-morbidity and provides a holistic view of health, essential for LMICs facing complex health challenges.	Feasibility: The focus on realigning and integrating existing resources, rather than requiring new infrastructure, makes the model feasible for LMICs. Including key elements like various health dimensions and stakeholder roles, the model effectively caters to the healthcare challenges in these regions.
15	Integrated sustainability framework	The Sustainability of Evidence-Based Interventions and Practices in Public	Applicability: Sustaining EBIs in LMICs necessitates adapting to their specific resources, cultural differences, and	Feasibility: While concepts like community engagement and cultural adaptability are essential for the success of EBIs in LMICs, sustainability frameworks that highlight these

		Health and Health Care	economic conditions. This adaptation addresses the challenges of applying interventions initially developed in more resource-rich settings.	aspects require further exploration. More research is needed to fully grasp their applicability across LMICs' diverse contexts, ensuring interventions are effectively tailored to local needs and realities.
16	RE-AIM Framework	Evaluating the Public Health Impact of Health Promotion Interventions: The RE-AIM Framework	Applicability: The RE-AIM framework, focusing on reach, efficacy, adoption, implementation, and maintenance, is adaptable for evaluating public health interventions in LMICs, addressing their effectiveness and sustainability.	Feasibility: Adapting to LMICs presents challenges due to resource limitations, cultural differences, and health system disparities. Unique challenges in these regions may require additional considerations beyond the five dimensions, ensuring comprehensive and context-sensitive application.
17	FRAME	The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions	Applicability: The FRAME framework, focusing on characterizing modifications to interventions, is suitable for LMICs as it addresses both planned and unplanned changes, critical in their diverse, resource-limited settings. It encompasses a wide range of intervention changes, including proactive	Feasibility: While FRAME provides a structure for understanding modifications, LMIC-specific challenges such as infrastructure, resource constraints, and cultural diversity may necessitate further consideration. This involves ensuring modifications align with original intervention goals while being sensitive to local contexts.

			adaptations and reactive modifications.	
18	ExpandNet framework	Practical guidance for scaling up health service innovations	Applicability: Focus on addressing technical, managerial, and financial aspects is crucial for LMICs, ensuring that interventions are suited to their specific healthcare contexts and resource limitations.	Feasibility: The necessity for additional resources poses a challenge in LMICs, where such resources are often limited. Effectiveness in these settings hinges on practical testing under real-life conditions unique to LMICs, to validate its adaptability and utility.
19	Multiple models	Framework for the establishment of a feasible tailored and effective perinatal education programme	Applicability: Focus on adapting antenatal education to the specific needs of women in LMICs, considering local healthcare systems and cultural contexts, makes it highly applicable. It addresses diverse population needs and covers comprehensive maternal and child health aspects, vital in culturally and socioeconomically diverse LMICs.	Feasibility: The emphasis on adaptability and relevance enhances feasibility in LMICs. Key concepts like personalized education and community involvement are essential for effective implementation in these regions, where tailored approaches are necessary to meet unique healthcare challenges.
20	A cross-cultural adaptation	A framework for cross-cultural	Applicability: The PACE Steps to Success program, aimed at	Feasibility: Implementing this program in LMICs requires adaptations to align with their unique

	framework	development and implementation of complex interventions to improve palliative care in nursing homes: the PACE Steps to Success programme	enhancing palliative care in nursing homes, is universally relevant for LMICs. Its comprehensive approach to palliative care is applicable across different cultural contexts, including those in LMICs.	health and social care systems, legal policies, and cultural norms. Adjustments are necessary to accommodate diverse resource availabilities and healthcare infrastructures, ensuring the program's effectiveness in these varied settings.
21	Greenhalgh et al.'s diffusion of innovation model	Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory	Applicability: The model emphasizes the importance of innovation adoption, organizational readiness, leadership, and managerial relations for the success of health interventions in LMICs, highlighting key aspects that are crucial for implementation in these contexts.	Feasibility: While these concepts are fundamental, additional context-specific factors may be necessary for LMICs. This includes adapting the model to align with the unique healthcare challenges and varying conditions of these regions, ensuring its practicality and effectiveness in local settings.
22	WICID framework	WICID framework version 1.0: criteria and considerations to guide evidence--informed decision-making on non--	Applicability: This framework, aligned with the WHO-INTEGRATE model, is designed for managing COVID-19 interventions and needs adaptation for LMICs, considering their cultural diversity and health	Feasibility: While it addresses health, social, economic, and rights-related aspects of COVID-19 management, customization is necessary for LMICs to address specific challenges like healthcare disparities and economic constraints, due to their unique contexts and resource limitations.

		pharmacological interventions targeting COVID-19	infrastructure.	
23	Hybrid Framework for Understanding Interventions to Reduce Under-5 Mortality	Development and application of a hybrid implementation research framework to understand success in reducing under-5 mortality in Rwanda	Applicability: Tailored for LMICs like Rwanda, offers comprehensive approach to reducing under-5 mortality, adapting existing frameworks with practical implementation suggestions and emphasizing local health system design, leadership, and community involvement.	Feasibility: This hybrid framework, focusing on equitable healthcare access and LMIC-specific factors, includes relevant concepts for implementing, adapting, and sustaining health interventions. It addresses contextual factors unique to LMICs, ensuring practicality in these diverse settings.
24	Conceptual framework for evaluating the scale-up and sustainability of digital solutions for front-line health workers	A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India	Applicability: The study on digital health tools in India provides insights applicable to LMICs, focusing on adaptability to local contexts and stakeholder engagement. It underscores the importance of addressing specific challenges like data governance and sustainability in these regions.	Feasibility: The scalability and sustainability of such tools in LMICs are contingent on strong government leadership, stakeholder collaboration, and a supportive ecosystem. These factors are crucial for the successful scaling of digital health solutions in LMICs.
TMFs with Limited Applicability and feasibility				
1	Complex	Adapting	Applicability: Emphasizes	Feasibility: Acknowledges the challenges posed

	Population Health Intervention Adjustment	Evidence-Informed Complex Population Health Interventions for New Contexts	adapting interventions to new contexts and conserving resources, relevant for LMICs with their complex systems, norms, and structures. Highlights importance of tailoring interventions to specific characteristics and needs of target populations in LMICs.	by the complexities in LMICs. While not explicitly focused on LMICs, its principles of adaptation and resource conservation are key to practical implementation in these settings, considering their unique challenges.
2	Sustainable Oral Health Promotion Framework	A framework for implementing sustainable oral health promotion interventions	Applicability: Framework for sustainable oral health interventions, encompassing prevention, intervention, and recovery, is adaptable to LMICs. It addresses various stages including training, adoption, implementation, and practice improvement, making it relevant for oral health challenges in these regions.	Feasibility: Feasibility in LMICs depends on factors like local resource availability, cultural relevance, and healthcare infrastructure. While comprehensive, specific applicability of its concepts may vary according to each LMIC's unique healthcare challenges and context.
3	Conceptual Framework to Prevent Childhood	Translating Policies Into Practice: A Framework to	Applicability: Designed for U.S. afterschool programs, focuses on policies and practices relevant to childhood obesity	Feasibility: While covering policy implementation, organizational change, and public health, it lacks specific consideration for adapting these concepts to the unique

	Obesity Through Policy-Level Initiatives in Afterschool Programs	Prevent Childhood Obesity in Afterschool Programs	and physical activity but doesn't explicitly address its applicability to LMICs, overlooking factors like resource availability, cultural norms, and economic conditions in these regions.	challenges and needs of LMICs, indicating a gap in its feasibility for application in these diverse contexts.
4	Complex adaptive system	Moving alcohol prevention research forward—Part I: Introducing a complex systems paradigm	Applicability: Focused on complex systems paradigm in context of U.S. college drinking. Doesn't address applicability to LMICs, neglecting aspects like resource availability, cultural differences, and economic conditions relevant in these regions.	Feasibility: While discussing complex systems and computational modeling, does not explore their relevance to LMICs, where context, particularly alcohol misuse and socio-ecological factors, differs significantly. Lack of specific coverage for unique LMIC challenges impacts feasibility of applying these concepts in such settings
5	Organizational theory	Organizational theory for dissemination and implementation research	Applicability: Discusses SafeCare's implementation theory in developed contexts, lacking specific guidance for LMICs. Its concepts, tailored for developed countries, may not directly translate to the diverse contexts of LMICs.	Feasibility: Focuses on general organizational theories and does not address unique challenges and requirements of LMICs, impacting the direct feasibility of applying these theories in such varied settings.

2.5 Discussion

This systematic review identified common features and differences across 37 TMFs associated with ASaS, and the inter-relationships among the influencing factors of ASaS of CHI.

Similarities and differences between the TMFs

All identified TMFs describe the importance of one or more of the three ASaS concepts. These TMFs seek to enable CHIs to be adapted in new contexts and populations, to scale up interventions, and to be effective in the long term. The components of the different TMFs share broadly similar descriptions, even where the terminology may differ. For example, except the TMFs such as the EPIS framework, MRC framework[17] and Sarma's framework[29] mentioned before, the Framework - oral health[79] also showed the similar result. It emphasizes the concept of adaptability within the second stage; the concept of scalability in the implementation stage; the concepts of sustainability in maintenance stage.

Similar stages may vary in the order in which they are presented in the different models, possibly reflecting how implementation of CHIs is inherently multi-stage and non-linear. Significant differences across the different TMFs occur mainly in relation to influences on ASaS. Furthermore, even where different TMFs use the same terminology to describe influencing factors, the meaning expressed in different TMFs may differ due to the inherent complexity and dynamics of these factors.

The complexity of influencing factors of adaptability, scalability and sustainability

The TMFs reflect how CHIs and associated influencing factors do not operate in isolation, but are non-linear, interacting and interdependent. Some influencing factors

appear across multiple studies. For example, researchers share a consensus about the importance of funding [8, 20, 28, 33, 36, 76-79, 81, 82, 87, 91, 95, 96, 98, 104]. Some studies emphasise adequate and sustained financial support from governments and foundations as prerequisite to the sustainability and spread [29, 87, 91, 145], while Sarma[29] recognizes the need to sustain interventions in the absence of adequate funding [20]. In addition, the sociopolitical context, leadership and organizational characteristics are repeatedly mentioned as essential components for implementation. Furthermore, all the factors mentioned in the literature are bi-directional; the same influencing factor may act differently under diverse conditions, either as a facilitator or as a hindrance.

To be specific, first, in terms of the outer context, strong leadership can facilitate effective use of resources while encouraging personnel to work towards a common goal. Also, sociopolitical factors covers ethical considerations [82, 97], legislation[78, 82, 87, 95, 98, 104], norms or regulations[20, 76, 78, 81, 95, 97, 98], policies [8, 19, 20, 36, 76, 78, 80-82, 87, 91, 92, 95, 97], and religion[98]. Legislation and policies not only guide, and often guarantee, complex interventions at the macro level, but also, at the empirical level, provide a basis for adapting CHIs to the local environment thereby making interventions suitable for scale up and long term sustainment[78, 82, 87, 95, 98, 104]. High quality interorganizational communication contributes to the implementation and sustainability of CHIs [111]. Additionally, weak leadership exerts a negative impact on the management of the organisation, funding applications and the recruitment of staff.

Leadership remains an important factor in relation to the inner context. Given that complex interventions are often run by the state, an organisation or a group, strong leadership can facilitate complex interventions. Also, the organisational culture, the vision/belief and the structure of the organisation interact with each factor and are influenced by funding, leadership and staffing.

Strong leadership needs to be accompanied by a structured organisation with a common vision in order to achieve the objectives of complex interventions. People as the carriers of culture, organisation, professional and personal attitudes, norms, interests and affiliations[146] also fulfil an important role. Individual adopter or provider characteristics are important influencing factors. When people within the organisation are aligned with the organisation's philosophy and culture, along with sufficient financial support, strong leadership and effective supervision, adaptation, scale up and long-term sustainment become possible for CHIs. Finally, intervention factors are influenced by both the outer context and the inner context, and bridging factors serve to unite the outer context, the inner context, and the intervention factors.

The dynamics of influencing factors of adaptability, scalability and sustainability

Factors that influence complex interventions are dynamic in both temporal and geographical terms. The role of influencing factors may change over time [42]; it is not uncommon for anticipated barriers to turn out to be facilitators [42]. For example, in the early stages of an intervention, individual adopters may have a skeptical, distrustful attitude towards implementation, thereby presenting a barrier to delivery of a CHI[147]. However, in the later stages of the intervention, if the intervention is effective, participant attitudes may change and they may become motivated to participate and cooperate with the intervention, thereby becoming facilitators[148].

Similarly, in the early stages of the intervention, newly recruited or local staff may be unfamiliar with an intervention, posing a hindering factor. Conversely, in the later stages of the intervention, as staff become familiar with the work content of the complex intervention, they are better able to handle and implement the intervention, thereby becoming a facilitator.

Identical influencing factors may activate different effects in different geographical and national contexts. For example, women are generally considered to be a vulnerable group worldwide, especially in LMICs, they tend to have lower income and lower social status compared with men making it difficult for them to access better health care resources[149]. However, in the matrilineal community in Indonesia, women occupy similar or even higher social status than men, with a cultural tradition of controlling family finances [150]. Therefore, in this context, gender and culture may facilitate interventions, especially maternal and child health related interventions. In relation to funding, reliable sources of funding help to sustain interventions[29], and one of the challenges to sustainability is the lack of long-term available funding[20].

In short, this systematic review offers a comprehensive understanding of factors influencing ASaS and provides a theoretical framework for effective CHIs in the future.

Have gaps in knowledge been addressed?

This is the first systematic review of ASaS related TMFs of CHIs. Previous studies have only explored TMFs related with one or two of the ASaS concepts. However, although some studies invoke the need to explore influencing factors and correlation among ASaS, no studies have actually conducted this research. For example, Barker, explores scalability, while also emphasising sustainability, before discussing the correlation between scalability and sustainability[19]. The study describes three activity phases of getting to full scale--Develop the Scalable Unit, Test of Scale-up, and Go to Full Scale. Also, Bradley identifies how the complex adaptive system facilitates the scaling-up process[98].

Furthermore,

“Sustainability has evolved from being considered as the endgame of a translational research process to a suggested 'adaptation phase' that integrates and institutionalizes interventions within local organizational and cultural

contexts.”[76]

This literature argues that sustainability is, in fact, a manifestation of adaptability, and that the two concepts are closely related. Additionally, Sarma[29] describe the implementation process from adaptation to scaling up to sustainment. However, these studies focus on the overall process and do not provide an in-depth analysis of influencing factors and the links between influencing factors [76].

Only one classic theory and one implementation theory are included. There are two possible reasons. Classical theories are borrowed from such disciplines as psychology, sociology and organisational development (e.g. the Diffusion of Innovation theory [70]. Similarly, the Health Belief Model was published in 1950[151] and the Theory of Planned Behavior in the late 1980s[152]. Given that inclusion requires publication after 2000, many classic theories predate the study period. On the other hand, other theories, such as the implementation climate theory[153], may not be conceptually related to ASaS, resulting in their exclusion.

Moreover, this review reveals the scarcity of theoretical models for LMICs. The review identified four main categories of theoretical models, (i) the generic TMFs (e.g. RE-AIM and CFIR), with no obvious geographical target (26/35); (ii) tailored TMFs developed by some high-income countries (e.g. [93, 94, 97]. for local needs (6/35); (iii) adapted TMFs (e.g. EPIS and Framework of Dissemination in Health Services Intervention Research), originally designed for high-income countries but now adapted to CHIs worldwide; (iv) TMFs specific to low and middle income countries (2/35) (e.g. [19, 20]). Across the included theories most (85.7%) are either generic or specific to high-income countries, with a lack of TMFs specifically targeted at LMICs.

What inter-relationships have been demonstrated between factors influencing scalability, adaptability, and sustainability of the complex health interventions?

Barker, explores scalability, while also emphasising sustainability, before discussing the correlation between scalability and sustainability [19]. The study describes three activity phases of getting to full scale--Develop the Scalable Unit, Test of Scale-up, and Go to Full Scale. Also, Bradley identifies how the complex adaptive system facilitates the scaling-up process[98].

Additionally, Sarma describe the implementation process from adaptation to scaling up to sustainment[29]. However, these studies focus on the overall process and do not provide an in-depth analysis of influencing factors and the links between influencing factors.

A meta-model combining the EPIS and CFIR frameworks has been created to explore interacting characteristics of influencing factors including 1) the outer context; 2) the inner context; 3) the intervention characteristics; and 4) the bridging factors. The interaction of these factors reveals them as complex, dynamic and co-operative and thus appropriate as a guide for subsequent research. This EPIS framework and CFIR framework will be further adapted for use in a subsequent systematic review to explore these factors within the empirical literature, thereby ensuring coherence of research methodology across both analyses.

Lack of TMFs designed for LMICs

The study's findings highlight a significant gap in the development of TMFs specifically tailored for LMICs. While a few models like AIDED and NPT show high applicability, the majority require substantial adaptation, and some are largely incompatible due to their HIC-centric design. For example, TMFs like the Chronic Care Model (CCM) and the PRISM Model, while theoretically adaptable, require meticulous planning and significant customization to fit the unique healthcare infrastructures and cultural

contexts of LMICs. The CCM's broad approach to chronic diseases necessitates alignment with the specific health challenges and resource constraints of different LMICs. The PRISM Model's feasibility in LMICs hinges on factors such as healthcare infrastructure and resource availability, which vary significantly across regions.

Furthermore, some TMFs, such as the Sustainable Oral Health Promotion Framework and the Complex Population Health Intervention Adjustment, while comprehensive in their design, lack explicit focus on LMIC contexts. These frameworks often overlook critical aspects like local resource availability, cultural relevance, and economic conditions, thereby limiting their direct applicability and feasibility in LMICs.

This underscores an urgent need for developing or refining TMFs with a primary focus on the unique contexts of LMICs, moving beyond the one-size-fits-all approach and addressing the distinct challenges and resource constraints in these diverse healthcare environments.

Strengths and Limitations

This systematic review retrieved topic-relevant literature through a systematic search across four databases. However, only studies published in English were included and studies from the grey literature may have been missed. It has proved challenging to identify relevant implementation TMFs. Complex interventions and implementation utilize diffuse terminologies, compounded by numerous variants. Exhaustive lists of synonyms would have proved prohibitive, in terms of both lack of specificity and overall numbers of false positives. The supervisor is an experienced information professional and advised on an optimal balance between sensitivity and workload. While the included studies were evaluated by a quality assessment tool, the risk of bias still may exist, particularly given only one author was responsible for data extraction.

Furthermore, although this review has identified how influencing factors interact, no clear theoretical model charts the specific TMFs, routes, and pathways from the influencing factors to the ASaS of CHIs. Finally, concepts such as acceptability, fidelity, and feasibility, are considered important in relation to CHIs [154] but fell outside the remit of this review.

2.6 Summary

This review presents and synthesises 37 TMFs that document factors that influence the ASaS of CHIs. A meta-model combining the EPIS and CFIR frameworks was created to explore interacting characteristics of influencing factors including 1) the outer context; 2) the inner context; 3) the intervention characteristics; and 4) the bridging factors. The interaction of these factors reveals them as complex, dynamic and co-operative and thus appropriate as a guide for subsequent research. This EPIS framework and CFIR framework will be further adapted for use in a subsequent systematic review to explore these factors within the empirical literature, thereby ensuring coherence of research methodology across both analyses.

After thoroughly analyzing and integrating numerous theoretical models related to complex health interventions, it becomes evident that a more detailed and comprehensive exploration of these interventions in real-world settings is particularly important. The purpose of this exploration is to investigate the deep complexity encountered during the implementation of complex health interventions, with a focus on identifying and understanding the key factors that play a decisive role in the adaptability, scalability, and long-term sustainability of these interventions in practice.

Through this process, this study aim to uncover and analyze various influencing factors, including but not limited to the design details of intervention strategies, the specific conditions of the implementation environment, and the capacity to adjust and optimize the interventions over time. Such in-depth exploration not only helps in understanding how to effectively apply these interventions across different settings

and conditions but also aids in revealing systemic factors that promote or hinder their widespread adoption and sustained effects. This study pay special attention to assessing the adaptability of the interventions in the face of environmental changes, including the flexibility of their components, responsiveness to local needs, and the potential for development and evolution while maintaining core principles.

In summary, this deep exploration of complex health interventions requires not only the analysis of theoretical models but also the exploration of the application of these models in reality.

Chapter 3 Empirical systematic review

Following the theoretical exploration in Chapter 2, which unearthed a significant gap in Theoretical Models and Frameworks (TMFs) specifically designed for LMICs, Chapter 3 pivots to an empirical systematic review. This review endeavors to scrutinize the practical application of Adaptability, Scalability, and Sustainability (ASaS) concepts within the LMIC context, aiming to validate and expand upon the theoretical gaps and challenges identified in Chapter 2. By analyzing empirical evidence from existing interventions, Chapter 3 seeks to provide concrete insights into how theoretical factors identified previously play out in real-world scenarios. This critical examination is instrumental for grounding the development of the framework of this study, ensuring its relevance and efficacy in addressing the unique challenges faced by LMICs. Through this empirical inquiry, the chapter contributes to bridging the theoretical and practical realms, enhancing our understanding of ASaS in complex health interventions and informing future implementation strategies in LMIC settings.

3.1 Introduction

With the burden of disease increasing in LMICs, complex interventions have been widely used in LMICs in health care delivery, public health practice, and social policy areas such as education, transportation, and housing[155]. With the evolution of complex interventions, has come a corresponding theoretical, concrete and practical need to plan their further development and evaluation[156]. As a result, in 2000, the Medical Research Council produced their *Framework for the Development and Evaluation of RCTs for Complex Interventions to Improve Health*, further updating this framework in 2008[157].

In addition, in accordance with chapter 2, diverse theoretical models or frameworks to implement complex interventions have been identified, and the relationship between the ASaS and the CHI implementation process has been explored. To be

specific, in the initial phase of the implementation of complex interventions, the researcher needs to determine whether this intervention can be adapted to the circumstances, and, only if it adapts well, will it move to the next scaling-up phase. In the final stage, if the complex intervention works effectively within a larger context, the complex intervention is verified as sustainable in real-world settings[158].

Therefore, the aim of this review is to identify the studies concerned at least one concepts of ASaS, and to further collect as many factors as possible that influence the all three concepts of ASaS. The purpose is to facilitate the evaluation by experts in subsequent Delphi study.

Objectives:

This systematic review aims to address the following:

1. To identify the published literature of empirical studies concerned with sustainability, scalability and adaptability of complex health intervention;
2. To collect as many factors as possible that influence the all three concepts of ASaS (scalability, adaptability, and sustainability) of the complex health interventions in empirical studies;
3. To explore the relationships among these factors influencing scalability, adaptability, and sustainability of the complex health interventions;
4. To appraise the methodological quality and reporting quality of the included literature;
5. To explore the gaps of theoretical studies and empirical studies.

3.2 Method

3.2.1 Search Strategy

A three-step search strategy was used for this review. A limited search of Google Scholar was first conducted based on the search strategy and keywords, reviewing the

first 10 pages of search results. This was followed by an analysis of the text words in the titles and abstracts, as well as the index words used to describe the studies. In conducting a comprehensive literature search on the implementation and effectiveness of complex health interventions, particularly in low- and middle-income countries (LMICs), a series of search terms were meticulously chosen to encapsulate the multifaceted nature of sustainability, adaptability, scalability, and their intersections. These search terms were aligned with the primary goal of identifying studies that address the sustainability (including capacity building, spread, or diffusion), adaptability (including adaptability, replicability, fidelity, or adoption), and scalability (including scalable approaches, scaling up, scale out, or expansion) of health interventions.

To ensure a thorough investigation, these terms were further combined using the Boolean operator "AND" with phrases capturing the concept of complex interventions (such as complex interventions, complex health interventions, health interventions, intervention studies, evidence-based practice, or evidence-based medicine). This strategic approach aimed to pinpoint literature that not only discusses theoretical frameworks but also provides empirical evidence on the practical application of these interventions in varying contexts.

Additionally, the search was tailored to focus on LMICs, recognizing the unique challenges and opportunities these countries face in implementing health interventions. This specificity was achieved by including a comprehensive list of countries and regions that fall under the category of LMICs, ensuring a wide-ranging yet focused dataset for analysis.

This methodological rigor in the literature search strategy was pivotal in assembling a robust body of evidence. It facilitated a nuanced understanding of the dynamics at play in the successful implementation, scaling, and sustainability of health interventions in

resource-constrained settings, laying a solid foundation for further research and policy formulation in global health.

The search strategy generally follows the methodology taken in the theoretical systematic review, but given the large number of empirical complex interventions and the workload, the filter was contracted by using the countries of all LMICs as qualifiers, according to the World Bank classification[159].

Search terms

Search terms across the four databases (PubMed, MEDLINE, CINAHL, Embase, Web of Science) and Google Scholar were organized within six search term groups including the three ASaS concepts (1. Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion; 2. Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption; 3. Scalability OR Scalable OR Scaling up OR Scale out OR expansion), complex interventions (4. complex NEAR3 intervention* OR complex NEAR3 treatment* OR complex NEAR3 training OR complex NEAR3 system* OR adaptive system); terms relating to theories (5. Theor* OR models* OR Framework* OR Heuristic* OR Lens OR Paradigm*), and the terms of relating to LMICs (6. "Low-and-middle-income countries" OR "developing countries" OR "LMICs" OR Afghanistan OR Albania OR Algeria OR American Samoa OR American Samoa OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR "Bosnia and Herzegovina" OR "Bosnia and Herzegovina" OR Botswana OR Brazil OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cote d'Ivoire OR ivory coast OR Cuba OR Djibouti OR Dominica OR Dominican Republic OR Dominican Republic OR Ecuador OR Egypt OR El Salvador OR Guinea OR Eritrea OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR

Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Korea OR Kosovo OR Kyrgyzstan OR Kyrgyz Republic OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Micronesia OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Pakistan OR Palau OR Panama OR Papua New Guinea OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Romania OR Russia OR Russian Federation OR Rwanda OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Melanesia OR Solomon Islands OR Somalia OR South Africa OR South Africa OR South Sudan OR South Sudan OR Sri Lanka OR Saint Lucia OR Saint Lucia OR St. Lucia OR "Saint Vincent and the Grenadines" OR "Saint Vincent and the Grenadines" OR "St. Vincent and the Grenadines" OR Sudan OR Suriname OR Swaziland OR Syria OR Syria OR Syrian Arab Republic OR Tajikistan OR Tanzania OR Thailand OR Timor-Leste OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR Palestine OR "West Bank and Gaza" OR Yemen OR Zambia OR Zimbabwe).

The specific search terms and strategy are described in Appendix 6.

3.2.2 Inclusion and exclusion criteria

Given that both theoretical and empirical reviews are mining essentially the same pool of papers but looking for different types of study within the pool, the inclusion criteria for this empirical systematic review were adapted from the previous theoretical systematic review as reported in section A. The specific inclusion criteria are shown in the Table 6 below:

Table 6: The inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Intervention type	Study relates to complex health interventions	Study does not relate to complex health interventions
Publication type	- Review - Books - Journal articles - Gray literature	- Editorials - Commentaries - Poster presentations - Protocol papers
Study type	- Reviews - Case study - Qualitative study - Quantitative study - Mixed Method study	
Population	People engaged in complex health interventions	People did not engage in complex health interventions
Intervention	Existing empirical studies (the CHI studies implemented in LMICs) concerned with the adaptability, scalability and sustainability of complex health interventions and also correlated with factors influencing the complex health interventions and internal relationship of the influencing factors.	- Statistical models (including regression, economic and econometric, and Markov models) - Disease models or frameworks (e.g. Animal models) - Drew on an existing models or frameworks without modifications
Comparison	Any (active or inactive control)	
Discipline	Health related areas	Non-human science
Study outcomes	The factors influencing the complex interventions	
Publication dates	After the first MRC guideline on complex intervention (2000)	

Publication language	• English	• Not English

3.2.3 Methodological quality assessment

The focus of this study is on the influencing factors of complex interventions, rather than the study design of included studies. As a result, even though some of the included studies possess limitations in their study design, they may provide valuable influencing factors for researchers. Hence, as an alternative to quantitative quality assessment tools, a generic quality assessment tool, CLEAR, is employed in this study[160]. Specifically, CLEAR is a checklist containing numerous questions, by which reviewers indicate whether they are appropriately addressed in the study (yes, no or mixed), together with a brief justification. In addition, reviewers summarise the main strengths and limitations of the included studies and their impacts on the findings.

3.2.4 Data Extraction and Synthesis

Data extraction

After the search, shortlisted articles selected by title and abstract were exported to Endnote and made accessible to reviewer and the supervision team. Also, at each selection stage in the review process (e.g., after merging all articles and before evaluating eligibility in accordance with title and abstract), a backup file of the Endnote database was produced to offer an audit trail for the tracing of any step-by-step procedures required in the review, as well as any third-party adjudication.

A single researcher screened all titles and abstracts against inclusion and exclusion criteria to identify potentially eligible studies and remove duplicates independently. All eligible studies were searched in full and reviewed by the researcher independently using a pre-designed eligibility form. Similarly, data from all included studies were extracted by one independent reviewer using a data extraction form that was pilot

tested by researcher and the supervision team on the same article.

As with the theoretical systematic review in Chapter 2 (the tables of Chapter 2 can be found in Appendix 4), three tables were created. The first table presents basic information about the included studies: Author/year, Name of the study, Objective, Country, Setting, Participants, Duration, used a TMF or not, Region, Topic area, Discipline, Study design, Study methodology, Organisation involved, National or International, and Implementation Outcomes.

Similar with the previous table in the review of TMFs, the second table describes the factors that influence the ASaS of complex interventions, based on the meta-model obtained from Chapter 2.

The third table shows the correlation between influencing factors mentioned in each included study and the three ASaS concepts. All these tables are shown in Appendix 8.

Data synthesis

Narrative synthesis is used to analyze the included studies, described as

“An approach to the systematic review and synthesis of findings from multiple sources and relies primarily on the use of words and text to summarize and explain the findings of the synthesis”[161].

Due to the diversity of studies in this review, as evidenced by the considerable heterogeneity in their methodologies, narrative synthesis is preferred to using meta-analysis [161].

- **Initial Narrative Analysis:**

The first step involved performing a thematic narrative analysis on the screened studies. For each qualified study, the following information was extracted: Author/year;

Name of the study; Objective; Country; Setting; Participants; Duration; Region; Study design; Study methodology; Implementation Outcomes (see Appendix 8). The researcher worked independently on this form. In cases of disagreement, the researcher and the supervision team discussed coding issues until consensus was reached and approved by all researchers.

- **Narrative Analysis Using NVivo:**

Similar to the approach in Chapter 2, the categorization of themes and identified factors was referenced. Key terms and concepts were extracted using NVivo software for thematic analysis. This process involved coding the data to identify the underlying themes. Specifically, themes highlighted the influencing factors of ASaS in complex health interventions in LMICs (Low- and Middle-Income Countries) and explored common factors influencing all three ASaS components, developing an Excel sheet to show overlap[162, 163].

- **Code Development and Validation:**

In the early stage of code development, the researcher coded 20% of data. Data were initially organized according to the factors influencing the complex interventions obtained from included studies, and then codes derived from existing TMFs mentioned in the Chapter 2.

The supervisor independently repeated the coding of the initial lists of transcripts and fed back on the coding structure. Following agreement within the supervision team and finalizing of the coding scheme, researchers coded the remainder of the data. 20% of the remainder data were double-coded to ensure the rigour and trustworthiness of the data analysis process. Themes were independently generated after reading the coded data, then discussed and agreed within the research team.

- **Synthesis of Findings:**

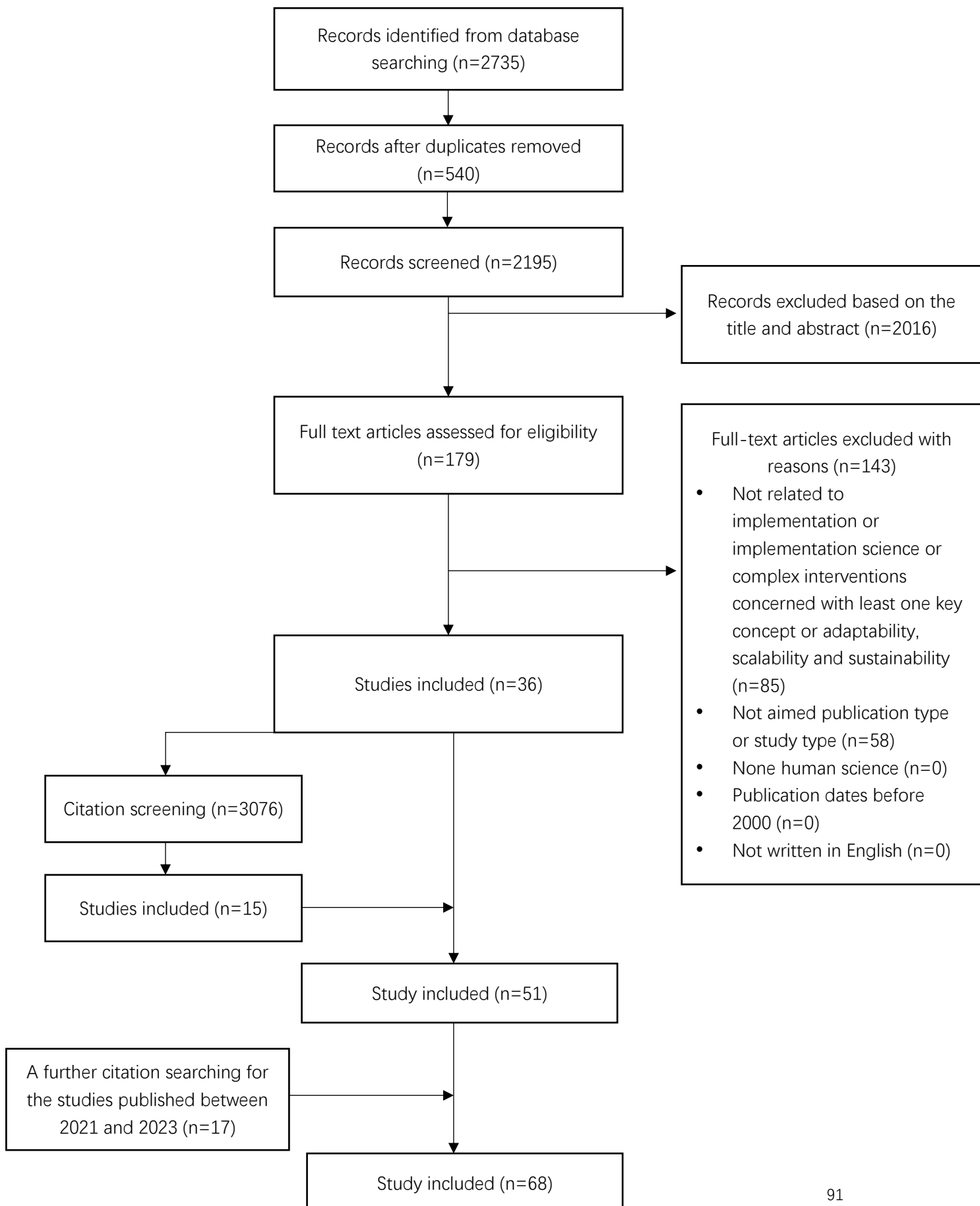
Following the approaches in Chapter 2, all findings relevant to identifying factors that influence ASaS of complex interventions, regardless of topic area, disease, or geographical location, were synthesized based on the meta model.

The analysis allowed flexibility to create new sub-domains and categories that emerged from the data induction. As this study was part of a PhD project, the coding process was independently undertaken by the researcher. Influencing factors were coded, consensus was reached within the supervision team, and the coding and verbatim quotes were reassembled into major themes.

3.3. Result

3.3.1 Description of studies

According to the search strategy, a total of 2735 articles were retrieved from four databases, including 175 studies from EMBASE, 994 studies from PUBMED and MEDLINE, and 1566 studies from Web of Science (WOS). 2016 studies were excluded based on the titles and abstracts and 179 studies were obtained for full-text screening. Of the 179 studies, 143 studies were excluded due to the inclusion criteria and 36 studies were obtained. Subsequently, citation searching was conducted for each of the 36 studies. As a result, 51 studies were included. Subsequently, a citation search was conducted to obtain the studies that published between 2021 and 2023. Finally, 68 studies were included in this research. (see Figure 3)

Figure 3: PRISMA diagram of article selection

The 68 studies included were mainly set in Africa, Asia and the Americas. Of the 68 studies, 41 studies (60.3%) were conducted in Africa[142, 164-203], 11 studies (16.2%)[204-214] were conducted in Asia and eight studies (11.8%) [215-222] were conducted in the Americas.

Four cross-regional studies were also included [150, 223-225]. The study conducted by Beardmore-Gray [224] was conducted in India (South Asia) and Zambia (southern Africa). The study conducted by Bhanbhro [150] was conducted in Southeast Asia and Oceania, another study was conducted in Nepal (South Asia) and Somaliland (Africa)[225]. A further study was conducted in southeastern Europe[223]. In addition, the search identified 4 literature reviews[226-229].

The included studies covered diverse health topics. For example, fifteen studies[166, 167, 171, 175, 177, 178, 187-189, 205, 208, 211, 215, 218, 219] focused on communicable disease, eight studies[169, 170, 180, 216, 223, 225, 226, 228] on health system improvement, eight[150, 165, 173, 179, 187, 206, 224, 229] on maternal health, eight on non-communicable disease (NCD)[174, 184, 186, 204, 207, 209, 217, 227].

In terms of research design, of the 68 items of literature, 47 were qualitative studies[142, 150, 165-169, 171-175, 177-181, 183, 185, 186, 188, 189, 195, 196, 199-203, 206, 208, 210, 211, 213, 214, 217-220, 222, 225, 226, 228, 229], 21 were mixed studies[164, 170, 176, 182, 184, 187, 193, 194, 197, 198, 204, 205, 207, 209, 212, 215, 216, 221, 223, 224, 227] and no quantitative studies were included.

From the perspective of research method, interviews and reviews were the most commonly used methods, with 50 studies using interviews or focus group discussions[142, 150, 164, 166, 167, 169-184, 188, 194-197, 199-201, 203, 206-208, 210-214, 216, 217, 219-225]; 18 studies using literature reviews[165, 170, 172-174,

176, 183, 185, 211, 215-218, 224, 226-229] with some overlap with the primary studies. As multiple research methods were used in the included studies, particularly in mixed method studies, multiple research methods were sometimes used in the same document.

3.3.2 The result of the quality assessment of the included studies

The quality assessment of the selected studies revealed overall strong performance across various criteria. Most studies demonstrated high levels of clarity and rigor in their design and implementation. Almost all studies clearly articulated their research questions and objectives, indicating a high degree of logical coherence and focus in the design phase. Background and theoretical frameworks were well-described, with only a few exceptions showing some ambiguity. Sample selection and description were thorough, ensuring the representativeness and reliability of the results.

In the data collection and analysis sections, nearly all studies employed reliable and appropriate methods, clearly detailing their data collection processes and analysis techniques. This consistency underscores the methodological robustness of the included research. The reporting and interpretation of results were also strong points, with most studies providing detailed and clear reports of their findings, accompanied by logical and reasonable interpretations. Conclusions were generally well-articulated and directly supported by the research questions, and most studies offered feasible recommendations based on their findings.

Overall, the quality assessment highlights the strong methodological foundations of the selected studies in implementation science theories, models, and frameworks. Despite minor shortcomings in a few studies, the overall quality is high, providing valuable insights and a solid basis for understanding and applying these scientific approaches. (See Appendix 7)

3.3.3 Narrative synthesis of finding

As mentioned in the previous theoretical review, the three ASaS concepts are closely related to the various processes of complex interventions. To maintain consistency, the classification of these influencing factors follows the same method used previously. The factors are categorized according to the EPIS (Exploration, Preparation, Implementation, Sustainment) framework.

Outer context

Outer context involves sociopolitical context, leadership, funding, client advocacy, interorganizational networks and environmental factors.

Socio-political context

Socio-political factors are one of the main factors influencing the ASaS of implementation of complex interventions[150, 171, 181-183, 195, 200, 206, 220, 223, 228].

According to the included literature, the socio-political context mainly includes ethical, legislation, norms or regulations, politics, religion, culture, and economy. Among these influencing factors, policy and culture are most frequently mentioned. Of the 68 included studies, 13 studies emphasized the policy[164, 168, 170, 173, 197, 204, 205, 207, 213, 222, 223, 227, 229], and 12 studies described the culture as an important factor[150, 164, 169, 172, 193, 202, 204, 208, 215, 219, 221, 223].

In addition, the factor of norms or regulation was mentioned in three included studies[204, 205, 216], and legislation factor was described in five included studies[195, 205, 216, 227, 228]. As found in the previously conducted theoretical systematic review, socio-political factors were shown to bear a strong correlation with other influencing factors.

The implementation of the law depends on the readiness of the organization or health system, the vision and the compliance of the individual with the rules[205, 216]. In addition, organisations and individuals need the support of appropriate policies to implement interventions[204]. The policy itself may involve the allocation of funds and resources[227].

Interorganizational Networks

Inter-organisational networks have a significant impact on the ASaS of complex interventions[169, 173, 186, 195, 205, 206, 210, 218, 220, 223, 229]. Similar to socio-political factors, inter-organisational networks correlate with diverse factors such as the working climate and the characteristics of the staff, and the community functions[169, 205, 206, 223].

When the community works in conjunction with other organisations, it may integrate local health resources and seek to sustain the intervention effectively, at low-cost and consistently in the local context[227].

For example, the study of Malin Upper Bogren., 2015[206] described how involving multiple organisations working together to train 3,000 midwives held the advantage that participants receive experience and guidance from multiple different organisations, but with the disadvantage that each organisation has its own tasks to deal with which, in the absence of proper coordination, may hinder project implementation.

In addition, the involvement of different organisations puts greater pressure on monitoring and supervision, requiring timely feedback and orderly, effective synchronisation to ensure the ASaS of complex interventions[206]. Additionally, the superior leadership not only can enhance interorganizational networks but also plays

a crucial role in fostering collaboration and trust among various stakeholders. Effective leaders can bridge gaps between different organizations, facilitating communication and cooperation. This, in turn, leads to more robust and resilient networks, capable of efficiently addressing complex challenges and adapting to changing environments[230, 231].

Funding

Twenty-three papers highlighted the importance of funding in the implementation of complex interventions[142, 167, 169, 171-173, 175, 176, 178, 185, 187, 191, 195, 197, 202, 204-207, 212, 213, 215, 216, 223, 224, 226, 228, 229].

In LMICs, during the implementation process of complex interventions, a lack of long-term stable funding is often encountered during the maintenance of the intervention[170]. For example, In Sub-Saharan Africa, funds are relied heavily on international aid projects[20]. As countries are chronically poor and funding for health care is limited, there are obvious pitfalls in relying solely on aid funding for stability.

Funding shortages have led to reduced compensation for healthcare workers, unsustainable medical transport costs, lack of medical supplies and inadequate infrastructure[170]. Ultimately, the sustainability and scalability of interventions is further compromised and interventions quickly stall after a shortage of funds[170].

Client Advocacy

Of the 68 included studies, six studies identified client advocacy as a key role in promotion, adaptation, scaling-up and sustainment of the intervention [185, 189, 196, 202, 227, 229]. Furthermore, during the actual implementation of the intervention, leveraging resources from governmental systems for advocacy purposes, in conjunction with active community engagement, can significantly expedite the process of promoting advocacy efforts[232]. This approach underscores the synergistic

effect of combining governmental support with grassroots involvement in enhancing the efficacy and reach of advocacy activities.[232].

For example, new models of health services or national drug benefit packages were advocated through leadership and media campaigns. As a result, health-related knowledge and attitudes and preventive practices have increased in Vietnam, Turkey and Jamaica[227]. In Vietnam, the "Eat Less Salt" and "12/8" programs resulted in changes in salt reduction behaviour in the participating communities in Vietnam[227].

Leadership

21 out of 68 studies (30.9%) described the vital of leadership in complex interventions[142, 165, 170, 173, 175, 177, 187, 192, 200, 203, 205, 208, 210, 212, 214, 216, 218, 222, 223, 227, 228].

In practice, leadership is about coordinating staff in the organisation and in the community, coordinating with the government to achieve effective use of resources, policies and motivating staff.

For example, the study of Raaj Kishore Biswas., 2020[205], places particular emphasis on leadership. When Bangladesh faced a new and rapidly spreading virus (COVID-19), this country experienced bureaucracy, lack of leadership and uneven distribution of resources, which ultimately led to the expansion of the epidemic.

A further study by Edwards[233] describes how, despite a wealth of research on approaches and methods to prevent and treat HIV, many programs are not scalable and sustainable.

If the complex intervention aims to be scaled up and sustained, it will require leadership, managers, frontline practitioners and target populations to work together

to build support for change, as well as a degree of resource and infrastructure support[233].

Inner context

Organisational characteristics

The theme of organisational characteristics covers eight influencing factors, including absorptive capacity[223], organizational readiness[170], structure[174, 204, 215], values or visions[191, 206, 224, 228, 229], working environment[177, 204], tension for change[192, 210, 229], organization culture[169], credibility and reputation[204, 210].

Of these influencing factors, values or visions were mentioned most frequently (five studies). This is followed by structure and tendency for change, which are mentioned in three papers.

Organizational characteristics are revealed as one of the main practical implementation factors for an intervention. In order for the intervention to be adaptable, scalable and sustainable, a constant reservoir of knowledge, a shared belief and a strong leader are all required by an organization[204].

In addition, during the process of implementation of complex interventions, the organisation needs to pay attention to maintaining close relations with other organisations[223], as well as reaching out to the community and communicating intensively with local managers and members in order to be able to carry out complex interventions effectively[223, 227].

For instance, when Médecins Sans Frontières (MSF) intervened with Syrian refugees, it required health-related education, mental health services, home visits and collaboration with community workers to enable the intervention to adapt quickly to

the local context and cope with the challenges of the complex post-war environment[204].

Individual adopter or provider characteristics

As mentioned previously in the theoretical review, in accordance with the definition of Greenhalgh,

“Individuals are carriers of cultural, organizational, professional, and individual mindsets, norms, interests, and affiliations..”[104]

From the perspective of providers, individuals represent the concrete embodiment of the organisation, representing its philosophy, goals, involvement in the intervention and playing an important role in the adaptation, scaling up and sustainability of complex interventions[8, 91].

From the perspective of adopters, these are individuals who are specifically involved in and affected by the complex intervention. The individual culture, knowledge, education and other factors of both individual providers and adopters influence the outcome of the intervention and ultimately influence the ASaS of complex interventions[225].

For example, in the study by Atun., 2007[223], local health care workers expect to be trained and educated to become professional health care workers and part of the health care management system during the process of implementation to further ensure the scaling-up and sustainment of interventions.

Leadership

As mentioned previously, of the 68 included studies, 21 studies emphasized the importance of leadership[8, 19, 20, 28, 78, 79, 83, 85-87, 91, 92, 97, 98, 200, 203, 212,

214, 222].

Staffing

Of the 68 included studies, 22 studies indicated staffing as an important factor[165, 168, 170, 171, 177, 179, 186, 188, 190-192, 194, 204-207, 211, 214-216, 226, 227].

Staff shortages can create barriers to the ASaS of complex interventions. For example, a lack of health workers due to bureaucracy hindered effective control of the COVID-19 pandemic in Bangladesh[205].

Additionally, irregularity or frequent rotation of staff can lead to unfamiliarity with the area of work and lack of training, which ultimately affects the implementation of the intervention[136]. For example, in the study of Sako, 2018[183], when there is a lack of training for managers, non-government organization (NGO) coordinators, development agents, association managers and new staff, together with a high turnover of staff, the activities of the grain bank operations were significantly influenced. In addition, the supervision and monitoring of interventions are also affected by a lack of capacity or lack of personnel.

Supervision, Monitoring and evaluation

15 of the 51 studies identified monitoring and evaluation as an important factor[164, 165, 168, 170, 172, 183, 184, 190, 191, 204-206, 211, 227, 229]. In the process of implementation complex interventions, supervision, monitoring and evaluation may act as a feedback modifier, enabling research staff to make timely adjustments to the intervention being delivered, thus enabling the intervention to be effectively adapted, scaled up and sustained[205]. In addition, interventions may be effective when accompanied by a comprehensive health system and good communication with the community members[168, 226].

Intervention characteristics

Intervention characteristics comprising 12 sub-components including communication, quality and fidelity monitoring/support, geographical, project champion, resources(health services, human resource, infrastructure), stakeholders involvement, support system or tool, technology advance or environment, time, governance/management, supply and distribution/delivery, long-term planning and Personnel management.

Among all these sub-components, the factor of quality and fidelity monitoring/support was indicated by 16 studies[164, 165, 168, 170, 172, 183, 184, 190, 200, 204-206, 211, 221, 227, 229], which confirms the explained importance of supervision, monitoring and evaluation in the inner context. In addition, the factor of resources (human resources and infrastructure) is a cornerstone, providing important support for complex interventions[142, 150, 165, 166, 168, 169, 173, 175, 176, 179, 186-190, 192, 196, 198, 200, 202, 205, 206, 208, 210, 212, 214, 216, 218, 219, 223-226, 229]. This is further illustrated by how the influencing factors of complex interventions interact with each other and influence each other to work together within complex interventions.

Bridging factors

The factors influencing the relationship among the inner context, the outer context, and intervention characteristics are described as bridging factors. Bridging factors include community function and purveyors/intermediaries.

Community function

Of the 68 studies, 27 studies mention the importance of community functions[142, 150, 164-166, 170, 172-175, 178-181, 183, 194, 199, 205, 206, 208, 209, 211, 212, 218, 225, 227, 228].

In the delivery of complex interventions, the community often acts as a bridge between the implementer and the recipient of the complex intervention[28]. By making good use of the community function, researchers can deploy community resources effectively, mobilise the autonomy of individuals within the community, reduce staff demands and costs, and further improve ASaS [140, 205].

For example, organising a kick-off event for the intervention in the community can attract the attention of the local population and help to create a climate for salt reduction[207]. Subsequently, the study suggests that organising health promotion activities in the community, according to local cultural practices, can ensure maximum participation of the villagers in the community in the sodium reduction intervention[207].

Purveyors/Intermediaries

Five studies highlighted the role of purveyors, with disseminators facilitating the factor of client advocacy and further facilitating the implementation of complex interventions[205, 208, 218, 223, 227].

During the COVID-19 epidemic, organisations, individuals, communities, media and stakeholders played a key role in sharing experience of epidemic preparedness measures and information to the public[205]. Purveyors assisting governments or organisations to disseminate information in a timely and transparent manner helped to reduce fear and anxiety in society, while maintaining social order and safety and further contributing to epidemic prevention interventions[205].

3.4 Discussion

As with the theoretical systematic review, based on the 68 empirical studies, this section describes four main domains of influencing factors that affect the ASaS of complex interventions in empirical research, including external context, internal context, intervention characteristics and bridging factors.

As mentioned previously, this section continues the use of the meta-model used in the theoretical model review as a guide to classify influencing factors in the empirical systematic review. Finally, this section provides detailed examples describing complexity, dynamism and co-operative nature of the influencing factors from an empirical-level perspective.

3.4.1 Similarities and gaps between definitions of adaptability, scalability and sustainability) and related findings in the empirical review

The definitions of ASaS were mentioned in section 2.4 of the theoretical systematic review. This section discusses how these three concepts are described in the studies included within the systematic empirical review.

- **Adaptability**

Consistent with the insights garnered from the theoretical review, the adaptability of empirical complex interventions is significantly shaped by a variety of factors, including cultural norms, organizational vision or belief systems, community participation, and leadership dynamics. This multifaceted influence is illustrated by the study conducted by Echaubard et al [182], serving as a case in point that aligns with the broader conceptualization of adaptability. Such findings underscore the intricate interplay between these determinants in facilitating or impeding the adaptability of

interventions within diverse contexts [208].

- **Scalability**

As with the findings of the theoretical systematic review, scalability is fundamentally recognized as the expansion of the implementation of complex interventions to reach a wide range of target populations and to maintain the effectiveness of the intervention.

Based on the results of empirical systematic review, when empirical research is conducted in a wider population, it may encounter different challenges such as socio-political, infrastructural and human factors, as well as the characteristics of the population[233]. These results are generally consistent with the description of the definition of scalability.

- **Sustainability**

In terms of the definition of Scheirer and Dearing[234],

“the continued use of program components and activities for the continued achievement of desirable program and population outcomes”.

Together with similar elements in the other two definitions[37, 38], In empirical research, this is reflected in the fact that the researcher will try to identify the factors affecting sustainability, and further adopt strategies to enable the project to proceed.

For example, the study of Fried [171], emphasizes factors that influence the sustainability of complex intervention including sociopolitical context, fund, leadership, health system and so forth.

In addition, the content concerned with the definition of sustainability in terms of how to sustain the complex interventions in the absence of funding is described specifically

in the empirical systematic review. For example, another study argued that making full use of existing available health care workers, clinics, hospitals, medical resources and supervisory staff in the health service is essential to sustain interventions in the resource-limited settings[168].

In summary, the related content of the definitions of adaptability and scalability are described in the empirical studies and no significant gaps were found between the empirical results and the definitions. As for sustainability, the gaps are concerned with the definition developed by Shediak-Rizkallah[234] referring to the need to maintain complex interventions with limited resources and funding. Some of the empirical studies were consistent with this definition, while others emphasised access to stable sources of funding.

3.4.2 The complexity of influencing factors of adaptability, scalability and sustainability

As mentioned previously, the complexity of complex interventions reflects how associated influencing factors are not isolated, but non-linear, interacting with each other, and together in complex interventions.

Of the 68 studies, the complexity of the influencing factors of complex interventions has been mentioned in some studies, but not all of them provide specific explanations. For example, the study by Adam et al [226] mentions the impact of several different health systems on complex interventions, yet does not explore the characteristics of complex systems such as non-linearity of effects or time delays. Furthermore, Kurk emphasized that considering the complexity of the intervention of improving quality of nursing care, researchers are required to treat several different components simultaneously[227]. However, the study offers little analysis or explanation of the links among these specific influencing factors.

A further study notes how the use of Electronic immunization registries (EIR) is influenced by multiple interrelated factors, including a strong strategy among partners, adequately staffed facilities, senior management training, use of data for monitoring, internet and electricity connections, and community outreach[170].

Several other studies identify the associations among these factors and yet lack a well-organized framework to present these relationships. For example, based on the study results of Atun [223], a new complex intervention involving organisational, financial, clinical and relational changes was developed in order to reform family medicine according to the Complex Adaptive System. More importantly, the analysis explores and illustrates the complex contextual and bi-directional interactions between innovation, adopters and the environment, which together ultimately influence the scalability of complex interventions.

In addition, Gruen supports how the relationship among the facilitators influences the scalability and sustainability of complex interventions[228]. In the implementation process of complex interventions, the allocation of resources depends on factors such as taxation, and financial assistance. In addition, interaction between governments, institutions, organisations and the countries providing assistance, collectively influences the scalability and sustainability of complex interventions.

In the case of large-scale infectious diseases, the process of implementing complex interventions involves diverse influencing factors, and the complexity of these factors is evident and linkages among these factors are strong. For example, the study of Rivière-Cinnamond [219] suggests that the determinants of endemicity of plague are complex, diverse and intertwined. Indeed, complex interventions for plague prevention and control cannot be accomplished by the Ministry of Health alone and may require assistance from stakeholder involvement, community participation,

media advocacy, and so forth.

Similar results can also be found in the study by Biswas [205], which argues that outcomes of these complex systems, or complex interventions concerned with the prevention and control of COVID-19 pandemic are unpredictable and complex. However, many organisations undertaking interventions fail to recognise the complex interactions among these influencing factors.

In summary, this section highlights a problem that researchers working on the development of complex interventions need to deal with. Although a researcher may have referred to a theoretical framework as a guidance, thought and discussed with other professionals as fully as possible about the barriers and facilitators to be faced when developing a complex intervention, many unexpected situations or influencing factors may yet arise during the actual implementation process.

3.4.3 The dynamics of influencing factors of adaptability, scalability and sustainability

Similar to the theoretical overview, this section analyses influencing factors in terms of both temporal and geographical dynamics.

For temporal dynamics, one situation that has emerged in empirical research is that the participation or adherence rate of a program gradually increases over time. In other words, there is a gradual increase in the acceptance of the project by the participants such that the project has been well adapted to the local context. For example, the study of Ansbro, (2021) [204], notes that home visits began in 2015 and that an appointment system with SMS appointment reminders and appointment tools was introduced to improve efficiency, achieving a 90% compliance rate by 2017.

However, not all project facilitators will increase, or barriers decrease, over time. For instance, in the study of Chu [207], notes that at a later follow-up period, some participating villagers felt that the content of the questions and implementation had become repetitive, and they did not have further new ideas to share, leading to a decline in participation. Also, the relatively low level of education of the local population led to an insignificant effect even though the intervention had been in progress for 18 months, with no significant difference in blood pressure between the intervention and control groups.

In general, geographical dynamics are a widespread problem at the macro level. When introducing a new intervention or one that may have already been implemented in other countries, a researcher may need to make specific adaptations to the specific local context in order to make the project run smoothly in that context[218, 223]. For example, although many empirical studies have used the CFIR framework as a guide in different geographical areas, researchers need to adjust to local contexts and specific influencing factors in order to make the intervention effective and sustainable[235].

In addition, some studies refer to geographical dynamics in their limitations. For example, as the 8 out of 26 selected community health centers were all located in rural areas of northern Vietnam, it is possible that the influencing factors identified in this study do not reflect the situation in other geographical areas of the country although similar health systems may encounter similar facilitators and barriers[210]. A further study states in its limitations that it only analysed the influencing factors changes of vaccination coverage in two regions and is not necessarily applicable to other regions in India[211].

Moreover, the geographical dynamics are also reflected in the urban and rural areas of the same region. The study of Mutale, (2017), argues that the infrastructure and medical resources may be superior in urban areas compared to rural areas, while

community participation is better in rural areas than in towns[180].

3.4.4 Links and differences in the influencing factors found in theoretical and empirical systematic reviews

Between Chapters 2 and 3 of this thesis, the relationship and distinction in the influencing factors found in theoretical and empirical systematic reviews are nuanced and multifaceted. The examination of these chapters reveals a layered understanding of how adaptability, scalability, and sustainability (ASaS) of complex health interventions are influenced across different contexts, particularly in LMICs. Here's a breakdown of the links and differences, along with specific examples and findings from both reviews:

Commonalities Across Reviews:

Both chapters identify that key influencing factors, such as sociopolitical context, funding, and leadership, are generally consistent across theoretical and empirical literature. This consistency suggests that empirical studies often employ theoretical models as a foundational guide, contributing to a degree of overlap in the factors highlighted by both reviews. For instance, over half of the empirical studies reviewed (39 out of 68) utilized theories or frameworks like RE-AIM and CFIR to guide their research. One possible reason for this is that increasing numbers of empirical studies use theoretical models as a guidance at the development stage.

However, the sub-components of some key influencing factors exhibit a degree of difference between the theoretical systematic review and empirical systematic review.

Differences Highlighted:

- **Specificity of Influencing Factors:** The empirical systematic review tends to provide more detailed descriptions of sub-components like age, gender, occupation, and personnel management, which are more broadly treated in

the theoretical review. This specificity indicates empirical research's capacity to address concrete realities and complex dynamics in intervention settings.

- **Cultural Factors:** Empirical studies delve into specific cultural contexts, revealing how culture can serve as both a facilitator and a barrier to intervention implementation. For example, in certain regions of Malaysia, cultural norms that favor matriarchal social structures were found to facilitate interventions aimed at women, contrasting with the more general discussions of culture in theoretical reviews.
- **Corruption and Local Governance:** Detailed considerations such as local governance and corruption issues are addressed in empirical reviews, highlighting specific challenges like those faced in Bangladesh during the COVID-19 response. These details offer insights into the practical complexities of implementing interventions in varied contexts, which are not covered in theoretical reviews.

Bridging Theory and Practice:

The interplay between theoretical and empirical findings underscores the necessity of integrating theoretical models with practical insights for the effective implementation of health interventions. The identified gaps and consistencies between the reviews advocate for a nuanced approach that considers the local context, cultural dynamics, and specific challenges of LMIC settings.

In summary, while both theoretical and empirical reviews converge on the critical importance of certain influencing factors for ASaS, the empirical evidence provides a more granular view of how these factors play out in specific contexts. This distinction underscores the value of empirical research in validating, refining, and expanding upon the theoretical understandings of complex health interventions' ASaS in LMICs

The strategic decision to focus exclusively on literature from Low- and Middle-Income

Countries (LMICs) in the second systematic review is driven by three key considerations, reflecting a deliberate methodological shift from the broader theoretical scope of the first review.

Firstly, the initial review highlights a scarcity of a general theoretical frameworks explicitly designed for or tested within LMIC contexts. Given this gap, it becomes imperative to cast a wider net to encompass a broader range of theoretical frameworks from both LMICs and High-Income Countries (HICs). This approach aims to identify and adapt relevant theoretical constructs that, while not initially designed for LMIC settings, may offer valuable insights or principles applicable to these contexts.

Secondly, by examining a wider array of theoretical frameworks, this study aim to assess how these models have been applied within LMICs, even if they were not originally developed for these settings. This exploration seeks to understand the adaptability of existing frameworks to the unique challenges present in LMICs, including variations in health systems, resource constraints, and cultural factors that influence health intervention implementation. Such an analysis is critical for identifying potential modifications or considerations necessary to make these frameworks more suitable for LMIC environments.

Thirdly, the focused examination of literature from LMICs in the second review directly supports the goal of developing a framework that is specifically tailored to the needs and conditions of LMICs. This approach acknowledges the distinct and diverse contexts of LMICs, underscoring the importance of developing health intervention frameworks that are both contextually relevant and grounded in the realities of these settings.

In summary, these methodological considerations underline the commitment to developing a robust, context-sensitive framework for Complex Health Interventions (CHIs) in LMICs. By incorporating a broad spectrum of theoretical insights and

examining their applicability within LMIC contexts, our research endeavors to bridge the gap between theoretical ambition and practical implementation, ensuring that the resulting framework is both comprehensive and directly applicable to the unique challenges faced by LMICs.

3.4.5 Limitations

Firstly, only four databases were included in the article, EMBASE, MEDLINE, PUBMED and Web of Science. Some grey literature or unpublished literature were not included. Also, only studies published in English were included, resulting in relevant studies not published in English being excluded.

As with the theoretical systematic review, this study may miss several relevant studies since not all potential keywords could be included in the searching process. Specifically, this study used the terms complex NEAR3 intervention* OR complex NEAR3 treatment* OR complex NEAR3 training OR complex NEAR3 system* OR adaptive system*). Hence, other relevant terms, such as implementation science, were not included.

As this was a PhD project study, the literature search and screening process were carried out independently by the researcher without the involvement of information professionals, which could have led to information bias and selection bias. In addition, the quality assessment of the included studies was also carried out independently by researcher and is therefore subject to the similar risk for bias. Although funding is widely discussed in the included literature, this may be a reporting bias as researchers who receive funding or who wish to attract future funding may emphasise this factor. Also, those researchers who discuss interventions with limited resources may illustrate the superior management capacity of their study group by emphasising the factor of funding. Hence, the underpinning narrative may be subjective rather than objective.

Additionally, although this study explores the influencing factors that are currently available in complex interventions and tries to map the relationships among these factors, it still does not provide a systematic framework for the relationships and linkages among these factors since the included studies did not focus on the relationships. Finally, this study explores the influencing factors of the three ASaS concepts.

3.5 Summary

The search strategy generally follows the methodology taken in the theoretical systematic review, but given the large number of empirical complex interventions and the workload, the filter was contracted by using the countries of all LMICs as qualifiers, according to the World Bank classification[159]. Overall, this chapter supports how the influencing factors collected were largely consistent for both theoretical and empirical reviews, and that the complexity and dynamics of the influencing factors mentioned in the theoretical review were concretely reflected in the empirical studies. However, both the theoretical and empirical systematic reviews were incomplete and incomprehensive in describing the relationships among the influencing factors. These shortcomings directed the researcher's focus and discussion in the second year, explored using a Delphi survey.

Also, based on the results of Chapter 2 and Chapter 3, three main gaps are identified. The first gap is that the current conception of the focus on complex health interventions remains relatively homogeneous, focusing mainly on one or two of the concepts such as scalability, without a unified analysis that acknowledges the interdependencies of the three related concepts identified in this study (ASaS).

The second identified gap is that previous literature has not adequately discussed the

non-linear nature of the links and correlations among the factors influencing complex health interventions. This study is designed to further explain and clarify the correlations and links among these influencing factors.

The third identified gap is that current TMFs of complex health interventions are mainly generic or have been designed for high-income countries, while TMFs for LMICs are less common. This study aims to construct a TMF for LMICs to describe the influencing factors of ASaS of complex health interventions.

Chapter 4 Research approach and methods

4.1 Chapter Overview

This chapter mainly describes the research methodology and methods utilised to collect and analyse data to address the research objectives. First, the philosophy underpinning the research approach, a Delphi mixed methods approach, incorporating quantitative and qualitative research methods of data collection and analysis, is discussed, followed by the a description of the stages of the Delphi data collection and analysis.

4.1.1 Research paradigm

In the realm of public health research, the four commonly agreed paradigms—postpositivism/post-positivist, constructivism/interpretivist, transformative, and pragmatism—each offer distinct perspectives on how to approach complex issues[236]. Quantitative studies in this field primarily align with positivism or post-positivism, which is rooted in the principles of natural science. This paradigm asserts the existence of logical causal connections both within and between phenomena, emphasizing the need to identify and scientifically validate these relationships using rational tools[237]. On the other hand, the paradigm for qualitative research, interpretivist or constructivism, diverges significantly. Constructivists, who are not realists but ontologically relativistic, argue that what are commonly referred to as 'facts' are subject to change depending on historical, geographical, contextual, and personal factors, making them not inherently 'true' or 'false' but rather assessed based on their 'appropriateness' to researchers' inherently subjective expectations'[238]..

Transformative theory focuses on marginalized groups and emphasizes addressing inequalities related to gender, race, ethnicity, disability, sexual orientation, and socio-economic class through political and social action, linking research aims directly to policy changes. Meanwhile, pragmatism, a philosophical tradition that understands

knowing the world as inseparable from agency within it[239],

“does not commit to any single system of philosophy or reality. It emphasizes the use of all available methods to solve research problems, making it well-suited for mixed-method research, which combines both qualitative and quantitative research approaches. This flexibility allows researchers to freely choose the methods, techniques, and procedures that best suit their purposes, avoiding the constraints of subscribing solely to quantitative or qualitative methods.” [240]

This study involves a certain level of complexity. The primary objective is to identify the factors influencing the ASaS of complex health interventions and to further develop a theoretical framework that is more applicable to LMICs. Initially, this study conducted a literature review, which provided a foundational understanding of the influencing factors of ASaS but was not sufficient. Therefore, the study also aims to identify and collect a comprehensive range of potential influencing factors.

Given the need to collect both qualitative and quantitative data, a single paradigm aligned only with qualitative or quantitative research is unsuitable for this study. Instead, an approach that allows a flexible, adaptable approach that can incorporate insights from multiple paradigms simultaneously – a pragmatic mixed methods approach – was considered appropriate. By employing the Pragmatic Worldview, the study does not limit itself to predetermined methodologies but remains open to employing whichever methods are most effective at each stage of the research, thereby ensuring that the resulting Theoretical Model Framework (TMF) is both robust and directly applicable to improving health outcomes in diverse settings.

Pragmatism informs the research design by prioritizing practical solutions over rigid adherence to a single methodological approach[241]. It is the most appropriate paradigm for this study because it accommodates the complexity of the research objectives and the diverse data collection methods required[241]. This paradigm

supports the integration of qualitative insights and quantitative rigor, ensuring a comprehensive understanding of the factors influencing ASaS in LMICs. By adopting a pragmatic approach, the research remains flexible and responsive to emerging findings, ultimately enhancing the applicability and impact of the TMF developed through this study.

4.1.2 Methodology

As mentioned previously, this study requires a balance between qualitative and quantitative research. Next the mixed methods approach is described, including a rationale for choosing this approach.

A Mixed Method approach,

“is an approach to inquiry that combines or associates both qualitative and quantitative forms. It involves philosophical assumptions, the use of qualitative and quantitative approaches, and the mixing of both approaches in a study. Thus, it is more than simply collecting and analyzing both kinds of data; it also involves the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research”[56].

The principles of pragmatism align with the use of both qualitative and quantitative approaches[241]. Pragmatism values the integration of various methods to address complex research questions, focusing on practical outcomes rather than methodological purity[241]. This perspective supports the use of mixed methods, as it allows for the combination of qualitative insights and quantitative data to provide a comprehensive understanding of the research problem[241]. Pragmatism's emphasis on flexibility and adaptability makes it particularly suitable for studies requiring diverse data sources and analytical techniques[241]. Pragmatism is fundamentally outcome-oriented, prioritizing the practical implications and applicability of research findings[242]. This paradigm supports methodological pluralism—the use of multiple

methods to achieve a more robust and nuanced understanding of research questions[241]. By leveraging both qualitative and quantitative approaches, researchers can capture a wide array of data, leading to more actionable insights.

For instance, while quantitative data might reveal statistical trends and correlations, qualitative data can provide deeper insights into the experiences and perspectives of individuals affected by health interventions. This dual approach ensures that the research findings are not only statistically significant but also contextually rich and meaningful, thereby enhancing their practical applicability.

4.1.3 Justification for using mixed method as methodology

In this study, the mixed method approach is appropriate for methodological purposes as different methods are used to collect both qualitative and quantitative data. Mixed methods combine both inductive and deductive reasoning and is grounded in the fundamental belief that a single method or mono-method is insufficient to fully address any research question.[243].

Choosing the mixed method approach as the methodology for this study offers distinct advantages over using purely qualitative or quantitative methods alone, particularly in the context of complex health interventions[244]. Mixed methods combine the statistical power and generalizability of quantitative research with the depth and contextual richness of qualitative research[244]. This dual approach provides a richer, more complete understanding of the phenomena being studied[244].

In health studies, a holistic approach is crucial as it considers both measurable outcomes and nuanced, context-dependent factors[245]. Quantitative methods offer broad trends and patterns that are essential for generalizability and scalability of findings. However, they may overlook underlying motivations, experiences, and contextual details that qualitative research can reveal[245]. Conversely, while

qualitative methods provide detailed and in-depth insights, they may lack the broad applicability needed to inform policy or practice at a larger scale [245].

By bridging these gaps, mixed methods enhance both the depth and breadth of insights into complex health interventions. This integrative approach ensures that the research findings are both comprehensive and applicable to real-world settings, thereby improving the validity and reliability of the study outcomes. This synergy is particularly aligned with the Pragmatic Worldview, which advocates for methodological pluralism and the use of diverse tools and approaches to solve practical problems effectively[246].

4.1.4 Delphi survey using mixed methods

In mixed methods research, several specific designs allow for the simultaneous collection of both qualitative and quantitative data, providing a comprehensive view of the research problem by leveraging the strengths of both data types[247]. The Delphi technique uses multiple rounds of surveys to gather expert opinions, including qualitative data from open-ended questions and quantitative data from rating scales, helping to build consensus on complex issues[248]. The Nominal Group Technique (NGT) involves participants generating ideas individually (qualitative data) and then discussing and prioritizing these ideas as a group, often through ranking or voting (quantitative data)[249]. Questionnaires and surveys can be designed to include both closed-ended questions (quantitative data) and open-ended questions (qualitative data), allowing for the collection of comprehensive information in a single instrument[250]. Mixed-methods also include structured or semi-structured interview guides that incorporate both quantitative questions (e.g., scales, yes/no questions) and qualitative questions (e.g., open-ended questions to explore experiences or opinions)[250]. Case studies integrate various data sources, including quantitative surveys and qualitative interviews or observations, to provide a detailed

understanding of the case[251].

the Delphi method was selected as the most appropriate methods due to their unique advantages in generating both qualitative and quantitative data[252]. Practical considerations, such as the inability to offer financial incentives to participants in this study, the relatively large number of participants and their global geographic diversity, made it difficult to convene a face-to-face meeting. In addition, to minimise group pressure and to protect participants' personal information, the use of Delphi was appropriate for this study[253].

Typically, in the first round of the Delphi method, a qualitative method similar to brainstorming is used to gather as much information as possible, and each subsequent round of the questionnaire, usually seeks to 'quantify early findings'[254]. Thus, the Delphi method would be considered a mixed method, combining qualitative and quantitative methods of consensus building[255]. Also, the Delphi method, with its iterative rounds of qualitative and quantitative data collection, aligns well with the pragmatic emphasis on flexibility and adaptability[248]. It allows for the continuous refinement of ideas based on expert feedback, ensuring that the final outcomes are relevant and applicable to real-world contexts[248]. Consensus meetings further enhance this alignment by providing a platform for experts to engage in in-depth discussions, validate findings, and collectively make decisions[256]. This collaborative approach is central to pragmatism, as it values the contributions of diverse perspectives and the integration of multiple forms of evidence to develop practical and effective solutions. Therefore, the Delphi method was chosen as the method used in this study.

4.1.5 The Delphi process

The Delphi survey was selected as the methodological approach for its unique capacity to converge diverse expert opinions on the adaptability, scalability, and sustainability

(ASaS) of complex health interventions, particularly within the challenging contexts of low- and middle-income countries (LMICs). This methodology offers several advantages over alternatives like focus groups, expert panels in real-time settings, or simple surveys.

One of the critical strengths of the Delphi survey is its ability to facilitate consensus building in complex fields, which is invaluable for health interventions in LMICs where the context and variables are numerous and intricate. The Delphi method allows for iterative rounds of questioning, enabling a structured way to build consensus among experts and a deeper dive into complex issues [257]. Unlike one-time surveys or focus groups, the Delphi technique provides a more dynamic and nuanced approach to understanding expert opinions and developing coherent strategies.

Additionally, the Delphi survey enhances the quality of data collected by offering anonymity, thus mitigating the bias that could be introduced by dominant personalities often present in face-to-face meetings or panels. This aspect of the methodology contrasts sharply with other methods where direct interaction could skew contributions towards a consensus driven more by authority than by evidence [258].

The method also supports global and diverse participation, overcoming the logistical and financial constraints of physically gathering experts from around the world in one location. This global perspective is crucial for research focused on LMICs, ensuring that the findings are inclusive and representative of the varied contexts within these countries [259].

The inherent flexibility and adaptability of the Delphi method's design allow for adjustments based on the evolving understanding of the research topic. This adaptability makes it superior to more static methods, enabling the research to more

accurately reflect the dynamic nature of health intervention strategies in LMICs [260].

Furthermore, unlike other qualitative methods that might concentrate on existing knowledge or retrospective analysis, the Delphi technique is forward-looking, emphasizing forecasting and planning based on expert predictions. This characteristic is particularly beneficial for developing frameworks aimed at future implementation of health interventions[261].

To ensure the trustworthiness and quality assurance of the Delphi method used in this study, several key aspects were meticulously considered. Rigorous expert selection was paramount; a diverse and well-informed panel of experts was carefully chosen to participate in the Delphi survey. The selection criteria aimed to encompass a broad range of perspectives from various disciplines and geographical locations, with a particular emphasis on including voices from LMICs to ensure the relevance and applicability of the findings.

The Delphi method's iterative nature, with multiple rounds of questionnaires, allows for the refinement of ideas and the achievement of a nuanced consensus among experts. This approach facilitates a thorough exploration of the ASaS factors, ensuring that the final consensus reflects collective expert insights. Maintaining the anonymity of responses was a critical feature of the Delphi process, helping to reduce potential biases that might arise from dominant personalities or hierarchical relationships among experts. This anonymity encourages open and honest feedback, contributing to the quality and reliability of the data collected.

After each round, summarized results were shared with the participants, providing a transparent feedback loop that enabled experts to reconsider their views in light of the collective responses. This transparency and openness to revision further contribute to the trustworthiness of the process and enhance the validity of the study

outcomes.

Integration of Qualitative and Quantitative Data

In the initial rounds of the Delphi method, qualitative data collected through open-ended questions were coded and categorized to identify key themes and patterns. This qualitative analysis provided in-depth insights into the factors influencing the ASaS of complex health interventions.

Subsequently, these themes inform the development of structured questionnaires for the later rounds, where quantitative data were collected using rating scales and other closed-ended questions. The quantitative data were statistically analyzed to measure the level of consensus among experts and to quantify the importance and relevance of the identified factors.

The integration of qualitative and quantitative data occurred through a process of triangulation, where the qualitative findings from the initial rounds were used to validate and explain the quantitative results. For example, if a particular factor was rated highly in the quantitative analysis, the qualitative data would provide insights into why this factor was considered important. Conversely, discrepancies between the qualitative and quantitative data would be explored to uncover underlying reasons and refine the research framework. This iterative process of qualitative and quantitative integration ensures that the final model is both comprehensive and grounded in the practical experiences and expert opinions of the participants.

Researcher Positionality

As the researcher, my positionality significantly influenced the study's design and implementation.

My positionality as a researcher significantly influenced the design and

implementation of this study. Growing up in China, my cultural background was shaped by traditional Chinese culture and values. I have been working and studying in the field of implementation science for four years. My undergraduate education in clinical medicine profoundly influenced my research perspective and methodology. I hold a bachelor's degree in clinical medicine and shifted to public health during my graduate studies. In the field of public health, I have accumulated extensive academic and professional experience, particularly in conducting health intervention projects in low- and middle-income countries (LMICs). These experiences have provided me with a deep understanding of the challenges and opportunities in implementing health interventions in diverse contexts. Witnessing the challenges of adaptability, scalability, and sustainability in health interventions in LMICs firsthand has motivated me to pursue this research, aiming to contribute to the development of more effective implementation strategies. I acknowledge that my background and experiences may bring certain biases and assumptions to the research. For instance, my belief in the importance of community-based approaches might influence my interpretation of the data. Recognizing these biases is crucial for maintaining objectivity and rigor in my analysis. To mitigate the influence of my positionality, I actively engage in reflexivity, continually reflecting on my perspectives and their impact on the research. Additionally, I seek diverse viewpoints by collaborating with colleagues from different backgrounds and disciplines. By acknowledging and reflecting on my positionality, I aim to provide a clear context for understanding the study's findings and their implications for the field.

Study Timeline

The following timeline (Box 1) encapsulates the phased approach undertaken in this research project, starting from the initial conceptualization through systematic reviews, data collection via Delphi survey and consensus meeting, to the development of a comprehensive framework and completion of the thesis document. Each phase was meticulously planned and executed to ensure a thorough investigation and

development of a novel framework tailored to the unique challenges of implementing complex health interventions in LMICs.

Timeline of this study

This timeline outlines the key phases and milestones of the study, from its initiation in October 2020 through to the final submission of the thesis in October 2023. Each stage of the study is designed to incrementally build upon the previous, culminating in the development of a comprehensive framework for understanding and enhancing the adaptability, scalability, and sustainability (ASaS) of complex health interventions in low- and middle-income countries (LMICs).

Box 1 The timeline of the overall study

Study Timeline Overview

Start of Study: October 2020

- **October 2020:** Initiation of research with preliminary literature review to identify existing gaps in the field of complex health interventions in LMICs.

Year 1 (2020-2021): Systematic Reviews

- **October 2020 - June 2021:** Conducting the first systematic review of theoretical frameworks to understand the adaptability, scalability, and sustainability (ASaS) of complex health interventions.
- **June 2021 - September 2021:** Conducting a second empirical systematic review to explore and validate the influencing factors of ASaS identified in the first review.

Year 2 (2021-2022): Ethical Approval, Pilot Study, and Delphi Survey

- **October 2021 - June 2022:** Securing ethical approval for primary data collection and conducting a pilot study to refine the research instruments.
- **July 2022 - September 2022:** Development and refinement of the Delphi survey questionnaire based on insights from the pilot study.
- **October 2022 - April 2022:** Execution of the Delphi survey across multiple rounds to gather expert opinions on the influencing factors of ASaS.
- **Round 1 (October 2022 - December 2022)**
- **Round 2 (January 2023 - February 2023)**
- **Round 3 (February 2023 - March 2023)**
- **April 2023:** Conducting a consensus meeting with Delphi participants to discuss the survey findings and address any unresolved issues.

Year 3 (2023): Framework Development, and Thesis Writing

June 2023 - September 2023: Writing and revising the thesis document to encapsulate the research findings and the developed framework.

October 2023: Final submission of the thesis for academic review.

Consent

In the email soliciting potential expert participants for the study, the attached UREC information sheet detailed how the data are handled and stored throughout the project. The letter informed experts that they were required to complete the Delphi questionnaire online and that Qualtrics was used to administer the survey.

Studies have shown that online surveys do not have the same response rate as other methods such as mail, telephone or fax [262-264]. This may be due to poor design by the researcher[265] or because the recipient's Internet security system identifies the incoming email as 'spam' [266]. The link to the questionnaire contained two sections; the consent form followed by the formal questionnaire; if an expert did not complete the consent form, they were considered to have withdrawn from participation in this study. Potential expert participants were encouraged to contact the researcher or the supervisors of the researcher by email or telephone if they had any questions about the study. In addition, experts who completed the consent form but were unable to complete the first round of questionnaires due to time constraints, the investigator followed up with an email to encourage them to participate in the second round of the Delphi questionnaire.

4.2 Delphi survey study phase

4.2.1 Study design

The Delphi method is first applied by the RAND Corporation in the 1950s and has since been widely used in environmental, healthcare and transport disciplines[267]. The essential components of the Delphi method involve maintaining participant anonymity in responses, employing multiple rounds or iterations, and providing participants with the chance to review feedback and revise their perspectives.[268]. Currently, in the health field, the Delphi method is being used extensively, many studies employ it within the various disciplines of clinical medicine, nursing, public

health including epidemiology, health economics and the development of indicators to evaluate the quality of health services[27].

The Delphi method is a “structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback”[269]. The Delphi method can be described as an approach for organizing a group communication process in a way that effectively enables a collective of individuals to address a complex problem.[270, 271]

The Delphi method has generated multiple variants over the years.[272] However, these different Delphi methods still share key features. For example, Beretta [273] lists the common characteristics of Delphi techniques as being:

“A panel of experts are used as the respondents; Exercises are conducted in writing, using sequential questionnaires; There is an attempt to produce a consensus of opinion; Anonymity of the panel and statements are guaranteed; There is use of iteration and controlled feedback; Exercises are conducted in a series of rounds. A summary of previous rounds is communicated to and evaluated by the panel.”

Rowe and Wright [274] provides four key characteristics of the Delphi method:

“Anonymity of Delphi participants, to reduce social pressure to conform to group views; Iteration to allow participants to change or refine their views in the light of the group’s progress from round to round; Controlled feedback to inform participants of the ideas and views of other participants; Statistical aggregation of group response, allowing quantitative reporting and interpretation of data.”

Generally, the Delphi method is basically carried out in the form of a questionnaire. After collecting the questionnaires completed by the experts, the researcher collates

the responses to the questionnaires and presents the results of the analysis, collation and summary as feedback to the expert participants.

Experts are then usually asked to rate whether they agree with the statements or domains via using a Likert scale or other similar methods[275]. The results of Likert scale indicate the level of agreement with each statement, or the percentage of experts who agree with the statement[275]. The Delphi method generally involves three rounds, during each of which participants are allowed to change their views as they learn about the views of the other group members and eventually reach a consensus of opinion, or at least a level of relative static in the opinions of the experts[275].

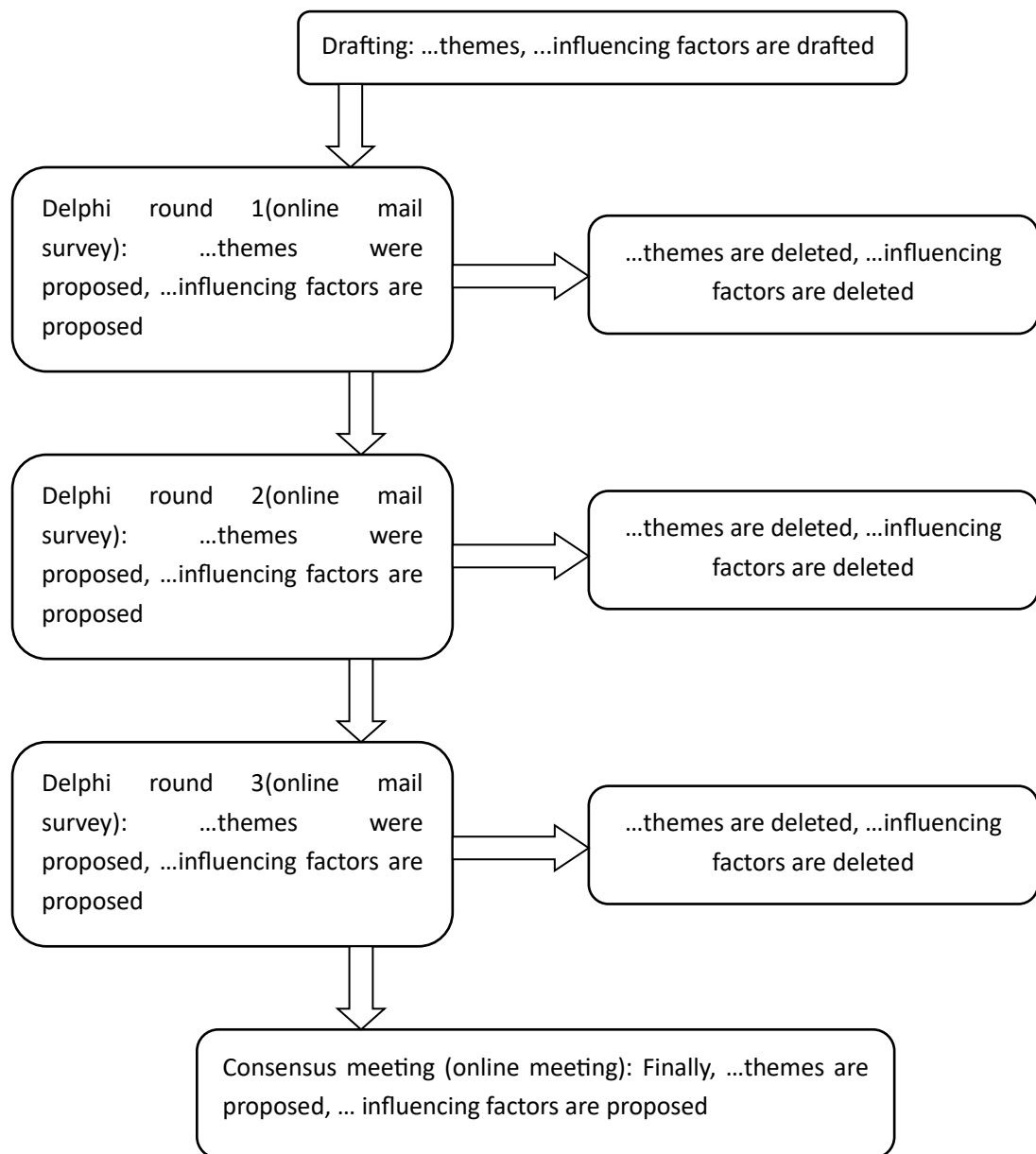
In view of the need to recruit experts from different regions of the world, the eDelphi Technique was chosen in this study and an electronic questionnaire was used. Experts sought for this study are typically international researchers or development workers who work in the LMICs. Also, using eDelphi Technique allowed experts to select their own time to participate in the survey and reduced geographical constraints on the study.

In terms of the rounds of the Delphi survey, a classical three rounds Delphi survey[258] is employed. Also, a pilot study was added in this study. As for the data collection, the aim of the pilot study is to develop the anonymous online questionnaire of this survey. Subsequently, the anonymous online questionnaires are used in the three rounds of Delphi survey.

As for the data collection tool, Qualtrics was used for electronic data collection to ensure ease and reliability of expert responses. One-to-one communication between the organisers and all invited experts was conducted via email to ensure that the experts understood the content of the items and the principles of Likert scale scoring,

but did not interfere with their subjective judgements.

This Delphi survey lasted approximately 3 months and, each round lasting 4 weeks, and the consensus meeting lasted approximately 2 hours. The comprehensive process of the Delphi survey is illustrated in Figure 4.

Figure 4: Flow chart of the study

The survey is structured in a way that maintains anonymity among experts, making it impossible for them to identify the source of any given opinion and ideally preventing them from knowing how many other experts share a particular viewpoint[275]. This approach is intentionally designed to prevent any one individual from unduly impacting the outcome due to their perceived authority, knowledge, or expertise. It also discourages participants from altering their opinions simply to conform to the prevailing consensus, as the most common viewpoint may not necessarily be the most accurate[275]. The goal is to ensure a diversity of perspectives for experts to consider without pressuring them to adopt a single viewpoint. This method confers distinct benefits when compared to collective methodologies such as the utilization of focus groups. In the latter, individuals who are notably assertive or self-assured in articulating their perspectives may exert disproportionate sway over the ultimate outcome.[275]

According to previous related studies, the decision rules for reaching consensus are divided into supermajorities and simple majorities (Organization, 2014). The thresholds of supermajority was decided by myself and my supervisors, the most common being 90%, 80%, 75%, 70% two-thirds and 60%. A simple majority means over 50% of the participants reach an agreement[276].

The conclusion drawn is that there isn't a singular, universally "correct" Delphi method. However, as Skulmoski, Hartman and Krahm [258] say: "the method is modified to suite the circumstances and research question". Hence, in this study, a consensus rate of 70% was set to achieve consensus.

4.2.2 Description of Participants

Choosing appropriate participants is a crucial aspect of a Delphi study. [277]

In general, the experts involved have experience and interest in the field or subfield

relevant to the topic. A poor selection of expert members can not only bias the results of a Delphi study, but also lead to a lower response rate between rounds of evaluation[248]. The basic principle in selecting valid experts is that they must be broad, representative and authoritative, taking into account the relevant areas of expertise and geographical distribution[248, 278]. For example, Adler & Ziglio[269] list four criteria that Delphi participants should possess:

“knowledge and experience of the subject matter, ability and willingness to participate in a Delphi survey, sufficient time to participate, and effective communication skills.”

The guidelines for conducting research using the Delphi survey technique assert that there are no established norms or precise criteria in existing literature for the selection of Delphi participants, “throughout the Delphi literature, the definition of ‘Delphi subjects’ has remained ambiguous”[248]. In order to optimise identification of target participants, this study applied the theory of participant identification from a previous study [279], adapting it to the characteristics of this study.

This study recruited researchers and practitioners from different countries and regions who have conducted theoretical studies or empirical studies since these participants from various geographic and cultural backgrounds contribute a wealth of expertise and insights, enriching the depth of the conversation[279].

The Delphi method requires selection of experts who have knowledge and working or research experience in complex health interventions related areas. In the subsequent analysis process, in order to compare the viewpoints among participants, the recruited participants were divided into two groups: high-income countries (HICs) group and low- and middle-income countries (LMICs) group. This choice was made because researchers from LMICs would likely have day-to-day familiarity with the constraints of the conditions in LMICs. However, many researchers from high-income countries also have extensive experience in implementing complex health interventions in LMICs.

Therefore, this study identified these potential participants in two ways. The first approach was to identify researchers who have been identified or referenced in previous systematic reviews.

Based on an analysis of organizations that frequently collaborate in the field of Implementation Science, as reflected in relevant publications, and institutions affiliated with authors who have published work on TMFs (Theoretical Models and Frameworks), a list of these entities was identified. Secondly, the potential participants were identified from diverse health related institutions or organisations including World Health Organisation (WHO), The Global Alliance for Chronic Diseases (GACD), National Health and Medical Research Council (NHMRC), São Paulo Research Foundation (FAPESP), Canadian Institutes of Health Research (CIHR), Directorate General - Research & Innovation, European Commission, Indian Council of Medical Research (ICMR), Agency for Medical Research and Development (AMED), Health Research Council (HRC), South African Medical Research Council (SAMRC), Health Systems Research Institute (HSRI), UKRI Medical Research Council (UKRI MRC), UK Department of Health and Social Care (DHSC), US National Institutes of Health (NIH), Quiescent Member: Secretariat of Government of Health (MINSAL), Quiescent Member: Chinese Academy of Medical Sciences (CAMS), Quiescent Member: National Council of Scientific and Technological Development (CNPq).

4.2.3 Sampling and Recruitment

For recruitment, a purposive sampling strategy was used to recruit a panel of participants. As this was a PhD project and there were no financial incentives for participants, a refusal rate may reach 40% to 50% based on the similar studies[279]. In addition, there can be attrition during the course of a Delphi study, which is typically in the region of 20-30%[280].

The sample sizes in Delphi studies exhibit significant variation, primarily due to the number of recognized experts in a specific field, which can be either extensive or quite limited. Additionally, constraints on time and available resources for the researcher may restrict the sample size. However, the Delphi process inherently accommodates the use of very large sample sizes, particularly since the survey is frequently administered through questionnaires distributed by mail or email.

For example, Turoff [260] advocates for sample sizes between ten and fifty in Delphi studies, whereas Skulmoski, Hartman, and Krahn [258] reported sample sizes ranging from four to one hundred seventy-one in their survey of Delphi studies. Generally, at least 12 participants are sufficient to achieve consensus in a Delphi survey, which is an evidence-based approach to study using qualitative research[281-283]. This study planned to recruit at least 50 experts from different countries since this study tended to recruit of experts from different countries and geographic regions around the world to obtain fruitful information about the ASaS of complex health interventions.

In the initial step of the Delphi survey, the email invitations were sent to 160 potential panelists assuming a 40 % to 50% rejection rate. The email was accompanied with a participants' information sheet that provides information about the study, the study purpose, how ethical issues are dealt with, any potential risks, as well as their rights as participants.

In accordance with the study results of Boel [284], Bringing back panel members who were absent in a previous round for a subsequent round can improve the accuracy of the opinions of the initially invited panel and decrease the likelihood of a misleading agreement, but it does not affect the ultimate result of the Delphi.

Hence, given that the first round of the Delphi questionnaire was open-ended and had more questions and took longer to fill in, it was made clear during the first round of

the Delphi when inviting experts that they could skip the first round and participate directly in the second round if they were busy or temporarily unable to participate due to time constraints. Therefore, in this Delphi study, there may be cases where some experts only completed the second and third rounds of the Delphi questionnaire without completing the first round.

Questionnaire Dissemination

After receiving the invitation email, the experts received another personalised email with a unique URL link that briefly described the project and led them to the Qualtrics website. In the Qualtrics included the consent form and the first questionnaire. In addition, details of the project were attached to the UREC information sheet inside the email and they were told that the process of filling out the questionnaire would take no more than 40 minutes. Experts were given a four-week window to fill out the questionnaire, with a notification that a reminder email would be dispatched to non-respondents after 14 days. All responses were saved on the 'Qualtrics' website first and then would be saved in the X: Drive.

4.2.4 Data collection

Pilot Study and the Development of the Final Questionnaire

A pilot study was used to inform the design of the Delphi questionnaire. The first draft of the questionnaire was piloted with a group of four people, including three university professors and a Centers for Disease Control and Prevention (CDC) staff member. The pilot questionnaire was considered important in supporting stakeholder engagement and guiding the Delphi process[285]. The pilot study had three main objectives: firstly, to identify any potential issues with the questionnaire's wording; secondly, to ensure the ease of use for respondents in the online format; and thirdly, to uncover any software or hardware-related problems. It was crucial to evaluate the questionnaire on various computer systems, including PCs and Apple Macs, with different Internet

connection speeds, and using different Internet browsers, providers, and screen settings. Additionally, specific questionnaire design elements required testing, such as the facility for respondents to access or return to the questionnaire at any time and a format to prevent respondents from advancing if they skipped a question. A fourth objective of the pilot study was to determine the time needed to complete the questionnaire.

Comments and suggestions obtained from experts involved in the pilot study resulted in 27 amendments to the pilot study .

The purpose of the first round of the survey was to identify possible influencing factors on ASaS for further evaluation in subsequent rounds of the survey. While the systematic reviews had identified numerous questions to present to experts in the first round of the questionnaire, making it lengthier compared to the second and third rounds, efforts were made to streamline the initial questionnaire as much as possible.

The genesis of the first-round questionnaire was methodically derived from both pilot study data and the outcomes from the systematic reviews. The researcher proceeded with a sequential questioning approach, inquiring about the factors influencing each stage of the intervention implementation process. This strategy was adopted because the primary objective in the first round of the Delphi survey was to gather as many influencing factors as possible, aligning with the goals surfaced by the review phase. The suitability of these factors to the research objectives was to be assessed and evaluated in the subsequent second and third rounds of the Delphi process.

All three questionnaires were kept concise given a negative correlation between the number of questions and response rates in online surveys. [286] . In addition, the questionnaire was designed with utmost simplicity to address concerns regarding technical problems, including potential delays caused by intricate graphics downloads

and compatibility with various web browsers and hardware systems.

To ensure the reliability and validity of the data collected by the online questionnaire, several measures were taken in designing the questionnaire. Firstly, it was ensured that the questionnaire was technically free from errors such as broken links or missing pages and was compatible across different web browsers and hardware platforms. The research team also addressed issues with internet connectivity and accessing and completing the questionnaire on mobile devices. To reduce the risk of these technical issues, research team tested the questionnaire on multiple platforms and browsers in advance and resolved potential technical issues in a timely manner. These measures ensured that accurate and reliable data were collected, and increased participant satisfaction in completing the questionnaire.

Round 1

- **Types of data collected**

In Round 1, the focus was primarily on collecting qualitative data, as the goal was to gather as wide variety of factors influencing ASaS as possible. This initial round aimed to lay a comprehensive foundation by identifying relevant factors, with the results section designed to reflect this expansive collection approach.

- **Specific data information to be collected**

Specifically, this survey collected basic demographic information of participants: including gender, age, title, education, years of work, field of work and the study areas (high-income countries, LMICs or both). These were summarized using descriptive statistics such as frequency and percentage.

In this round, firstly, experts were asked to write down the factors influencing the ASaS of complex health interventions according to their knowledge and experience. After the experts provide the influencing factors, they were also requested to provide the

relevant reasons and justifications for these factors. Subsequently, under each concept of ASaS, three questions were set for the experts to answer, and these questions were developed based on the studies identified from the two reviews. Additionally, experts are invited to express their opinions on the definitions of the three concepts of ASaS in the first round of the questionnaire.

Surveys were available online for a maximum of four weeks, and if participants hadn't responded, reminder emails were sent around seven days after the initial invitation. Once the participants' responses were received, the gathered data was transformed into a meticulously organized questionnaire. The questionnaire is shown in Appendix 9.

Round 2

- **Types of data collected**

The second round of research collected both qualitative and quantitative data. In terms of quantitative data collection, this phase of the study entailed the application of a Likert scale to rate the importance of the previously collected factors. For qualitative data collection, the experts were also asked to interpret the scores they gave.

- **Specific data information to be collected**

In the second round, each Delphi participant was given a second questionnaire via emails to review and score the factors influencing the all three concepts of ASaS of complex health interventions by using a 9 points Likert scale (Bertram, 2007). In accordance with the study of Chyung (2017), the 5-point, 7-point and 10-point Likert scales were the easiest to use, while the 2-point, 3-point and 4-point scales were the fastest to use. On the other hand, respondents felt that a 9, 10 and 11-point Likert scale would give them the opportunity to express their feelings better.[287] In this

study, to enable participating experts to think holistically and give feedback, this study therefore used 9 points Likert scale

Based on the factors influencing ASaS identified in the first round of the Delphi study, as well as those gathered from the two prior systematic review, this research develops a new list of ASaS factors. This new list integrates all the factors mentioned in both the first round of Delphi study and the two systematic reviews. The experts were required to evaluate the importance of these factors and comment accordingly. Specifically, in this process, experts first rate the importance of each factor within its respective theme. Subsequently, they rate the importance of each theme across the three dimensions of ASaS. This approach helps reduce the burden on experts and saves time.

In addition, participants were able to comment on any influencing factors and the experts were allowed to use the free text to further clarify or add to the research questions.

Round 3

- **Types of data collected**

In the third round, similar to the second Delphi process, both qualitative and quantitative data were collected. The purpose of continuing this methodology was to not only rate the factors collected by using Likert scale, but also to allow the experts to provide detailed explanations of their assessments. This allowed for a comprehensive assessment of the factors that had been the subject of controversy in the previous discussions, as the experts were able to articulate their reasoning, thereby increasing the depth of the analysis and the understanding of the results.

- **Specific data information to be collected**

In the third round, each Delphi group member was given a questionnaire that included

a rating of the influencing factors summarised from their previous round of comments together with reasons why some of the influencing factors fall short of consensus. In Round 3, the Delphi group members had the opportunity to reflect further on the importance of scoring the influencing factors and reasons why they give this. In addition, they could also express their opinions and views on the themes in the free text section of the questionnaire.

4.2.5 Data analysis

Basic demographic information relating to experts includes gender, age, title, education, years of work, and field of work. Data were summarized using descriptive statistics such as frequencies and percentages.

The completion rate of experts

The completion rate of experts = number of participants who responded to the consultation / number of participants selected $\times$ 100%. The higher the positivity coefficient, the higher the level of interest of the participants in the study.

Round 1

In the first round of Delphi survey, a large amount of qualitative data was analysed thematically. Following the advice of Krippendorff[288], it is advisable to use three coders from similar professional backgrounds to ensure coding accuracy. However, as this study was a PhD thesis, it was not possible to recruit other researchers to code alongside.

During the analysis of the qualitative data collected in the consensus meeting, the thematic analysis method was employed[289]. Specifically, it contained the following steps:

1. Become familiar with the data

Considering the data were in the form of audio/video files, the researcher took the role of transcribing these data to transcripts. Subsequently, the transcripts were read carefully and notes were actively taken to record the meanings and patterns that appeared across the data set to prepare for the potential codes to create.

2. Generate initial codes

The NVivo software was used. After familiar with the data, a set of initial codes were developed to represent the meanings and themes. A codebook was created to keep track of the codes. Subsequently, the excerpts in line with the themes were identified and appropriate codes were applied to them. Also, the excerpts representing the similar or the same meaning were assigned the same code.

3. Search for themes

After generating a set of initial codes, the similarities and overlaps between codes were identified, and the codes were sorted into potential themes. Furthermore, the potential themes were further explored whether there are themes can be made into sub-themes.

4. Review and revise themes

In the step, the initial set of themes were reviewed and revised to guarantee each theme is mutually exclusive and that each has sufficient data to support them. The similar themes were merged and the themes with insufficient data backing up were deleted. The revisions made were all based on the themes mentioned in the currently available TMFs as well as the modifications mentioned in the questionnaire by the experts

5. Define themes

In this step, the essence or the definitions of each theme was explored. Also, the relationships among diverse themes were explored. Additionally, the interact and the correlations among sub-themes and main themes were explored.

6. Write narrative

The final step of analysis was the production of a dissertation. “Writing and analysis are thoroughly interwoven in qualitative research—from informal writing of notes and memos to the more formal processes of analysis and report writing.”[290]

Round 2

In the second round of Delphi survey, SPSS software was used to calculate the descriptive statistics – mean, mode of Likert scale in each group.

When the consensus rate for an influencing factor was lower than 50% (50% or less experts rating the indicator in the upper third (7-9)), this factor would be given a final opportunity to be scored and discussed in the third round of the Delphi survey. If this factor did not meet the prior consensus rate of third round of Delphi survey (65% or more of the experts rated the indicator in the upper tertile (7-9)) consensus rate, this would be discarded. When the consensus rate for an influencing factor is between 50% and 70% (with 50% to 70% of experts rating the indicator in the upper third (7-9)), it would be discussed in the third round of the Delphi survey. When the consensus rate of an influencing factor is more than 70% (70% or more of the experts rated the indicator in the upper tertile (7-9)), it was considered as having reached a consensus and did not need to be discussed in the third round of Delphi survey. As for the content written in the free text, these viewpoints were used narrative synthesis approach to analyse, and further shared with experts via emails.

After three rounds of Delphi survey, using the pre-determined consensus thresholds

[256], influencing factors not achieving consensus would be presented for review at the consensus meeting.

For the results of scoring the importance of themes factors across the three dimensions of ASaS (adaptability, scalability and sustainability), if a theme's consensus rate is 50% (exclusive of 50%) or below in any dimension of ASaS, it indicates a lack of consensus on some of the factors within that theme.

If a theme's consensus rate falls between 50% and 70% (exclusive of 70%) in any dimension of ASaS, it also suggests a lack of consensus on some of the factors within that theme.

If a theme achieves a consensus rate of 70% or higher across all three dimensions, it suggests that most of the factors within that theme have reached consensus. Experts still have the change to offer suggestions for improvement during the third round of the Delphi survey and the consensus meeting.

Round 3

During the third round of Delphi survey, factors that have already achieved a consensus in the second round of the Delphi survey would be omitted (for the factors with consensus rate over 70%), with the third round concentrating on questions that failed to garner consensus in the preceding round.

As mentioned in the Round 2, for the factor with the consensus rate lower than 50%(50% or less experts rating the indicator in the upper third (7-9)) in the second round of Delphi and lower than 65%(65% or less experts rating the indicator in the upper third (7-9)) in this round, it would be discarded.

When the consensus rate for an influencing factor was between 50% and 70% (with 50% to 70% of experts rating the indicator in the upper third (7-9)) in the second round of Delphi survey, and it did not achieve 65% (65% or less of the experts rated the indicator in the upper tertile (7-9)) in this round, it would be discussed in the consensus meeting. When the consensus rate of an influencing factor is more than 65% (65% or more of the experts rated the indicator in the upper tertile (7-9)), it was considered as having reached a consensus and did not need to be discussed in the consensus meeting. As for the content written in the free text, these viewpoints were used narrative synthesis approach to analyse, and further shared with experts via emails.

Furthermore, experts would be asked to provide insights into the reasons behind the lack of consensus on these questions. In the third round, experts would have the opportunity to rank the importance of the summarized themes. These themes are reconstructed based on the existing themes identified in the review, as well as the data and expert opinions collected in the previous rounds.

The degree of coordination of experts' opinions: expressed as the coefficient of variation (CV) and Kendall's coordination coefficient W.

Also, Kendall's W and the coefficient of variation was employed to indicate the degree of coordination of experts' opinions. The Kendall's W indicates the coordination of the opinions of all experts on all items[276]. In this study, three rounds of correspondence were completed.

If, after three rounds of correspondence, a gradual increase in the Kendall's W value and a gradual decrease in the coefficient of variation for each indicator is observed, this indicates an increase in the level of agreement among the experts. After the analysis of these data, the results were displayed by both textual summary.

Analysis of variability among the different groups

Based on the collected basic information, participants were divided into two groups: high-income countries (HICs) group and low- and middle-income countries (LMICs) group.

This study calculated the mean, plurality, and Kendall's coefficient for the HICs and LMICs groups separately. Also, the similarities and differences between the two groups of experts in scoring as well as feedback were summarised by means of thematic analysis.

4.3 Consensus meeting phase

4.3.1 Study design

The consensus meeting was chaired by the researcher and assisted by the supervisors of the researcher, who are experienced facilitators with extensive knowledge in the field of complex health interventions. Their role was crucial in guiding the discussions, ensuring that every participant had the opportunity to voice their opinions, and steering the conversation towards productive conclusions.

The online consensus meeting was held twice on the same day, with identical content in both sessions. This scheduling accommodates experts from various regions around the world, allowing them to choose a time that suits their availability. The online consensus meeting is open-ended and includes the following elements: (1) a discussion of the specific lines of influence on the relationship among these factors (2) A discussion of the relationship between ASaS and the various stages of complex interventions. (3) Member comments and criticisms of each influencing factor mentioned in the review, the relevant wording and concepts, and the addition or

removal of influencing factors.

Experts who are unable to participate in the online meeting can provide their responses through interviews or email correspondence. The questions they need to address were identical to those discussed in the online meeting.

The process of consensus followed an evidence-based guideline for developing consensus meetings[291]. Supervisors, as senior academic staff, facilitated the consensus meeting. Currently, no generally accepted uniform decision rules exist for determining when consensus has been reached[292]. Similar to the third round of the Delphi process, achieving a prior consensus rate of 65% is considered as reaching consensus. In general, the stricter the decision-making threshold, the more difficult it is to achieve consensus [293]. In such cases, sometimes meaningless results are reached[294, 295].

During the discussion process, the consensus of participants is ensured as much as possible genuine and not a product of pressure, manipulation, fear, excessive persuasion, misunderstandings about alternatives, or exhaustion from discussions.[293]. Ultimately, disagreements are resolved early enough in the appropriate consensus based decision-making process to maximise the inclusion of all minority views.

The detail of the consensus process is described below:

1. Following the Delphi study, each influencing factor requiring discussion was added to the meeting agenda for discussion by the participants. Firstly, the participant raising the query explained the interpretation of this influencing factor and where they discussed it. As a facilitator of the process, I ensured that the participant stated the question clearly and in positive terms.

2. All participants in the online meeting took part in discussing the issue. Each participant was given an equal opportunity to speak with discussion being kept focused on the issues raised. This helps to enable participants to express their thoughts and feelings without inhibition and succinctly, and to listen to others.

3. In the course of the discussion, when participants arrived at a common outcome. each participant was asked about their opinions on whether all issues had been resolved to their satisfaction. If so, a consensus had been reached and this was noted in the minutes of the meeting.

4. When there was no consensus among the participants on the issues raised, these issues were solved in a second discussion. During this discussion, each participant was given the same amount of time to comment individually on the issues raised and no one interrupted or influenced any participant in the middle of the round (other participants could ask questions and requested clarification from the participant who spoke after completion of their comments).

5. Summarising the discussion points: When the discussion was over, what participants said was summarized and the current status of the issue was clarified.

6. When individual differences merged during this round into a common answer, the results were noted in the minutes.

4.3.2 Description of participants

The participants in the Delphi survey were invited to participate in the online consensus meetings. The meeting saw the participation of 12 experts who were actively involved in the previous rounds of the Delphi survey. These participants represented diverse backgrounds, including public health, policy-making, and on-the-

ground implementation in LMICs, ensuring a rich and varied perspective on the topics under discussion.

4.3.3 Sampling and recruitment

Since the strategy of sampling of the consensus meeting is the same as the previous Delphi survey. Participants in the Delphi were invited to the consensus meeting.

4.3.4 Data collection of consensus meeting

- **Types of data collected**

For the consensus meeting, data collection process encompassed both quantitative and qualitative types. The quantitative aspect involved scoring previously identified factors from the Delphi rounds that had not yet reached consensus. Simultaneously, the qualitative component was emphasized by soliciting experts to provide explanations, rationales, or additional opinions regarding their scores or the factors themselves. This dual approach ensured that, alongside a systematic quantification of factors' importance, there was a rich narrative context. It enabled a deeper exploration into why certain factors were deemed critical or not, capturing the nuanced perspectives of the experts. This methodology aimed to foster a comprehensive understanding and robust consensus on the factors influencing the adaptability, scalability, and sustainability of complex health interventions.

- **Specific data information to be collected**

Google meeting platform was employed to conduct the consensus meeting and the interview. Participants were told that the meeting proceedings would be recorded (both video and audio with participants permission) using Google's own screen recording function. However, if participants did not want a video recording, they could feel free to turn off the camera at the start of the session, therefore only the audio was recorded. For experts responding via email, their replies were collected and

included in the analysis.

For the collection of quantitative data, during the consensus meeting, experts were asked to score the factors that had not yet reached a consensus, similarly to the previous questionnaire, using a Likert scale. As for qualitative data, within the consensus meeting, experts were required to explain the reasons behind their scores. Additionally, they had the opportunity to engage in free discussions, such as about the relationships between factors, and any modifications to the naming of themes and factors.

After collecting the records, the raw data was transcribed manually by the researcher. In the process of transcribing the records from the consensus meeting, there were instances where certain words were not clearly audible. To address this issue and ensure the accuracy of the transcription, consultation was sought from the SchARR Transcribers Group (STG).

4.3.5 Data analysis

As with the data analysis approach used in the first round of Delphi survey, the qualitative data collected in the consensus meeting also used the thematic analysis method [289]. It therefore used the following steps (1) Become familiar with the data; (2) Generate initial codes; (3) Search for themes; (4) Review and revise themes; (5) Define themes; (6) Write narrative. In terms of the quantitative data collected in the consensus meeting, the 9 point-Likert scale was used. When the consensus rate of an influencing factor did not achieve 65% (65% or less of the experts rated the indicator in the upper tertile (7-9)), it was discarded. When the consensus rate of an influencing factor was more than 65% (65% or more of the experts rated the indicator in the upper tertile (7-9)), it was considered as having reached a consensus. As for the content written in the free text, these viewpoints were analysed using a narrative synthesis approach, and further shared with experts via emails.

4.4 Ethical considerations

4.4.1 Ethics approval

The University of Sheffield ethics committee granted the ethical approval for this study on 20/07/2022 (Reference Number 043075).

4.4.2 Informed consent

Informed consents were obtained from the invitation emails received by potential participants. This email made clear that the study was divided into two parts: the questionnaire and the consensus meeting. Hence, there are two separate consent forms: One is for the Delphi questionnaire survey, which participants need to consent to before completing the survey, and the consensus meeting, which participants need to also consent to before participating in the meeting.

As for the participants did not agree to participate in the survey, they did not sign both consent forms; for the participants only agreed to participate in the Delphi survey and did not agree to participate in the consensus meeting, they signed the consent form of the Delphi survey. For participants agreed to participate in both the Delphi survey and the consensus meeting, they signed both consent forms.

In the first phase of the study (Delphi), three rounds of online questionnaire were administered. In order to be able to better protect the privacy of the experts and maintain anonymity in the Delphi survey, a pseudonymized approach was used. This was also because anonymity could not be guaranteed in the subsequent consensus meeting. That is, the participants were informed that their full names would not be included in the transcription of the data, instead they would be identified with a participant ID number, which would be assigned to each participant during data processing and analysis. The personal information of the participant was known only to me and was not disclosed to anyone.

Participants were also informed that participation were voluntary. They may stop their participation in the study at any time during the survey; before, during and before the data is analysed. In the consent form it made clear that if the participants drop out, the data provided by them can still be used by myself.

A link to the official survey tool developed by the University of Sheffield (<https://staff.sheffield.ac.uk/itservices/software/qualtrics>) were included, where participants reconfirmed their willingness to participate in the study and a consent statement was generated for experts to complete. After the experts completed the informed consent form, they continued to participate in the follow-up questionnaire. As for the experts selected no, they did not participate in this study.

In the second part of this study, a consensus meeting was conducted, in which the complete anonymity of the participants' information cannot be guaranteed due to communication with other participants via online meeting.

Furthermore, the results of the research may be showcased at conferences, documented for publication, or utilized for other research intentions, as elaborated in this information document. At the conclusion of the project, the participants were asked if they wish to be acknowledged by name for their contribution within any final project report, published or otherwise. However, the participants were not linked to their responses at any time.

The detailed consent form is shown in the Appendix 9.

4.4.3 Privacy and confidentiality

Any information involved during the study that may identify a participant were kept confidential by myself to the best of my ability. All participants' personal information

and email addresses were stored in a password-protected X: drive and would only be accessible to the me. These information were only disclosed by the researcher with the permission of the participant or when required to do so by law.

For confidentiality and protection of personal information purposes, the pseudonym approach was used. Each participant in the study was identified by a separate ID number and this ID number was associated with the participants' email addresses.

The audio and/or video recordings of participants captured during this research were exclusively employed for analysis and as visual aids in conference presentations and lectures. No other utilization of these recordings was permitted without the written consent of the participants.

After the participants have signed the consent, all consents were encrypted with a password and stored in the X: drive.

4.4.4 Safety issues

As this is a Delphi survey, the participants are mostly researchers, academics or public health practitioners with strong scientific and ethical credentials. However, it is important to note that since the focus of this study is on low- and middle- income countries (LMICs), sensitive influencing factors such as religion, culture, customs, or geographical characteristics may influence the judgment of participants particularly. However, this study does not carry any potential physical harm on the participants. In terms of the potential risks of the consensus meeting, there may be some potential non-physical risks to the participants such as the issue of anonymity in the process of conducting the consensus meeting.

The participants were informed that everything discussed in the consensus meeting were kept confidential in the information sheet. Also, the participants were asked to

keep the contents of the discussion confidential. In summary, the risks associated with participation in this study were minimal, and were mitigated by the researcher.

4.4.5 Data storage and protection

A word document named README was created to describe what kind of data was stored in which file. Whether it's a Delphi study or a consensus conference, the collected data were separated into two categories: (1) personal details together with other responses provided participants (these data would be deleted only once the PhD is awarded, and (2) results of the analysis and synthesis of the collected data (these data would be kept for 10 years according to the University of Sheffield data storage regulation).

4.4.5.1 The data of Delphi survey

- **The basic information and raw data of the participants**

When employing online surveys or questionnaires for data collection, an introductory page was offered to participants before they began the survey. This page included a concise overview of the project, contact information for myself and my supervisors, and a downloadable participant information sheet.

In this project, the protection of personal privacy was considered at a technical level when designing the database. In the Delphi survey process, the full name of the participants in the transcription of the data were not included, but a specific ID was assigned to each participant, and the personal information of the participants were known only to me.

These data were stored and backed-up in the University storage account (X: Drive) because of its high level of security, and they were checked every week.

- **The results of the analysis and synthesis of the data**

In the process of the Delphi survey, the results of the analysis and synthesis of the data were stored and backed up in the University storage account (X: Drive) after each time of the collection of the questionnaire and also were checked and backed up in the X: Drive every week. All the collected data and backup data were password protected.

In accordance with open research principles, the anonymised results from data analysis can be made available to other academics or organizations following a formal request to the investigator.

4.4.5.2 The data from consensus meeting

- **The basic information and raw data of the participants**

Similarly, the personal information and raw data from the consensus meeting were transcribed and stored in the University of Sheffield storage account (X: Drive) and were backed up regularly.

- **The results of the analysis and synthesis of the data**

Similar with the results of Delphi survey, the results of the analysis and synthesis of the data of consensus meeting were stored and backed up in the University storage account (X: Drive) after the end of the consensus meeting and also were checked and backed up in the University storage account (X: Drive) every week. All the collected data and backup data were password protected.

4.5 Summary

Notwithstanding many unresolved issues with the Delphi method, it remains a widely used method in healthcare[248]. As with many studies of a similar nature, the Delphi method represents a good match to the needs of this study. This together with other factors described above helped to justify the selection of the Delphi method as the

research method of choice for this study. The next three chapters described the findings of three rounds of Delphi respectively.

Chapter 5 Delphi questionnaire survey round 1

Chapter 5 embarks on the empirical phase of this research with the first round of the Delphi survey, directly engaging a panel of global experts to distil the preliminary list of factors influencing the ASaS of complex health interventions in LMICs. This chapter represents the practical application of the methodological foundation laid in Chapter 4, marking the transition from theoretical exploration to empirical validation and refinement of identified factors. The survey conducted in this study consisted of three rounds, and this chapter presents the results of the first round of the Delphi study.

5.1 The Expert Panel

Overall Participant characteristics

The invitation was sent to 160 experts. At the end of the recruitment phase, the study had recruited a total of 62 experts, which exceeded initial target for the overall sample size ($n=50$). Specifically, 62 experts were from 22 countries (Argentina; Australia; Canada; Chile; China; Ghana; India; Ireland; Kazakhstan; Kenya; Malaysia; Mexico; Nigeria; Norway; Papua New Guinea; Poland; Qatar; South Africa; Tunisia; UK; USA) had volunteered to take part in the Delphi survey with a response rate of 35.6%. This group of 62 experts includes 46 researchers, 6 healthcare providers, 2 policymaker, 1 commissioner of health services, and 7 others such as healthcare Lecturer and the government workers in the community. 32 of the 62 experts were male and 30 were female. In terms of their employment status, 43 were academics working in universities (or other academic institutions), 4 in hospitals, 13 in research/non-profit or governmental agencies, and 3 in other settings. The basic information of experts is shown in the Table 7.

Table 7 The Basic information of experts

Category	Count	Percentage
Gender		
Female	30	48.4%
Male	32	51.6%
Area		
LMICs	36	58.1%
HICs	26	41.9%
Country		
Argentina	1	1.6%
Australia	2	3.2%
Canada	2	3.2%
Chile	2	3.2%
China	10	16.1%
Ghana	2	3.2%
India	3	4.8%
Ireland	5	8.1%
Kazakhstan	1	1.6%
Kenya	2	3.2%
Malaysia	1	1.6%
Mexico	1	1.6%
Nigeria	8	12.9%
Norway	1	1.6%
Papua New Guinea	1	1.6%
Poland	1	1.6%
Qatar	1	1.6%
South Africa	4	6.5%
Tunisia	2	3.2%

UK	7	11.3%
USA	5	8.1%
Current primary position		
researchers,	46	74.2%
healthcare providers,	6	9.7%
policymaker	2	3.2%
commissioner of health services	1	1.6%
others	7	11.3%
Place of work		
universities (or other academic institutions)	43	69.4%
hospitals	4	6.5%
research/ non-profit or governmental agencies	13	
other settings	3	4.8%

5.2 The expert panel of first round of Delphi survey

In this Delphi study, a total of 42 experts participated, comprising 23 males and 19 females. The experts are from a mix of 25 low and middle-income countries (LMICs) and 17 high-income countries (HICs). The country-specific breakdown shows participants from Australia, Canada, Chile, China, Ghana, India, Ireland, Malaysia, Mexico, Nigeria, Papua New Guinea, Poland, Qatar, South Africa, Tunisia, the UK, and the USA. None of the experts come from Argentina, Kazakhstan, Kenya, or Norway.

The experts hold various primary positions, with the majority being researchers (33), followed by healthcare providers (4), a policymaker (1), a commissioner of health

services (1), and others (3). Their places of work are predominantly universities or other academic institutions (34), with fewer working in hospitals (2), research, non-profit, or governmental agencies (5), or other settings (1). This diversity of backgrounds and locations provides a wide range of insights into the study. The Basic information of the experts of the first round of Delphi survey is shown in Table 8.

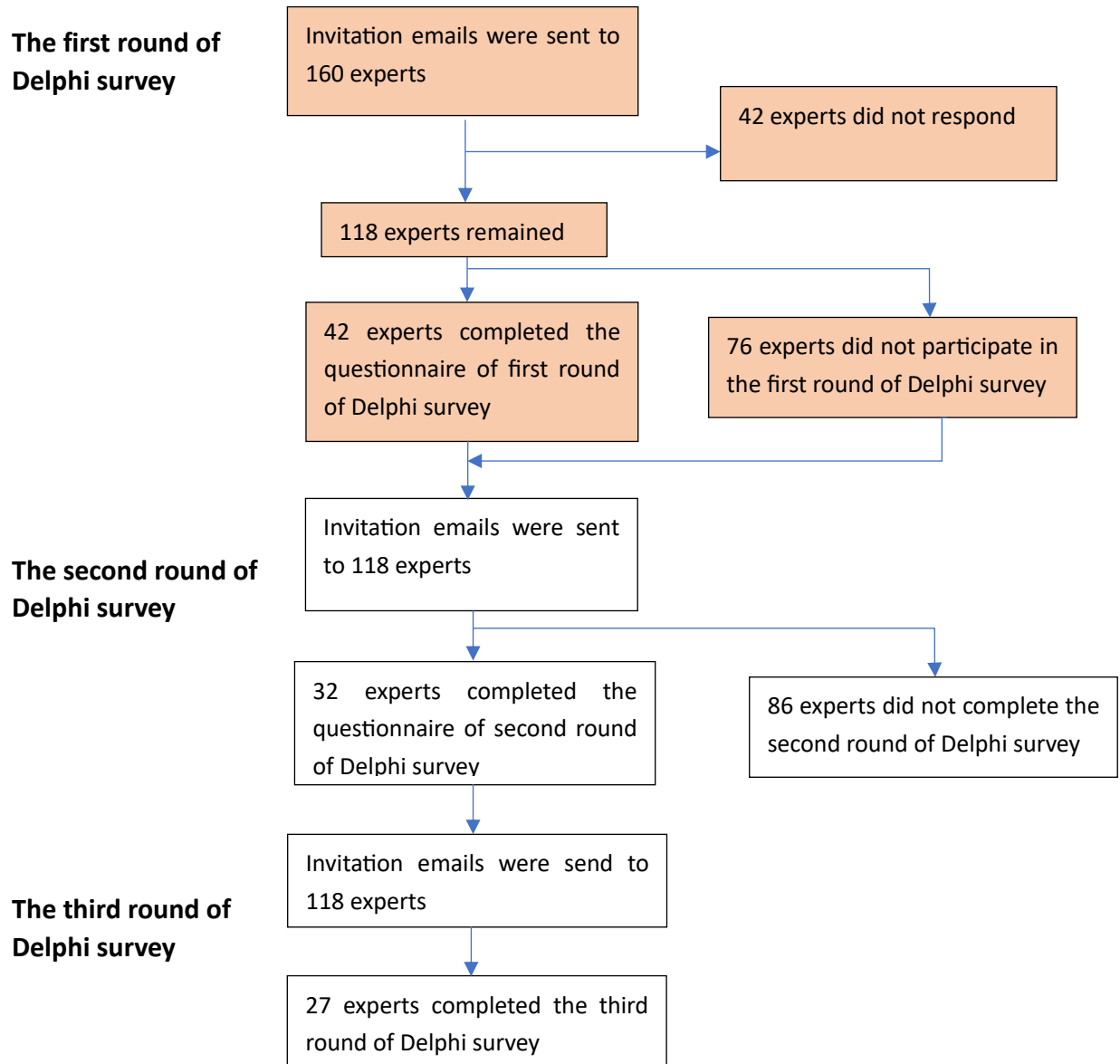
Table 8 The Basic information of the experts of the first round of Delphi survey

Category	Count	Percentage
Gender		
Female	19	45.2%
Male	23	54.8%
Area		
LMICs	25	59.5%
HICs	17	40.5%
Country		
Argentina	0	0.0%
Australia	1	2.4%
Canada	1	2.4%
Chile	2	4.8%
China	7	16.7%
Ghana	1	2.4%
India	2	4.8%
Ireland	3	7.1%
Kazakhstan	0	0.0%
Kenya	0	0.0%
Malaysia	1	2.4%
Mexico	1	2.4%
Nigeria	7	16.7%

Norway	0	0.0%
Papua New Guinea	1	2.4%
Poland	1	2.4%
Qatar	1	2.4%
South Africa	2	4.8%
Tunisia	2	4.8%
UK	5	11.9%
USA	3	7.1%
Current primary position		
researchers,	33	78.6%
healthcare providers,	4	9.5%
policymaker	1	2.4%
commissioner of health services	1	2.4%
others	3	7.1%
Place of work		
universities (or other academic institutions)	34	80.9%
hospitals	2	4.8%
research/ non-profit or governmental agencies	5	11.9%
other settings	1	2.4%

The overall of the Delphi study process is shown in the figure 5 below.

Figure 5: The Delphi study process



5.3 The results of the first round

The themes presented in this study have their origins rooted in established models such as EPIS and CFIR. They are not arbitrary constructs but rather derive from the studies identified from the two reviews along with the feedback from the first round of Delphi survey, which have been subsequently adjusted and refined through discussions.

The design inspiration for Theme 1 (Context) and Theme 2 (Setting) comes from topics already discussed in multiple models, such as those mentioned in "Advancing a Conceptual Model" literature and the Dynamic Sustainability Framework (DSF). Theme 3 (Organizational Attributes) and Theme 6 (Recipient Factors) are based on findings from existing literature and survey studies, for example, "Advancing a Conceptual Model" and the "NASSS Framework." Theme 4 (Human Resources) was determined by frequently mentioned content in survey studies. Theme 5 (Provider Factors) and Theme 7 (Project Management Process) are the result of combining literature research and survey feedback, as mentioned in both "the triple C model" and the "NASSS Framework." The establishment of Theme 8 (Monitoring and Supervision) is based on themes mentioned across various existing theoretical frameworks. Lastly, Theme 9 (Embedding in Communities) reflects the significant attention many experts pay to community-related content, also based on a comprehensive analysis of "A Systematic Review and Conceptual Framework for the Sustainability of Health Interventions in Sub-Saharan Africa" and the EPIS framework. The formation process of these themes demonstrates a thorough analysis of existing models, combining expert opinions and observations from practice to ensure the comprehensiveness and applicability of the research findings.

In the first round of Delphi survey, a total of nine Themes and 50 factors were collected, four factors within Theme 1, four factors within Theme 2, five factors within Theme 3, three factors within Theme 4, two factors within Theme 5, four factors within Theme 6, nine factors within Theme 7, ten factors within Theme 8, nine factors within Theme 9. The specific information is shown in the Table 9.

Table 9: The results of the First round of Delphi survey Total frequency count of the influencing factors derived from Round One eDelphi survey in HIC and LMICs group

Influencing factors	Total frequency count					
	Adaptability		Scalability		Sustainability	
Experts' area	HIC	LMICs	HIC	LMICs	HIC	LMICs
Theme 1 (Context)						
sociopolitical context	3	9	3	null	null	null
participant's accessibility to interventions	null	2		1	1	1
participant's acceptability to interventions		4	1	2	1	2
available of resources	8	12	3	6	4	2
Theme 2 (Setting)						
health system	1	10	5	3	4	5
local legislation	1	2		1	2	
local culture	9	16	11	9	2	1
local social norms or regulations	null	1	1	null	1	null
Theme 3 (Organizational attributes)						
interorganizational networks	null	1	1	null	null	null
organizational culture	null	1	1	1	null	null
organizational readiness	null	null	null	null	null	null
organizational structure	null	null		4	null	null

local gatekeepers	13	19	4	1	3	6
government support	3	null	null	null	2	null
Theme 4 (Human resources)						
training and education of staff	4	1	2	7	5	2
staff turnover	null	null	null	2	1	null
capacity of staff	3	4	null	1	null	null
Theme 5 (Provider factors)						
implementer and local stakeholders sharing a common language	null	null	1	null	null	null
local stakeholders perception of the need for change	2	1	null	null	null	null
Theme 6 (Recipient factors)						
participants' understanding and awareness	null	3	3	1	null	2
differences between individual culture	null	null	null	2	null	null
education level of participants	null	1	null	null	null	1
training and education of participants	null	null	2	null	null	null
Theme 7 (Project Management processes)						
experience in implementing similar	null	null	null	1	null	null

projects						
leadership	2	null	null	2	1	null
resource allocation	3	null	null	null	null	2
support systems or tools	null	1	null	1	null	null
integrating the intervention to existing system or projects	null	null	3	null	6	8
technology advance	null	1	null	1	null	2
time constraints	1	null	4	null	null	null
project champion	1	null	1	null	2	null
local stakeholders involvement	7	6	5	8	5	3
Theme 8 (Monitoring and supervision)						
the role of existing community structures and personnel	null	null	null	null	2	null
feedback mechanism	null	null	null	null	null	1
actionable timelines	null	null	null	null	null	1
empowering the state and non-state actors	null	null	null	null	null	1
local supervisor support	null	null	null	null	2	null
ongoing evaluation and reporting	null	null	null	null	1	null
the remote support from intervention developers	null	null	null	null	1	null
routine system	null	null	null	null	1	null

training and education of staff	null	null	null	null	1	null
using frameworks	null	null	null	null	1	1
Theme 9 (Embedding in communities)						
community based organizations	null	null	null	1	null	null
community acceptance	null	null	null	null	null	3
community culture cooperation	null	null	null	1	null	2
community education level	null	null	null	null	null	1
regular feedback	null	null	null	null	null	1
community ownership	null	null	null	1	null	null
training community volunteers	null	null	null	null	null	2
affordable and available in target community	null	1	null	null	null	null
turnover of community key members	null	null	null	null	1	null

The structure and methodological approach of this survey are designed to specifically address the first round of questionnaires, wherein experts were asked to evaluate the factors influencing each of the three dimensions of ASaS (Adaptability, Scalability, and Sustainability) from their respective viewpoints. After independently summarizing and analyzing the influencing factors for each ASaS concept, this section also delineates the differences in the factors emphasized by experts across the three concepts of

ASaS—Adaptability, Scalability, and Sustainability. This comparative analysis highlights the unique and shared elements that experts have identified as significant within each dimension, providing a clearer understanding of how these concepts interact and contribute to the overall framework of ASaS.

Adaptability

This section explores the adaptability of complex health interventions through eight critical themes: Context, Setting, Organizational Attributes, Human Resources, Provider Factors, Recipient Factors, Project Management, and Embedding in Communities. Each theme highlights essential factors such as sociopolitical influences, infrastructure, organizational culture, stakeholder involvement, and resource allocation that impact the effective implementation and sustainability of interventions across different global regions.

Theme 1 Context

Within this theme, the four factors proposed by experts include Sociopolitical context, Beneficiaries' accessibility to interventions; Beneficiaries' acceptability of interventions; Availability of resources. Generally,

The analysis of the provided diagram offers a structured comparison of the emphasis placed on different aspects of scalability and sustainability by experts from High-Income Countries (HICs) and Low- and Middle-Income Countries (LMICs).

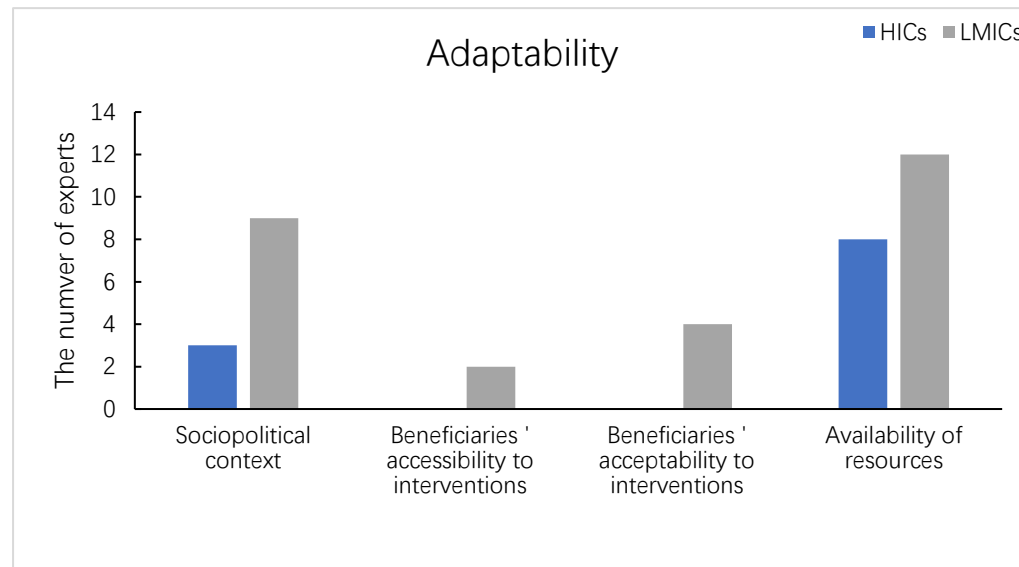
Within the adaptability section, experts from LMICs group referenced these factors more than experts from HICs group. In the section on scalability and sustainability, the experts from HICs group and LMICs group revealed a different focus. Within the domain of scalability, the sociopolitical context is more frequently highlighted by experts from HICs. Conversely, in discussions pertaining to sustainability, the

availability of resources is a topic more commonly brought up by experts from HICs. Apart from these distinctions, it is noteworthy that for most other components under review, the frequency of mentions is consistently higher among experts from LMICs. This observation suggests a differential prioritization or encounter of challenges in the implementation and sustainment phases of health interventions across varying economic contexts, thereby underlining the significance of tailoring approaches to suit the specific needs and constraints of LMICs and HICs alike.

Overall, experts from LMICs proposed influencing factors more frequently than those from HICs. Both mentioned sociopolitical context and availability of resources. However, experts from HICs and LMICs differed in their focus. Specifically, in the LMICs group, nine experts mentioned the sociopolitical context, while experts in the HICs group mentioned fewer factors, with three experts mentioning the sociopolitical context. 12 experts from the LMICs group mentioned the availability of resources, compared to eight from the HICs group. (see Figure 6)

In addition, two experts from the LMICs group mentioned Beneficiaries' accessibility of interventions and four experts from the LMICs mentioned Beneficiaries' acceptability of interventions, while the experts from the HICs did not reference these influencing factors. (see Figure 6)

Figure 6: The importance of influencing factors within Theme 1 to the adaptability component



Sociopolitical context

Sociopolitical context refers to the background that can influence interventions' design and implementation. The sociopolitical context may vary from country to country; therefore, country-specific interventions need to consider these differences.

In the first round of the Delphi study, 12 experts identified the sociopolitical context as an important influencing factor of ASaS (see Figure 6). Several others described it as the basis for implementing the intervention while some experts even considered it indispensable:

“a starting place is always context (physical resources required by the intervention) and the skill level of the intervention delivery personnel ” (University Researcher---USA-HICs)

In addition, five experts only mentioned the importance of the socio-political context without elaborating or analysing this factor further. Others mentioned several sub-

factors including social factors, economic factors, policy factors and so forth incorporated within the factor of socio-political context. Among these sub-factors, the socio-economic context was the most frequently mentioned, indicating that the local economic and political context is crucial for the implementation of complex health interventions.

“Broadly, social, political and economic aspects of the context need to be considered” (University Researcher -----India-LMICs)

Beneficiaries ' accessibility to interventions

Beneficiaries' accessibility to interventions pertains to the degree to which interventions are readily available and user-friendly to intended beneficiaries. It encompasses both the physical accessibility of interventions as well as their ease of use.

In low- and middle-income countries (LMICs), two experts emphasized that infrastructure emerges as a crucial determinant of participants' access to interventions. Specifically, adequate infrastructures such as well-maintained road networks, reliable electricity systems, and other supportive infrastructural elements are critical to facilitate the access of participants to interventions.

“Without basic infrastructure it cannot get off the ground” (University Researcher -----Canada-HICs)

Acceptability of interventions to beneficiaries

Acceptability of interventions to beneficiaries is closely related to accessibility to interventions. The acceptance of a complex intervention by its beneficiaries is critical,

especially in the initial stages of the intervention. Furthermore, if the intended beneficiaries of an intervention cannot even access or come into contact with it, for instance, due to transportation and infrastructure limitations, then it becomes exceedingly challenging for them to avail themselves of the intervention. If the intervention does not receive the support and acceptance of the beneficiaries, it will be difficult to implement and its effectiveness will be seriously compromised. The experts confirmed this relationship between Accessibility to and Acceptability to beneficiaries.

Experts also referenced the previously mentioned example from Durao[296] where, in order to increase the likelihood that participants accept these interventions, diverse projects have utilized different measures to make interventions accessible to Beneficiaries. These ranged from interventions to promote and facilitate physical activity by making green spaces or other spaces accessible, to improving walking or biking trails or extending highways away from residential areas.

Despite being granted access to interventions, participants may decline to engage due to various reasons, including but not limited to sociopolitical context, cultural factors and educational background, Any of these may influence their acceptance of the intervention.

Two experts from the survey emphasized the significance of participants' knowledge, awareness, and comprehension of the complex health interventions. When beneficiaries exhibit weak understanding and low literacy levels, significant time may be required to promote comprehension of objectives and benefits of complex health interventions, and further facilitate acceptance of the interventions.

Availability of resources

Apart from accessibility to and acceptability of interventions, availability of resources was also identified as a crucial factor, as emphasized by experts. In many low- and middle-income countries (LMICs), resources are frequently insufficient to meet the need of residents, making it challenging to implement interventions effectively.

Availability of resources had previously been mentioned by experts within the factor relating to Sociopolitical context. In LMICs countries, resources are often limited, requiring that interventions are adapted and tailored to local conditions. For example, Darzi [297] identifies how the adoption of existing high-quality guidelines seems a sensible option when viewed from a financial and human resource perspective. Nonetheless, variations in culture and organizations among countries can result in divergent recommendations, even when derived from the same body of synthesized evidence. This underscores the idea that recommendations applicable in one context may not necessarily translate to another and thus require adaptation.

According to the expert feedback “resources” encompasses two main aspects, human resources and non-human resources.

Staff with the skills and knowledge to adapt to evolving local conditions of the intervention were critical to the success of the intervention. However, in most cases, especially in the LMICs, experts indicated that human resources were lacking, even to the extent that many staff were multi-tasking or taking on tasks beyond their capability.

Experts also suggested that allocation of resources may be important during multiple detailed steps. For example, when transporting and storing medicines, consideration needs to be given to the use of reasonable freight methods, transport times and temperature control to ensure the safety and efficacy of the medicines.

In addition, resources include other elements associated with intervention implementation, such as equipment, facilities, staffing and time, the allocation and use of which are also critical to the success of the intervention. Therefore, when planning and implementing complex interventions, resources need to be considered holistically. Strategies and measures need to be put in place to ensure appropriate allocation and effective use of resources to support successful implementation and evaluation of the intervention.

“Availability of skilled manpower is crucial for the success of the intervention”
(University researcher----Nigeria-LMICs)

“Movement of materials, drugs and even Human Resources entails adequate logistics planning”(Policy maker in hospital----UK-HICs)

Therefore, in order to achieve success with complex interventions, adaptation, the skills and knowledge of staff and the allocation of resources need to be taken into account.

In addition to limited resources, implementers of interventions face the problem of how to allocate and optimise resources. Experts mentioned the possibility of using theoretical frameworks to direct the rational use of resources. Rational allocation of limited resources can promote the adaptation, expansion and sustainment of health interventions.

“I consider resources that are already available in the local context and how to maximise them. For instance, locally sourced Human Resources, when trained, can perform some task better than outsiders due to their knowledge of the local context----- (Policy maker in hospital----UK-HICs)

“The intervention should as much as possible be aligned with the health need of the population (to arouse their interests), the culture of the people and enabling health care structure like availability of health facility, skilled staff, equipment, consumables and the basic amenities needed to deliver the intervention.”
(University researcher---Nigeria-LMICs)

Theme 2 Setting

The distinction between "context" and "setting" in complex health interventions is nuanced and significant, underpinned by various scholarly discussions and frameworks that attempt to articulate these concepts and their implications for research and implementation. The literature suggests that while both terms are integral to understanding and evaluating health interventions, they encapsulate different dimensions of the environment within which interventions occur.

"Context" is understood as encompassing a wide range of external factors that can influence the implementation and outcomes of an intervention. This includes the broader socio-political, economic, and cultural milieu, within which health interventions are designed, developed, implemented, and evaluated. Context is dynamic and can vary significantly across different interventions, shaping how and why interventions produce certain outcomes. It is not merely a backdrop but actively interacts with interventions, influencing their design, execution, and effectiveness. The conceptualization of context has evolved over time, with recent frameworks emphasizing its complex, emergent nature, and its role in shaping interventions through the ongoing actions and interactions of various stakeholders involved in health care delivery

On the other hand, "setting" refers more specifically to the physical and organizational space where the intervention is implemented. This can include healthcare facilities, schools, communities, or homes. Settings provide the immediate physical and

organizational infrastructure necessary for the implementation of interventions. The distinction between context and setting can be nuanced, with setting often considered a component of the broader context. However, setting is more focused on the immediate environment that directly impacts the delivery and reception of the intervention

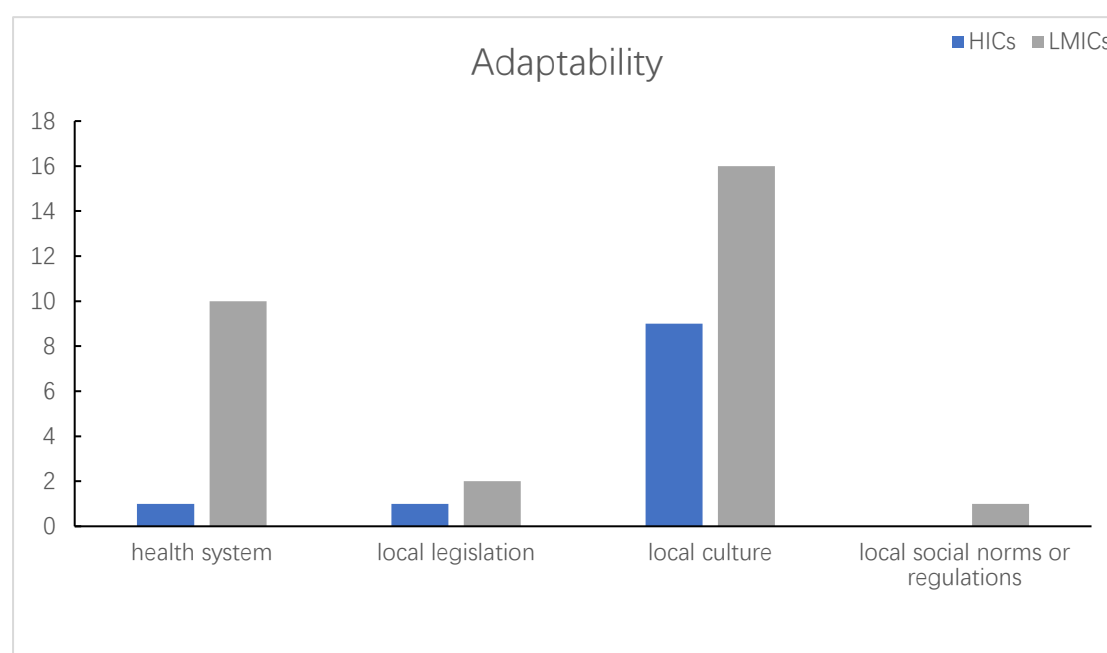
In terms of adaptability within theme 2, experts from LMICs and HICs focused on the following factors: health system, local legislation, local culture, and local social norms or regulations. (see Figure 7)

Adaptability

For adaptability, experts from LMICs proposed influencing factors more frequently than those from HICs. The influencing factors of health system, local legislation, and local culture are mentioned by experts from both HICs group and LMICs group.

Health system is mentioned by one expert from HICs group, while ten experts from LMICs group emphasized this factor. Nine experts from HICs group mentioned local culture, and 16 experts from LMICs group mentioned this factor. Local legislation was proposed by one expert from the HICs group and two from the LMICs group. Local social norms or regulation was mentioned by one expert from LMICs group. (see Figure 7)

Figure 7: The importance of influencing factors within Theme 2 to the adaptability component



In terms of adaptability aspect, it is worth noting that the experts from LMICs placed more emphasis on the factor of health system than those from HICs. Based on the experts' feedback, the health system was described in different ways, for example in terms of health-related policies and health information.

On the other hand, the factor of local culture was also given joint importance in terms of adaptability by experts from LMICs and HICs, but was mentioned more often by experts from LMICs than by experts from HICs.

For the factor of local social norms, only one expert from LMICs mentioned it, which may mean that social norms are less important than other factors in the experts' consideration of adaptability.

Health system

Health system is an influencing factor that includes several sub-factors including health policies and health information. These experts believed that the health system is critical to the implementation of complex interventions, and that it was a highly recommended factor to take into account when delivering complex interventions throughout the implementation phase.

“Without participation of the health system the research will not take off (University researcher---India---LMICs)”

In the health system, various health-related policies are often issued, and it is to these policies that the implementers of interventions refer and adapt the interventions to be carried out.

“Lack of policy support e.g lack of service package describing the elements of HIV and PHC services that needed to be integrated during the implementation of HIV services within PHC in Nigeria” (University researcher---Nigeria---LMICs)

In addition, experts emphasized the close relationship between health policy and infrastructure. The formulation and implementation of health policy is crucial in ensuring access to health resources and services. The effectiveness of health policy has a direct impact on the planning and construction of healthcare infrastructure, which together influence the adaptability of public health systems. At the same time, experts also pointed out that the formulation and implementation of health policy is significantly influenced by the availability of financial resources. Adequate financial resources can support better localization of health policies, such as the construction of health infrastructure and the training of health personnel. Inadequate funding, on the other hand, may limit the localization of policies.

“Funding for public health in low- and middle-income countries is often inadequate, resulting in the failure to implement many effective health policies.”
(University researcher---China---LMICs)

In addition, the health system acts as an information dissemination tool for implementers to increase the health knowledge and awareness of participants.

“Access to the adequate sources of information for local context analysis toward tailoring the intervention.” (Research/ non-profit or governmental agency----South Africa----LMICs)

Culture

From the perspective of adaptability, experts address the barriers that local culture can pose in two main approaches. In the first case, attention needs to be paid to adapting the intervention to the local culture.

An expert then mentioned the example of the situation of treatment interventions for mental illness in the Middle East compared to Western countries. In the study of Gearing [298], compared to individuals in Western countries, the Middle East has a much lower rate of individuals with mental illness receiving treatment. At the same time, this study refers to 17 studies that reported there were a total of 78 distinct obstacles and difficulties encountered in implementing mental health or psychosocial treatments, services, or interventions in Arab countries. A majority of these barriers related to cultural compatibility of the intervention.

“Culture brings with it myths taboos, misconceptions and attitudes. These are negative, the interventions are also negatively affected.” (University researcher---Nigeria---LMICs)

Also, experts suggest that the factor of culture is also related to the factor of implementer and local stakeholders sharing a common language. Also, an expert mentioned a study of Gearing [298], it suggested that the final category relates to local cultural and environmental contexts and is primarily related to language and translation, particularly in relation to communication barriers that may exist between healthcare providers and patients from different cultures. In this case, mental health professionals may lack adequate language skills and therefore need to rely on interpreters for patient-provider communication. In addition, they may also lack an understanding of the ways in which symptoms manifest in different cultures, leading to an increased risk of misdiagnosis.

“Culture means the language and determines the acceptability of new things”
(University researcher---China---LMICs)

The second is for the staff to educate the local population to eliminate any cultural discrimination against the intervention in order to make it acceptable.

“their own environment and cultures to find out what needs to be adapted and how----(University researcher---Canada---HICs)”

“it is imperative to emphasize the importance of respecting local cultures when training personnel. The effectiveness of any intervention or program greatly depends on our ability to integrate cultural sensitivity into our methodologies.”

In addition, local legislation and social norms were identified as important factors by experts from LMICs and experts from HICs. Experts suggest that staff need to consider local laws, regulations and social norms, as these factors can also have a significant impact on the adaptation of interventions. Knowledge of local regulations and social

norms can help determine what is legitimate and culturally appropriate, and thus help the intervention to be in line with the expectations and values of the local society, which will further contribute to the acceptance of the intervention by the beneficiaries and the adaptation of the intervention in the local context.

“Also, experts supported that the interventions need to be adapted to the local environment and cultures. Some cultures have already existing myths and misconceptions which need to be dispelled first before rendering services. Some cultures have a way they prefer a service to be rendered by particular sex (gender), dress code, and other values (Research/ non-profit or governmental agency---UK--HICs)”

Experts also commented that cultural practices are also closely related to researchers and healthcare workers,, and that in some areas people are distrustful and uncooperative with interveners for cultural reasons. Such cultural factors may be rooted in historical traditions, religious beliefs or social values that lead to barriers in the health arena. In these cases, in order to successfully scale up health interventions, health systems and interveners need to take a culturally sensitive approach that respects local cultural practices and belief systems. This may require establishing close links with local community and cultural leaders to build relationships of trust and increase understanding and acceptance. At the same time, education and awareness-raising can be used to ameliorate cultural barriers and promote positive cultural change to better support the implementation and promotion of health interventions. Such an integrated approach helps to ensure that health interventions are widely supported and successful in different cultural settings.

“Cultural practices affects how people in Nigeria for instance see and receive interventions . For instance, in some places, strangers are viewed with suspicion and seen as intruders with ulterior motives.” (University researcher---Nigeria---

LMICs)

Theme 3 Organizational attributes

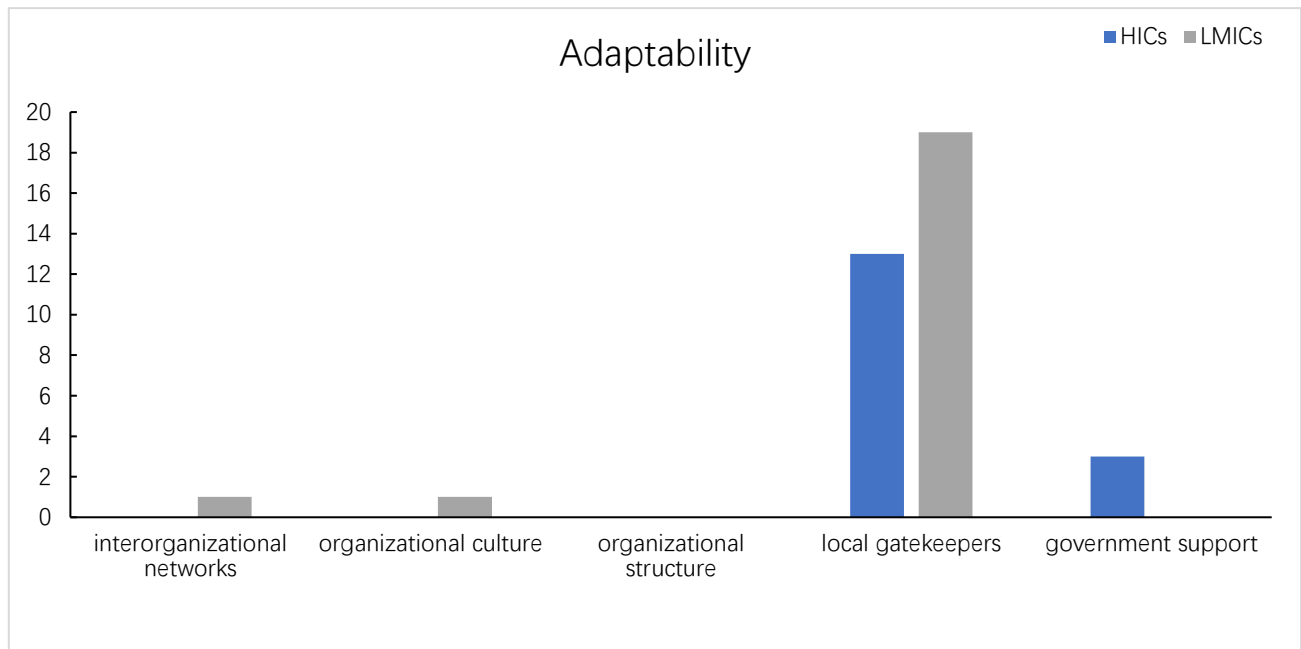
Within Theme 3, five factors are mentioned, namely interorganizational networks, organisational culture, organisational readiness, local gatekeepers, and government support. The factor of local gatekeepers received most attention from the experts. (see Figure 8)

Adaptability

In the section on adaptability, there are four factors mentioned. Of these, local gatekeepers is highlighted several times by the experts from both HICs group and LMICs group, while the other factors are mentioned sporadically. Specifically, local gatekeepers was mentioned by 13 experts from HICs group and 19 experts from LMICs group.

Also, the factor of government support was proposed by 3 experts from HICs group, and the influencing factors of interorganizational networks and organizational culture were mentioned by one expert from LMICs group.

Figure 8: The importance of influencing factors within Theme 3 to the adaptability component



Local gatekeepers, to a large extent, control the local acceptance of the targeted intervention. When carrying out an intervention, experts say it is often necessary to negotiate with local gatekeepers and gain their support in order to adapt and carry out the intervention locally.

In addition, in detail, this support from local gatekeepers is linked to other factors, such as the deployment of resources, staff support and possible obstacles caused by the local culture, all of which can be dealt with well by gatekeepers who are familiar with the local situation.

“Local leaders have impact on adapting complex health intervention by exercising their influence to promote interventions that aligns with their political, social, economic---(Hospital---UK---HICs)”

In addition, experts emphasized that the relationship between local gatekeepers and local communities is critical in the implementation of complex health interventions.

Local gatekeepers often have influence and trust in the community, and their support and collaboration are critical to the successful implementation of interventions. Establishing good collaborative relationships and gaining support from local gatekeepers can help mitigate potential cultural and social barriers and promote acceptance and sustainability of the intervention. Such interactions with local communities can also help to better understand local needs and cultural dynamics. This can, in turn, lead to better adaptation of the intervention to better fit the local context, increasing the probability of success of the intervention.

“The optimal approach would involve involving communities and local gatekeepers prior to the trial's formulation, enabling them to determine their own priorities. These priorities could then serve as the foundation for crafting the intervention.” (University researcher---China---LMICs)

However, as previously suggested in the section of adaptability, some local gatekeepers are in control of the local acceptance of the targeted interventions, but may lack the experience and knowledge to implement the intervention, which in turn may hinder the implementation of the intervention.

Sometimes, local gatekeepers are not able to participate in the implementation of the intervention, which may hinder the successful implementation of the intervention to some extent. An expert mentioned how, in the study conducted by BAILEY [299], that local gatekeepers (parents, caregivers, hospital and school staff) can be either supporters or barriers to the implementation of the intervention. Local gateway figures may not be involved for a variety of reasons. In particular, staff may find it difficult to actively participate due to other commitments, lack of time, etc. These factors may have a negative impact on the implementation of the intervention.

“Local leader impact is a key element for effective implementation. Usually, by

virtue of their absence as key implementers.----(Independent research Consultant--USA----HICs)”

In addition, during the adaptation phase of the intervention, experts emphasized factors related to local gatekeepers and training and education. When local gatekeepers do not have a sufficient level of understanding of the intervention, or are unable to effectively cooperate with the implementation of the intervention due to a lack of capacity, the research team needs to consider providing them with training and education. This can help to fill the knowledge and skill gaps and increase their level of understanding and participation in the intervention, thereby increasing the probability of its success.

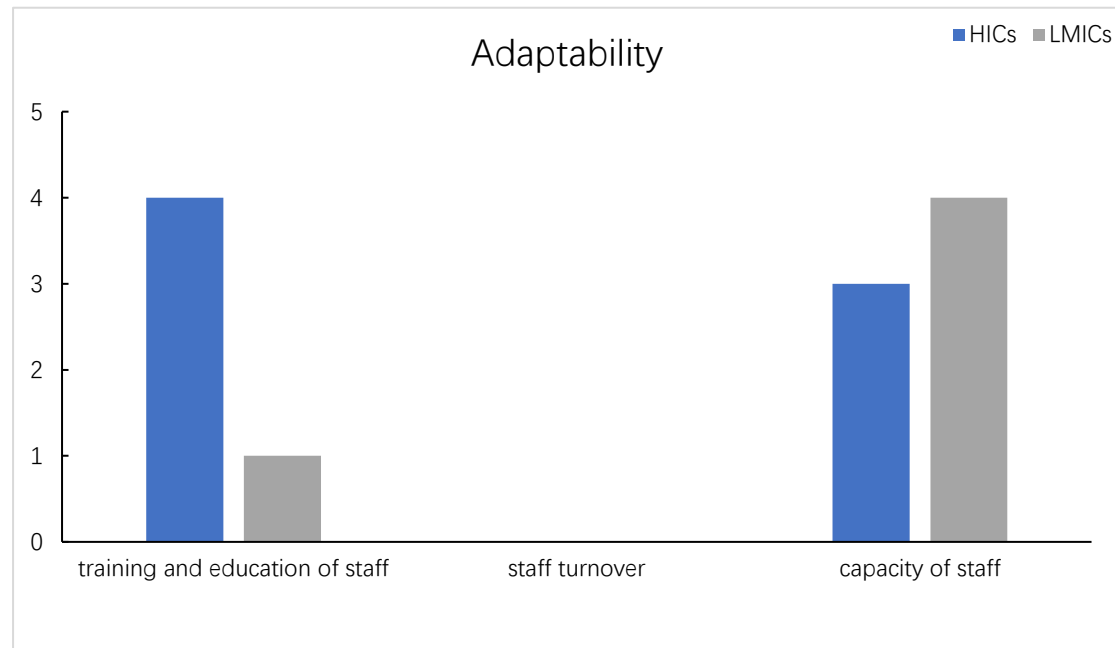
Theme 4 Human resources

In Theme 4, three factors are involved, namely training and education, staff turnover and capacity of staff. (see Figure 9)

Adaptability

In the section on adaptability, training and education of staff and capacity of staff were mentioned by experts from both HICs and LMICs. Specifically, four experts from the HICs mentioned training and education of staff and three mentioned capacity of staff. Of the experts from LMICs, one mentioned training and education of staff and four mentioned capacity of staff.

Figure 9: The importance of influencing factors within Theme 4 to the adaptability component



From the aspect of adaptability, only training and education of staff and capacity of staff are mentioned. Experts generally agreed that capacity of staff was important because it could determine whether the intervention was successful in matching the work required by the intervention in the early stages of adaptation. To address this issue, experts from HICs and LMICs recommend training and education to increase the ability of staff to participate in interventions.

“The staff number, level of training can also pose challenges to the uptake of intervention. reduced number of staff implies adding more tasks to existing staff when a new intervention has to be introduced. Non-experienced staff positions the need for training as priority prior to implementing the intervention.”
(Research/ non-profit or governmental agency----South Africa----LMICs)

However, such training may be difficult to implement due to work overload. Based on expert feedback, many experts noted that many health workers in low-income countries (LMICs) already have a huge workload and do not have enough time and energy for additional training. This situation may pose a barrier to the local adaptation

of complex health interventions.

“In China, village doctors in rural areas are already required to participate in many government-assigned tasks resulting in a heavy workload, and thus they have little willingness to participate in additional training related to complex interventions.”
(University or other Academic Institution----China----LMICs)

Therefore, it is important to consider staff training and capacity development in the planning and implementation of intervention strategies to ensure that they are able to adapt to the requirements of intervention implementation. Consideration also needs to be given to ways of reducing the workload of employees so that they have sufficient time and energy to participate in training for the new intervention.

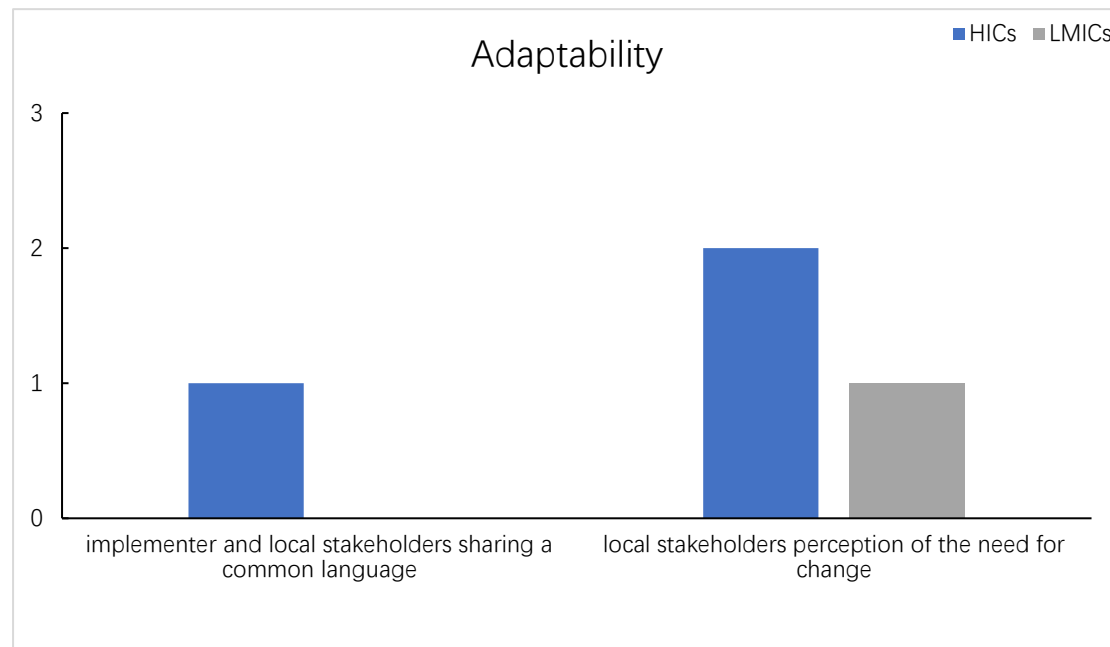
Theme 5 Provider factors

Theme 5 deals with relatively few factors, including implementer and local stakeholders sharing a common language and local stakeholders perception of the need for change. However, in general, both LMICs and HICs experts only occasionally mention these two factors. (see Figure 10)

Adaptability

For adaptability, one expert from HICs mentioned the need for implementer and local stakeholders (refers to individuals or groups within the local community who control or regulate access to resources, information, or decision-making processes) to share a common language. In addition, two experts from HICs and one expert from an LMIC mentioned local stakeholder perceptions of the need for change.

Figure 10: The importance of influencing factors within Theme 5 to the adaptability component



As mentioned for previous themes, local stakeholders are able to speak the local language fluently and understand the local culture, values, and social context, which enables them to better connect and communicate with the local community. Therefore, during the adaptation phase of an intervention, local stakeholders play a key role in the demand for a change in the status quo.

Therefore, experts propose that if researchers can collaborate with local gatekeepers, engage in effective communication with them, and make them aware of the need for change in the local health conditions, it can provide a foundation for tailoring intervention measures. By establishing trust and rapport with local gatekeepers, a better understanding of local needs and challenges can be gained. Subsequently, leveraging the influence of local gatekeepers when implementing interventions can help ensure that the intervention measures align effectively with local requirements. This, in turn, enhances the acceptance and adaptability of the project among local residents. This collaborative approach is considered crucial in the design and

implementation of complex health interventions, contributing to their effectiveness and adaptability.

In addition, experts suggest that those adapting interventions, should not only communicate effectively with local stakeholders so that they recognize the need for change in the local health situation, but, even more critically, should seek to establish a win-win partnership. This model of cooperation represents not just a unilateral transfer of information, but rather a convergence of the interests of multiple parties, so that interventions are closer to the actual needs of the local community. Local gatekeepers thus become motivated to change the local health situation.

“There are a few challenges including understanding the need for change, the desired outcome and the benefits that will result after the implementation. Education and training are all essential for this work to happen. There has to be a winwin situation for all stakeholders involved(University or other Academic Institution----Australia----HICs)”

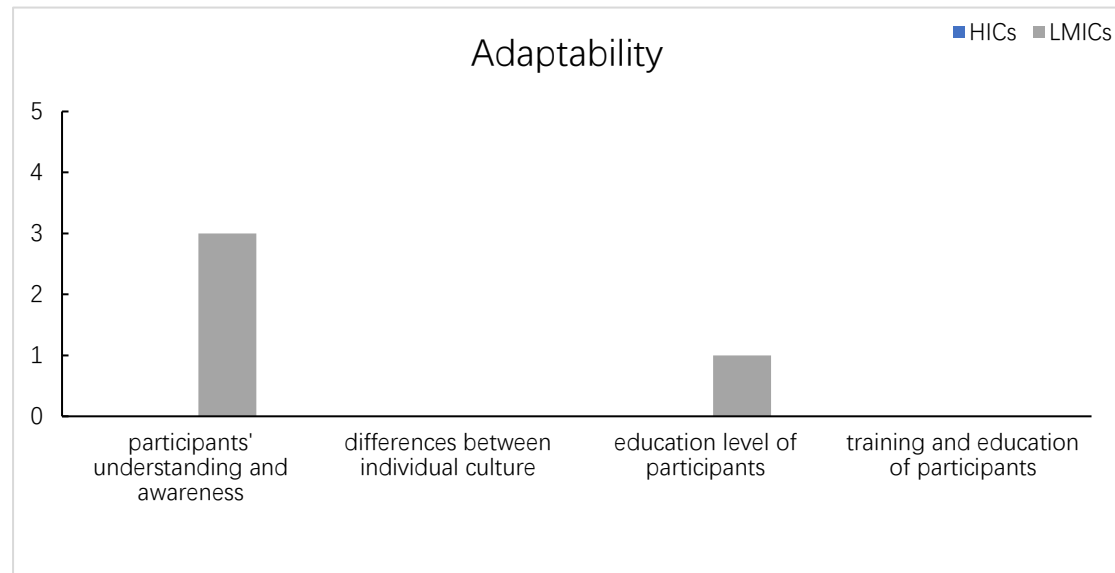
Theme 6 Recipient factors

For Theme 6, overall, four factors were included, participants' understanding and awareness; differences between individual cultures; education level of participants; training and education of participants. (see Figure 11)

Adaptability

For adaptability, the experts from the LMICs mentioned the participants' understanding and awareness and education level of participants, while experts from HICs did not mention any specific factors.

Figure 11: The importance of influencing factors within Theme 6 to the adaptability component



The two factors are interrelated, with the participants' level of education and their comprehension generally being positively correlated. In other words, the higher the level of education, the greater the cognitive ability of the participants.

“People's general awareness of their health needs and the potential health benefits they stand to gain will influence the acceptability of the health intervention----- (University or other Academic Institution----Nigeria----LMICs)”

At the same time, experts also mentioned that participant comprehension was not only affected by the level of education, but also by other factors, such as cultural background, language skills and cognitive development.

“Need to consider the education level of local residents, and their cultural values or beliefs. (University or other Academic Institution----China----LMICs)”

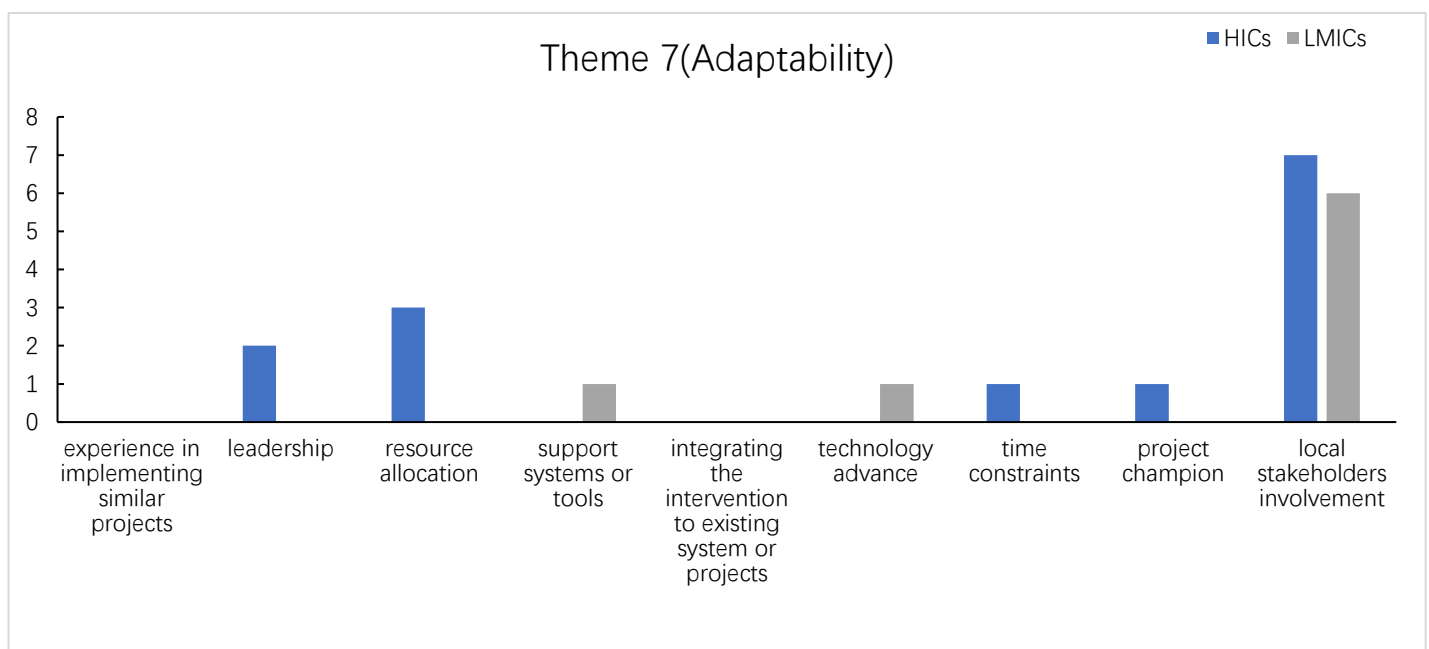
Theme 7 Project Management processes

Within theme 7, a total of nine influencing factors are provided by experts. (see Figure 12)

Adaptability

For adaptability, a total of seven factors are proposed. The factor of local stakeholder involvement was repeatedly highlighted by experts from LMICs group and HICs group, while the other factors were not commonly mentioned. In detail, for the experts from HICs group, two mentioned leadership, three mentioned resource allocation, one mentioned time constraints, and one mentioned project champion. For LMICs group, one mentioned support systems or tools and one mentioned technology advance.

Figure 12: The importance of influencing factors within Theme 7 to the adaptability component



First and foremost, especially during the adaptation phase of an intervention, experts generally recommend establishing good linkages with local stakeholders and trying to

ensure their active participation in the project. The establishment of such linkages is crucial to the success of the project, as local stakeholders have unique knowledge and insights that can provide a deep understanding of the local environment, culture and social dynamics. Their involvement can facilitate the adaptability of the project and ensure that interventions are better tailored to local needs and challenges. In addition, close collaboration with local stakeholders can help build trust and consensus and reduce potential resistance and conflict.

In addition, the experts' advice is to allow as many stakeholders as possible to benefit from the intervention, which in turn will encourage the intervention to adapt well to the local environment, as in this case local stakeholders are usually motivated to drive the implementation and maintenance of the project. Therefore, close collaboration with local stakeholders should be considered as an important strategy for project management to ensure that the project can be adapted well to the local context in a complex local environment.

“I think it's critical that all stakeholders who would be involved in administering or receiving the intervention are involved in its design and evaluation(University or other Academic Institution----Ireland----HICs)”

“There are a few challenges including understanding the need for change, the desired outcome and the benefits that will result after the implementation. Education and training are all essential for this work to happen. There has to be a win-win situation for all stakeholders involved”(University or other Academic Institution----Australia----HICs)

Furthermore, besides the assistance of local stakeholders, the project champion plays a crucial role in complex health interventions.

Experts supports that the project champion acts as advocates and sponsors, securing necessary resources and organizational support by promoting the project's importance and benefits to key stakeholders. The support of project champion can help to address potential resistance or opposition, leading to broader recognition and support for the program. Unlike leaders who have broader responsibilities and formal authority, project champions focus specifically on a single project, ensuring it receives the attention and resources it needs.

Because of these responsibilities and the need for project champions to perform well in implementing interventions, leadership is a factor that has been emphasized many times by experts. Project champions with good leadership skills are often better able to promote local adaptation of complex health interventions.

“Certainly. Leadership is necessary to facilitate the implementation of interventions”(University or other Academic Institution----China----LMICs)

In the adaptation phase of complex interventions, in addition to the consideration of project champions, experts also emphasize the allocation of local resources. According to expert feedback, the more adequate the allocation of resources, the greater the likelihood that complex health interventions can be adapted locally.

More importantly, considering the resource is frequently limited in LMICs, the question of resource allocation as an influencing factor also relates to whether resources can be allocated appropriately, whether there will be corruption among staff, and so forth, which affects the sustainability of the intervention.

“Resources means the level of resources that you could allocate in new settings.”
(University or other Academic Institution----China----LMICs)

Besides the factor of resource allocation, the experts also place emphasis on the supporting system and technology, while the experts from the HICs place emphasis on the overall allocation of resources and how the project is managed.

Some experts noted that during the adaptation phase of an intervention, the help of technology, particularly telemedicine technology, could go some way towards addressing the shortage of healthcare workers in regions of low- and middle-income countries (LMICs). Telemedicine technology compensates for the limitations of the uneven distribution of healthcare workers by providing online training, teleconsultation and telemedicine services. This means that even in remote and sparsely populated areas, healthcare workers can access knowledge and support via the Internet to improve their skill levels. In addition, telemedicine technology can help improve patients' access to healthcare services by enabling them to receive timely medical advice and treatment. Although the digital divide and infrastructure issues remain, the use of technology provides opportunities for complex health interventions in LMICs to bridge the challenges of healthcare worker shortages and improve the quality and accessibility of healthcare services. Therefore, the integration of science and technology during the adaptation phase of interventions should be considered a key strategy to help improve health care in LMICs areas.

“In rural area of China, many residents have begun using smartphones to upload their blood pressure and glucose values into the local community healthcare system, eliminating the need for community doctors to travel to each resident's home to take measurements, and largely alleviating the problem of understaffing of community doctors in the area.” (University or other Academic Institution----China----LMICs)

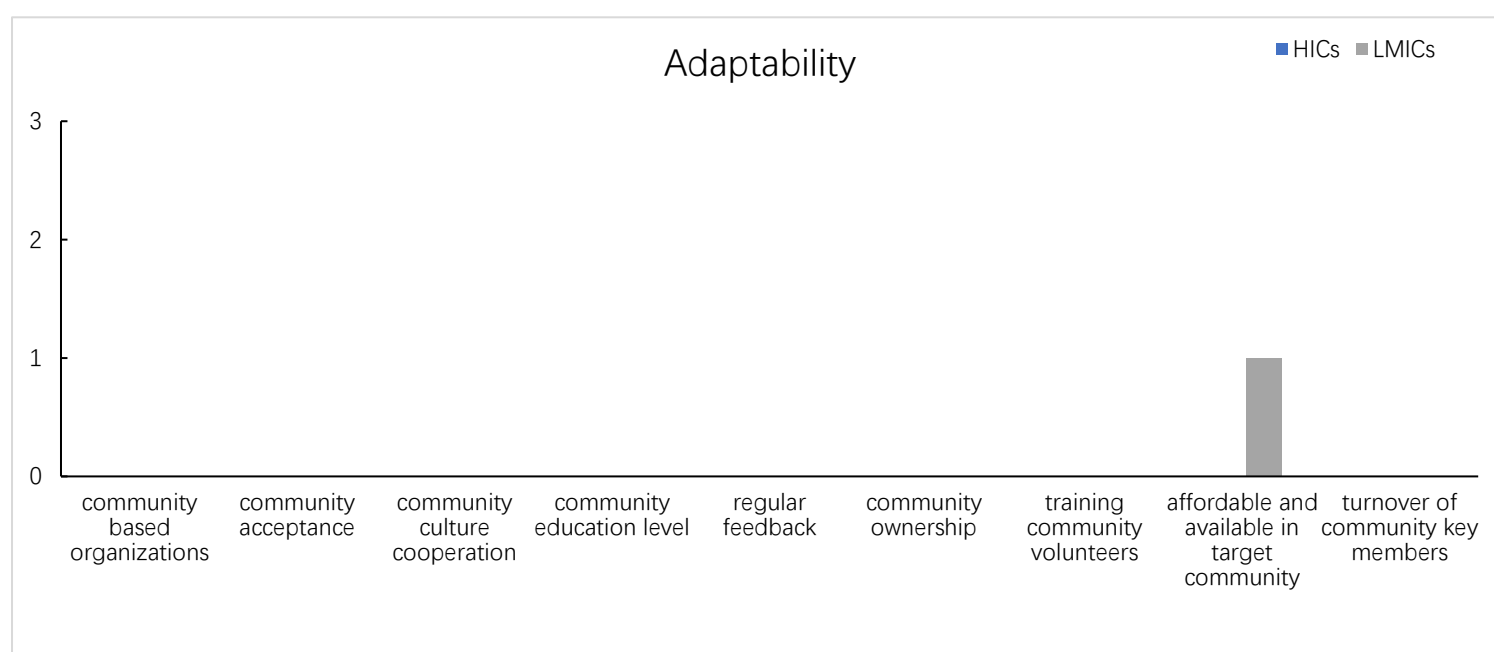
Theme 9 Embedding in communities

In general, experts identified factors pertaining to the theme of community as pivotal, albeit with a lack of specificity. Conversely, experts from low- and middle-income countries (LMICs) provided greater granularity when articulating the community's impact. According to the feedback from the experts, the role of the community is mainly played during the sustainability phase of the complex health interventions. (see Figure 13)

Adaptability

For adaptability, a specific factor mentioned by one expert from LMICs was affordability and availability in target communities.

Figure 13: The importance of factors within Theme 9 to the adaptability component



In the adaptation phase of complex health interventions, experts advised of the need to assess whether the local community can afford the intervention. An intervention that is not affordable to the local community cannot be well adapted locally.

Subsequent scaling up and sustainability of the intervention becomes even more challenging:

“If it is a nutrition intervention, is there evidence that the intervention product will be acceptable to the study participants? After completion of the study, will the intervention product be affordable and available in the target community? Is there evidence that the intervention may have a beneficial effect in the target population?”

(University or other Academic Institution----South Africa---LMICs)

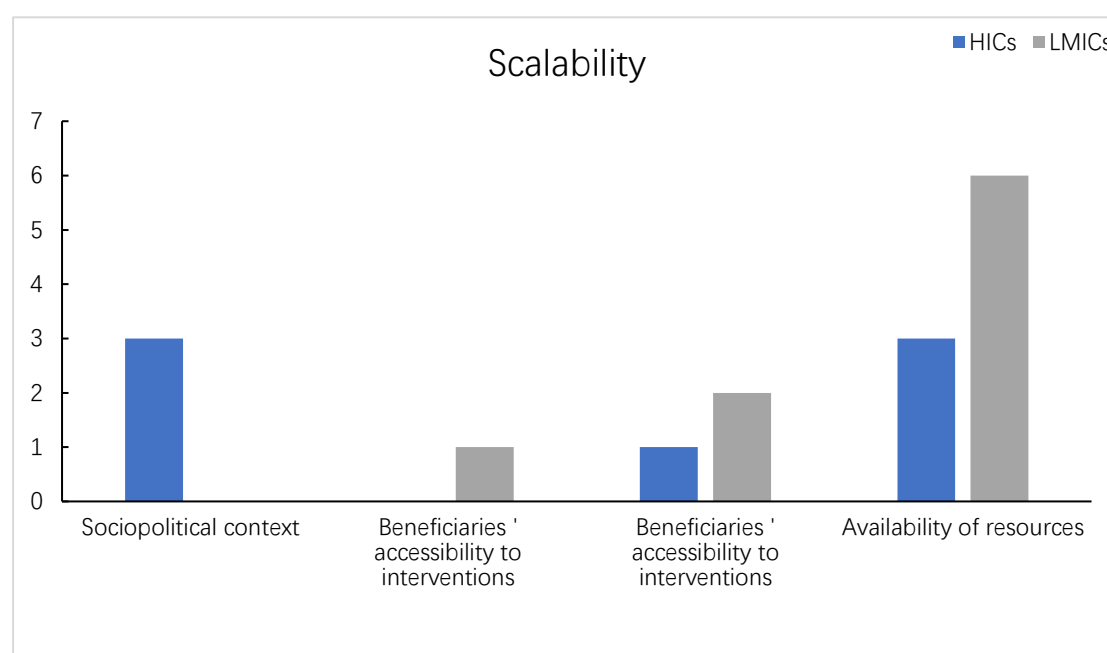
Scalability

This section explores the scalability of complex health interventions, focusing on eight pivotal themes that are essential for the successful expansion of these interventions across different regions. These themes encompass Context, Setting, Organizational Attributes, Human Resources, Provider Factors, Recipient Factors, Project Management, and Embedding in communities. Each theme addresses how interventions can be scaled up effectively by considering.

Theme 1 Context

Experts from both LMICs and HICs mentioned the Acceptability of interventions to beneficiaries and availability of resources. Specifically, in the LMICs group, two experts mentioned the factor of Acceptability of interventions to beneficiaries, while one expert in HICs group mentioned this factor. Also, six experts from the LMICs group mentioned the availability of resources, compared to three from the HICs group.

Additionally, the two groups of experts differed in their views on scalability. Three experts from HICs mentioned sociopolitical context. One expert from LMICs raised the influencing factor of beneficiaries ' accessibility to interventions. (see Figure 14)

Figure 14: The importance of factors within Theme 1 to the scalability component

Sociopolitical context

When it comes to scalability, experts emphasise not only the importance of this factor in its own right but also how this factor interacts with other factors.

Experts suggested that socio-political contextual factors and cultural factors can be seen as mutually reinforcing. These factors are intertwined and together they shape the character and behaviour of a society. Government policies, laws and institutions are important components of this, and they can directly or indirectly influence people's behaviours and values. For example, government policy choices can have a direct impact on society, such as in determining the allocation of resources and the shaping of socio-economic structures, which in turn influence culture. In turn, cultural factors can influence which policies are implemented by local governments, as cultural values and belief systems can influence attitudes and acceptance of policies.

“These factors can be either helpful and make it all work or can completely work against the intervention. Its understanding how the intervention works and

interacts with the local context, which includes culture and its customs, that's paramount to initial design and in the scaling process.” (University researcher---USA---HICs)

Beneficiaries' accessibility to interventions

When considering this factor specifically in relation to scalability, as for adaptability, the experts are primarily concerned with how the local infrastructure might ensure access to interventions for local participants.

“Access roads and communication methods to contact participants”(University researcher---South Africa---LMICs)

However, experts also highlighted a distinction from the adaptability phase. They emphasize that while some interventions may excel in being adaptable to local environments, further large-scale expansion remains subject to various factors. Among these factors, sociopolitical considerations and a shortage of healthcare personnel are frequently cited as primary challenges confronting those implementing interventions.

For example, an expert mentioned the study conducted by Chola[300], in 2009, South Africa undertook multiple important initiatives to improve the areas of public health and childcare. First, they have incorporated the African rotavirus vaccine into their childhood immunization programme, which has proved to be very effective in preventing severe rotavirus diarrhoea and has achieved moderate coverage of 64% in South Africa. Considerable efforts and funding have been allocated to ensure that over 90% of the South African population can avail themselves of clean public water sources, and that more than 70% have access to hygienic latrines or toilets. However, despite these positive results, important challenges remain. Approximately 46% of households

do not have access to piped water at home, while 11% of households still need access to sanitation services. In addition, 26% of households have sanitation services that need to meet standard requirements due to deteriorating infrastructure. In addition, many other recommended interventions, such as hand washing and oral rehydration salts, continue to have low coverage. While these health promotion interventions are affordable, significant challenges remain in increasing their uptake. [300]

Beneficiaries' acceptability to interventions

Similarly, participant acceptability received equal attention from the experts in this section. In this section, the experts mentioned how it is also crucial to test the pilot before conducting a formal intervention, to facilitate the implementer to see if this intervention can be extended to a larger scale.

“It is only if the piloted intervention is deemed accepted by the people that we can think of scaling it up.” (University researcher---Nigeria---LMICs)

Experts also illustrate the links between other factors and the factor of participants' acceptability to interventions. The factor sociopolitical context mentioned earlier and the local culture, knowledge or health information described in subsequent sections all have an impact on Acceptability of interventions to beneficiaries.

“Socio-economic development levels and health beliefs often impact on the acceptability and engagement in the program.” (University researcher---China---LMICs)

Availability of resources

Firstly, experts have noted that the availability of resources not only influences the adaptability of interventions but also plays a crucial role in their expansion. This is particularly pertinent in the context of low- and middle-income countries (LMICs), where many high-quality interventions are constrained by resource limitations and cannot be implemented. These interventions face constraints due to inadequate fiscal budgets, insufficient essential supplies, and equipment shortages. Even if these interventions have proven successful in localized trials and demonstrated their effectiveness, their scope and scale are hampered by the requirement for increased financial, human, and equipment investments for the purposes of intervention expansion.

Five experts therefore also mentioned that this factor is related to the policy and the sociopolitical context, where trade-offs have to be made and targeted and important measures have to be chosen to maximize the efficiency of the use of resources in a context of limited resources.

An expert mentioned that in South Africa, children living in poverty have approximately ten times the risk of dying from diarrhea than those who are privileged[300]. This example highlights the magnitude of social inequalities in diarrhea and the strong links between socioeconomic status, health and healthcare resources.

Compare with the adaptability phases, in the phase of scalability, the imperative for human resources appears to exceed, or bear greater urgency than, the demand for medical resources proper. This observation aligns with certain experts' subsequent observations regarding the impediment to intervention expansion in select regions, wherein notwithstanding the availability of resources, staff capacity or availability deficits prevail.

“Implementation support and resources may be only partially provided during scale ups”(University researcher---Canada---HICs)

“Should the intervention use humans as implementers, the availability of potential implementers and training requirements (if needed) is a determining factors. Should the implementation uses technology, then availability and accessibility of the technology becomes a determining factor.” (Research/ non-profit or governmental agency---South Africa---LMICs)

The Expert mentioned that in the study of Cabassa[301], it indicated that due to limited resources, clinics are unable to hire and place primary care providers to meet the health care needs of their clients.

In addition, during the scale-up phase, experts emphasized the link between local human resources and local language and culture. Experts expressed the need to fully utilize local talent and to understand the local linguistic and cultural context as critical to ensuring that interventions resonate with communities and are successfully scaled up for implementation. Such linguistic empathy enhances the acceptance of interventions and contributes to their effectiveness.

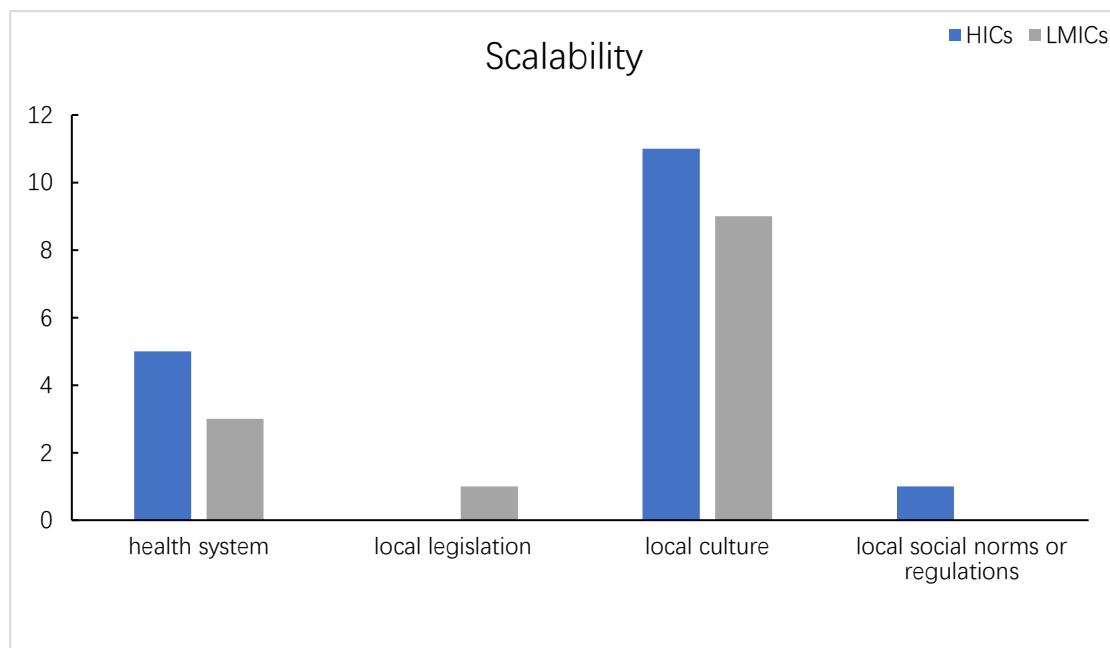
“Scaling up is almost impossible without the assistance of local fieldworkers who can speak the local language” (University researcher---South Africa---LMICs)

in addition to medical resources, the experts also mentioned some auxiliary resources, such as some resources of technological equipment, for some interventions that require technological equipment support, such as telemedicine, which need to be equipped with the appropriate technological equipment in order to allow further expansion of the intervention.

Theme 2 Setting

In considering scalability, experts from both LMICs and HICs mentioned the two influencing factors of health system and local culture. Experts from HICs were slightly more concerned with these two factors than those from LMICs. Specifically, five experts from HICs group and three from LMICs group mentioned the health system. 11 experts from HICs group and nine from LMICs group mentioned local culture. Also, one expert from LMICs group mentioned local legislation, and one expert in HICs group mentioned local social norms or regulations. (see Figure 15)

Figure 15: The importance of influencing factors within Theme 2 to the scalability component



Health system

Similar to the phase of adaptability, the help of the health system is essential in the process of scaling the interventions.

“Third would be to identify platforms and processes into which the intervention aspects specific to the concerned system may be introduced(University researcher---India--- LMICs)

At the same time, experts also indicated that in LMICs, as for adaptation of interventions, expansion of interventions within the health system is constrained by multiple factors, especially human resources and financial constraints.

In addition, health system factor is inextricably linked to government support, and the functioning and development of health systems are directly influenced by government policies and resource allocation. Government funding, strategic planning and the management of health services all have a profound impact on the efficiency and scalability of health systems.

“The health system is run by different tiers of government with little synergy.”(University researcher---India--- LMICs)

Culture

In the scaling up process, experts also emphasize that the staff may be able to educate the local population to eliminate any cultural discrimination against the intervention in order to make it acceptable. This may be due to the fact that local culture can influence the way in which social interactions take place, the way in which communication takes place, and the perception of health.

“In some cultures perceptions exist about the appropriateness of certain foods, such as eggs, for infants or pregnant women.” (University or other Academic Institution-----South Africa----LMICs)

In addition, legislation and social norms or regulations were also mentioned by individual experts in the context of scalability. This shows that although apparently not as important as the health system and local culture, they remain factors that cannot be ignored in the implementation of interventions.

At the same time, those scaling up interventions need to be aware that cultural factors may add additional constraints. For example, experts noted that in some regions of low- and middle-income countries, inequalities in the social status of women, may have a negative impact on the scaling up of interventions. In these social contexts, women may face social constraints and cultural constraints that may affect their ability and willingness to participate in health interventions.

“Young women may not be allowed to participate in a study until she got permission from older family members or her husband.” (University or other Academic Institution-----South Africa----LMICs)

However, culture also has a dual nature in terms of intervention scaling up. While many studies have shown that local culture can hinder implementation of interventions to a certain extent, local culture can conversely be a powerful enabler to facilitate interventions where researchers utilize cultural factors correctly. For example, one expert referenced a study in China that, in recognising the local emphasis on children, was able to better extend its reach by being skillfully combined with children's education. This emphasizes that cultural factors can be a catalyst for successful interventions depending on the specific context, and not just a barrier. Therefore, an in-depth understanding of the complexities of the local culture is crucial when developing intervention programs.

“In our salt reduction project, we find that the children at home often play a key

role to provide some health education. Therefore, the complex intervention could scale-up from children or primary students.” (University or other Academic Institution-----China-----LMICs)

The role of cultural factors in the scaling up of interventions needs further exploration. Unlike small-scale local adaptation of interventions, the influence of cultural factors is particularly important when scaling up larger scale complex health interventions. Consequently, experts recommend customizing different interventions in different regions to fully take into account local cultural contexts and characteristics. Such customized approaches can improve the acceptability and effectiveness of interventions in different communities, thereby better achieving public health goals.

“Depending on the intervention, will be the acceptance or not of an intervention. More traditional religious cultures may have a narrow perspective of reluctance for some types of interventions. Political interactions may play a role in scaling up and may be linked to cultural or religion beliefs. Even in the same country, settings may differ. Differences between sub-urban, rural and rural-indigenous beliefs and acceptance may differ.” (Research/ non-profit or governmental agency-----Mexico-----LMICs)

It was argued that even within the same city, different interventions might be required for specific populations due to diverse factors such as ethnicity, religious beliefs and cultural differences. This demonstrates the complexity and diversity of interventions, with different communities potentially having different values, habits and needs. Therefore, when designing and implementing interventions, it is important to have an in-depth understanding of the diversity of local communities to ensure that interventions are not only effective, but also appropriate and acceptable.

Within such diverse contexts, it becomes crucial to customize intervention strategies

to meet the specific needs and expectations of various communities. This may include adopting different modes of communication, languages and cultural sensitivities to enable interventions to be better integrated into the lifestyles and values of different communities. In addition, close collaboration and partnerships with local communities need to be established in order to better understand their needs and plan interventions accordingly.

“Difference in culture in the geographic areas and populations targeted impact significantly on the scale-up. We have been involved in a project where within the same city we had to have different screening/risk stratification tools, different contents of the interventions for two populations groups due to cultural differences. (University or other Academic Institution-----South Africa----LMICs)

And also:

“Different cultures in the same geographical areas and populations targeted have a huge impact on the scale up of intervention, as these generally translate into the need for different sub-intervention to accommodate the cultural need of sub-populations. For the South African Diabetes prevention program for instance, only in Cape Town, the needs emerged to have components of the program that specifically address the needs of mixed-ancestry populations and Black populations, which needs could be completely different, due to cultural specificities” (Research/ non-profit or governmental agency-----South Africa-----LMICs)

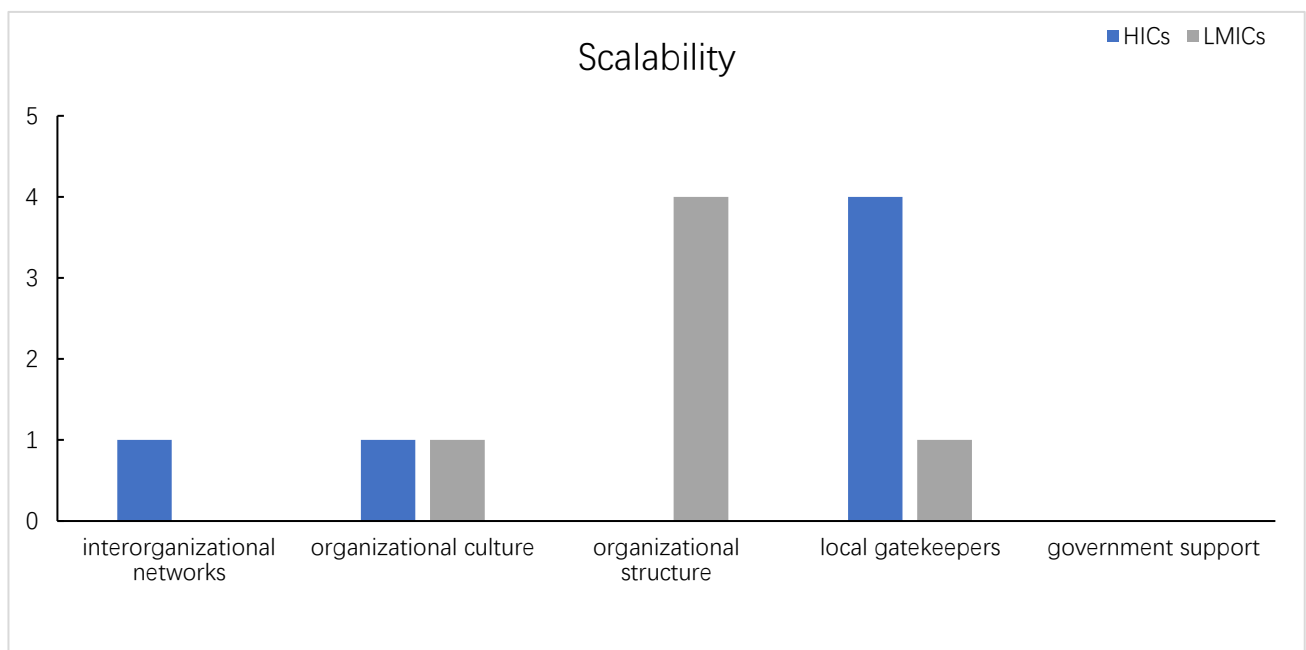
In summary, cultural factors have a crucial place when expanding an intervention. By tailoring interventions precisely to the cultural characteristics of different populations and geographic areas, interventions can be targeted and adaptable, thus better meeting the needs of different communities.

Theme 3 Organizational attributes

In terms of scalability, this factor of local gatekeepers was mentioned by four experts from the HICs group and one expert from the LMICs group.

For scalability, experts from the LMICs were more concerned with organizational structure, with four experts mentioning this factor, while experts from the HICs did not mention it at all. Additionally, interorganizational networks were mentioned by one expert from the HICs group, and organizational culture was proposed by one expert from each group. (see Figure 16)

Figure 16: The importance of influencing factors within Theme 3 to the scalability component



As with the adaptation phase of the intervention, Local gatekeepers play an important role in the expansion of the intervention because they are familiar with the local culture, the local community, and the allocation of local resources, and therefore

largely influence the scalability of the intervention in the target area.

“Their input is very important as that tells about how much local collaboration and support the project may get” (University or other Academic Institution----QATAR---HICs)

Experts noted that increased collaboration and information-sharing between organizations was essential for the scaling up of complex interventions, especially with organizations not previously involved in the intervention. Close collaboration between organizations could help to improve the efficiency of information transfer and reduce barriers that might be encountered in the course of an intervention. By sharing experiences and resources, different organizations can work better together and leverage each other's expertise, thus facilitating a smooth scaling-up of the intervention. Such cross-organizational collaboration helps to break down barriers, reduce redundancies and increase overall efficiency, making it more likely that interventions will be successfully implemented on a wider scale.

“Poor cooperation and synergy between Public and the growing private health sector/hospitals----- (University or other Academic Institution-----LMICs-----Nigeria)”

Experts mentioned that the expansion of interventions is smoother in a well-cohesive intra-organizational cultural climate. This cultural climate fosters collaboration, coordination and information sharing. At the same time, this culture also helps members of the organization to build trust with each other, making team members willing to actively participate in the scaling up and application of the intervention.

Moreover, organizational structure has a significant impact on the implementation of interventions. The dynamism and flexibility of an organizational structure are key

determinants, conversely a rigid organization can be a serious impediment to the implementation and success of interventions. An organizational structure with a high degree of dynamism and flexibility is better able to adapt to rapidly changing health environments and complex challenges. Such an organizational structure is able to quickly adjust staffing, resource allocation, and strategic direction to respond to emerging health issues and needs, thereby increasing the adaptability and scalability of interventions.

In contrast, rigid organizational structures are often limited by lengthy decision-making processes, excessive layers of management, and a lack of innovation. These factors can reduce the organization's responsiveness, lead to wasted resources, slow down the process of intervention implementation, and even lead to program failure. In addition, a lack of flexibility may make it difficult for organizations to attract and retain professionals with the diversity of skills and knowledge that are critical to meeting evolving health challenges.

“A rigid structure can make the adoption of an intervention challenging particularly when this requires the participation of the leadership of the organisation.” (Research/ non-profit or governmental agency----South Africa----LMICs)

By optimising the organisational structure and maintaining a good relationship with local gatekeepers, the scalability and adaptability of the interventions can be improved, thus better achieving the goals of the health interventions.

In the section on scalability, the experts from LMICs repeatedly mention organizational structure, which the experts from HICs do not mention in this section.

“Local and community structures such as the buy-in of their leadership is

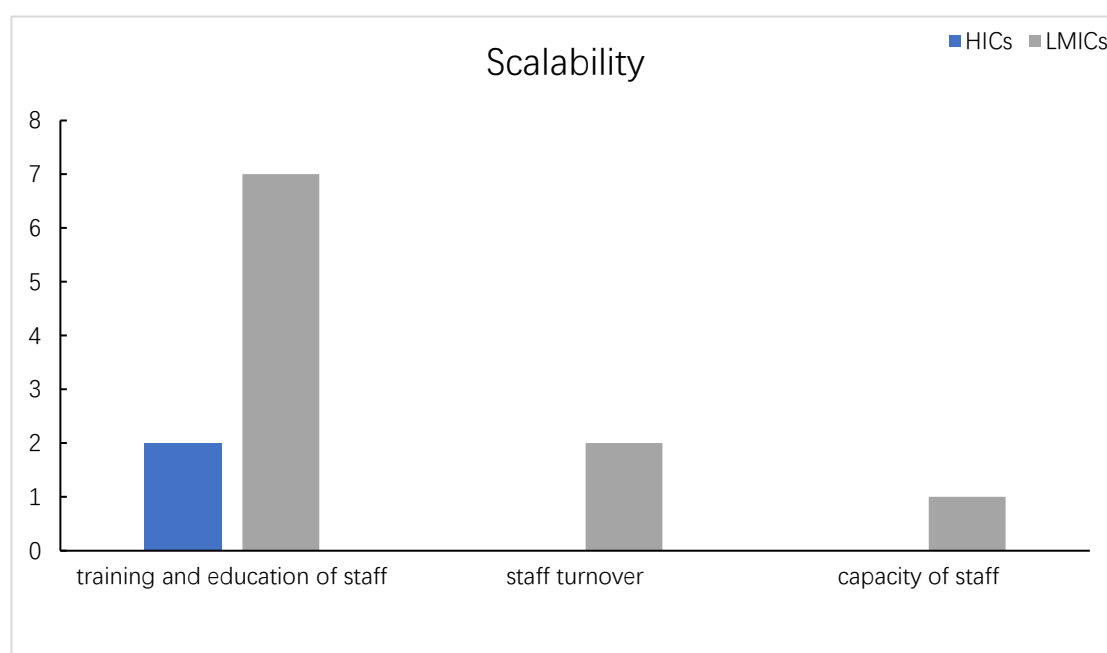
critical.”(University or other Academic Institution----Nigeria----LMICs)

Theme 4 Human resources

In the scalability section, all 3 factors were mentioned, mainly by experts from LMICs. Two experts from HICs mentioned training and education of staff; experts from LMICs mentioned this factor more often, with seven experts mentioning it. Furthermore, staff turnover was mentioned by two experts, and capacity of staff was mentioned by one expert.

In particular, the factor of training and education of staff was mentioned more often by experts from LMICs than those from HICs. This suggests that in LMICs, experts are concerned about how to enhance the capacity of staff through training and education in order to achieve scalability of interventions. (see Figure 17)

Figure 17: The importance of influencing factors within Theme 4 to the scalability component



First, the shortage of experienced health workers has been an obvious problem in low-income countries (LMICs). Compared to the adaptive phase of complex interventions, the need for health workers becomes acute during the scale-up of interventions, as the interventions need to be implemented on a wider scale and involve larger numbers of participants.

“One key issue that affects scale up of any intervention is the understanding of the community or local institution of the core concept of the intervention. Unfortunately, most health care delivery in LMICs is understaffed or poorly staffed and so training and retraining on the core concepts will need to be employed in order to address this. -----(University or other Academic Institution----Nigeria----LMICs)

Low and middle-income countries (LMICs) not only encounter a shortage of health workers, but also problems relating to their experience and competence, which has become a major issue hindering complex health interventions. One of the solutions proposed by experts is to train relevant staff to improve their skills and competencies. This means not only increasing the number of health workers, but also ensuring that they have sufficient knowledge and skills to participate effectively in interventions. Through training, medical staff who would not otherwise be able to perform the interventions can acquire the competencies needed to improve the quality and effectiveness of the interventions.

“The most important thing is the level of training and skill set in the organization. The more the training the easier the project implementation----- (University or other Academic Institution----Nigeria----LMICs)”

“Staff with the requisite knowledge or skills needed to implement the intervention is crucial for expansion of the scale”----- (University or other Academic Institution-

---Nigeria----LMICs)

Experts also pointed out that the process of intervention is significantly hindered where staff have insufficient basic competencies and skills to be trained. This not only manifests itself in slow progress due to the inability of staff to undertake tasks effectively, but may also lead to staff being discouraged from participating in the implementation of the intervention due to frustration, thus further exacerbating the problem of understaffing in low- and middle-income countries (LMICs).

“Staff at smaller local organisations may be overwhelmed by the multitude of services that they must deliver and may not have received sufficient training to perform all the procedures expected from them. They may therefore be reluctant to participate in proposed interventions.” (University or other Academic Institution----South Africa----LMICs)

However, the increase in training-related staff, while contributing to the effectiveness of intervention programs, also raises problematic issues. First, increasing the number of training staff can lead to a significant increase in the budget of the intervention program, which can trigger financial pressures in a limited resource environment. Second, training takes time, and time is a limited resource, especially in low- and middle-income countries (LMICs), and the investment of time may interfere with other much-needed programs and activities. Finally, increased human resources costs due to the training and education represent a key issue, as scarcity of resources was a constant problem in LMICs, which could make the increase in human resources costs unaffordable. Therefore, experts suggest that the potential enhancement of program effectiveness from an increase in training staff needs to be carefully weighed against the budget, time, and labour costs to determine whether such costs are acceptable. This decision needs to be fully evaluated and analyzed to ensure that the objectives of the project are maximized while remaining sustainable and economically sound.

“Is training costly? Feasible and linked to scaling up?” (Research/ non-profit or governmental agency----Mexico----LMICs)

“In Nigeria, during the early response to HIV, some staff at public hospitals left government employment to join non-governmental organizations because of higher remunerations thereby weakening the public health system. Also, due to a shortage of skilled manpower, some healthcare workers with lower competence were trained under the task-shifting policy to perform roles that were initially above their competence in different complex health interventions(University or other Academic Institution----Nigeria----LMICs)”

In addition, some experts argue that it is essential to emphasize that in certain regions, recruiting qualified healthcare professionals may pose greater challenges compared to training existing medical staff. Remote or resource-limited areas may lack available healthcare personnel for recruitment. In such cases, organizations or projects may need to resort to expensive approaches, such as bringing in medical volunteers or foreign medical teams, to fill the gap in healthcare services. This not only increases project costs but may also lead to complex coordination and management issues. Therefore, when considering the feasibility and sustainability of a project, careful consideration of these additional expenses is necessary to ensure maximum healthcare coverage while maintaining economic viability.

“the availability of staff with the required skills is critical. It determines whether you can scale up or not and what you will need to do. For example if there are staff without the required skills they can be trained. If there are no staff, it may be more complex because the MoH will need to recruit the staff but they may not have funding from the ministry of finance” (Research/ non-profit or governmental agency-----Ghana-----LMICs)

Also, as mentioned in the scalability phase, experts supported how, in the scalability phase of the intervention, some staff also may already be overloaded and may lack the capacity or time to participate in the intervention training.

“Staff at smaller local organisations may be overwhelmed by the multitude of services that they must deliver and may not have received sufficient training to perform all the procedures expected from them. They may therefore be reluctant to participate in proposed interventions-----” (University or other Academic Institution----South Africa----LMICs)

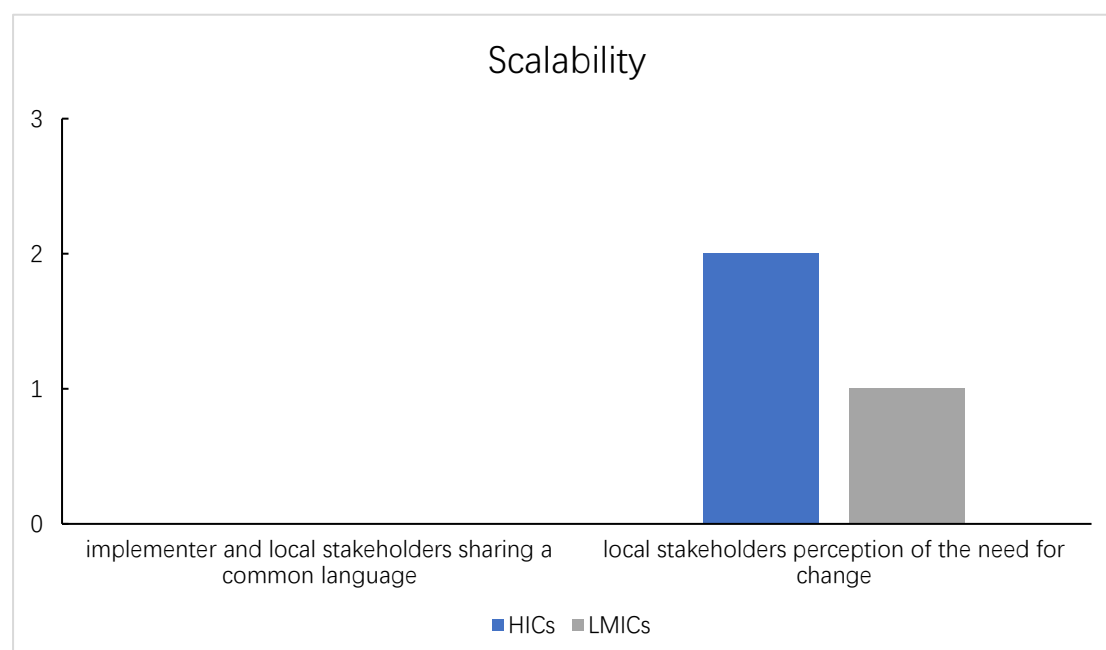
It is important to note that training and education programmes can be affected by staff turnover and overload, which can affect the effectiveness of intervention delivery. Therefore, measures such as recruiting more staff, improving staff welfare and improving the working environment need to be considered to reduce the problem of staff turnover and overload.

“Unfortunately, most health care delivery in LMICs is understaffed or poorly staffed and so training and retraining on the core concepts will need to be employed in order to address this.”(University or other Academic Institution----Nigeria----LMICs)

Theme 5 Provider factors

In the scalability section, stakeholder perception of the need for change was mentioned by two experts from HICs and one from LMICs. (see Figure 18)

Figure 18: The importance of influencing factors within Theme 5 to the scalability component



In terms of scalability, Similar to findings for adaptability, experts highlighted this influencing factor in relation to the incentives of resources or funding. Local stakeholders expected to acquire a win-win cooperation situation when working with complex health interventions implementers because of the greater need for funding and resources during the scale-up phase of an intervention.

we've observed a pivotal factor being the alignment of resources or financial incentives with the expectations of local stakeholders----- (University or other Academic Institution-----China-----LMICs)

Further, experts have also shown that this cooperative win-win is ideally a win-win for all stakeholders, not just some of them. Specifically, in prompting the willingness of local gatekeepers to change the status quo, it is important to ensure that all stakeholders are included as much as possible. This is because in a health intervention program, if some people or groups of stakeholders are compromised or a win-win situation cannot be achieved, the program may be hindered or encounter opposition.

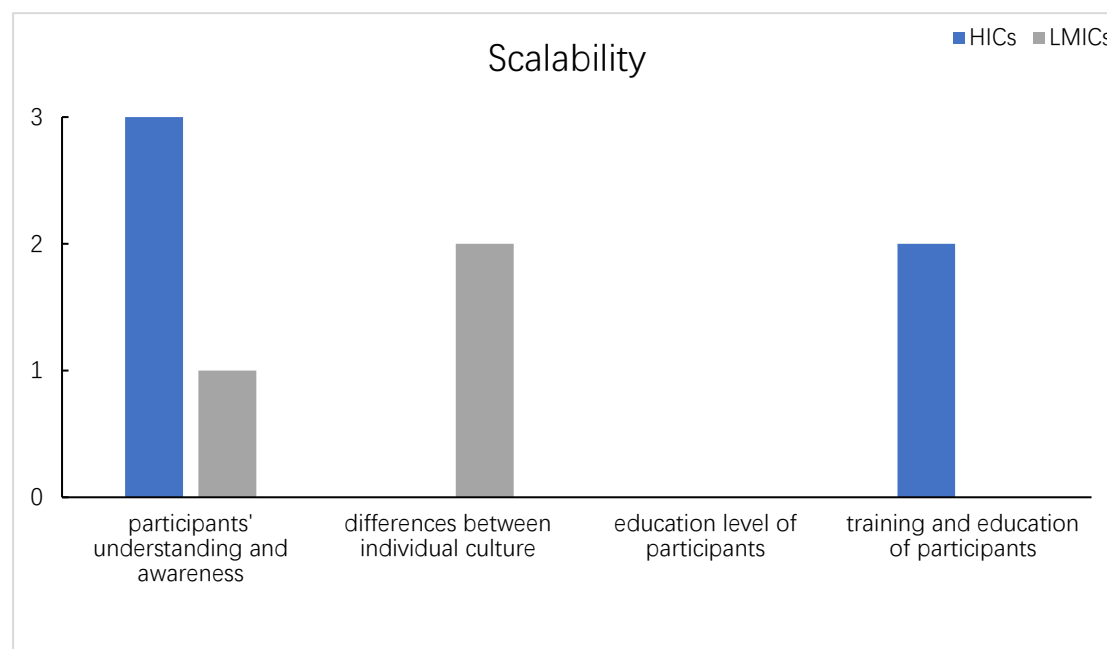
Synthesizing the interests and needs of all parties and building consensus is key to ensuring successful project implementation. By engaging diverse stakeholders, potential resistance and conflict can be reduced, increasing the chances of project sustainability and long-term success. Therefore, those implementing interventions need to coordinate and communicate to ensure that all stakeholders are involved in the project, are able to voice their opinions, can resolve potential disagreements, and ultimately move the health intervention program forwards toward a common goal. This comprehensive stakeholder engagement helps to create an environment that is conducive to health improvement and maximizes the likelihood of scaling up the intervention.

“The need to bring all stakeholders to the table, engender discussions between all stakeholder groups that will be involved with the implementation is key. In doing this, you will need to carefully identify the feelings of the stakeholders and their perception of the needs for scale up and what exactly needs scaling up-----
(University or other Academic Institution-----Nigeria-----LMICs)

Theme 6 Recipient factors

The focus of the experts from the LMICs and the HICs also differed with regard to scalability. Firstly, the experts from LMICs group and HICs group mentioned participant understanding and awareness. Furthermore, two experts from LMICs group mentioned differences between individual cultures, while two experts from HICs focused on the factor of training and education of participants. (see Figure 19)

Figure 19: The importance of influencing factors within Theme 6 to the scalability component



If participants have superior understanding and awareness of interventions, it can promote the process of implementing the interventions. Hence, when participants do not have a good understanding of the intervention, experts propose that they can be educated and trained to improve their understanding.

"Understanding the mechanisms and goals of health interventions is paramount for participants," (University or other Academic Institution----Mexico----LMICs)

Furthermore, the process of education and training is also influenced by the individual culture of the participants. As mentioned by previous experts, some participants refused to participate in the intervention for personal religious or cultural reasons.

"Religious beliefs also determine locus of control. In most, northern parts of Nigeria, the cleric determines what most people accept as true or even agree to implement no matter how scientifically sound" (University or other Academic

Institution----Nigeria----LMICs)

Theme 7 Project Management processes

A total of eight influencing factors were mentioned in the scalability section. As for adaptability, local stakeholder involvement was repeatedly highlighted by experts from LMICs group and HICs group. Five experts from HICs group and eight experts from LMICs group focused on this factor. (see Figure 20)

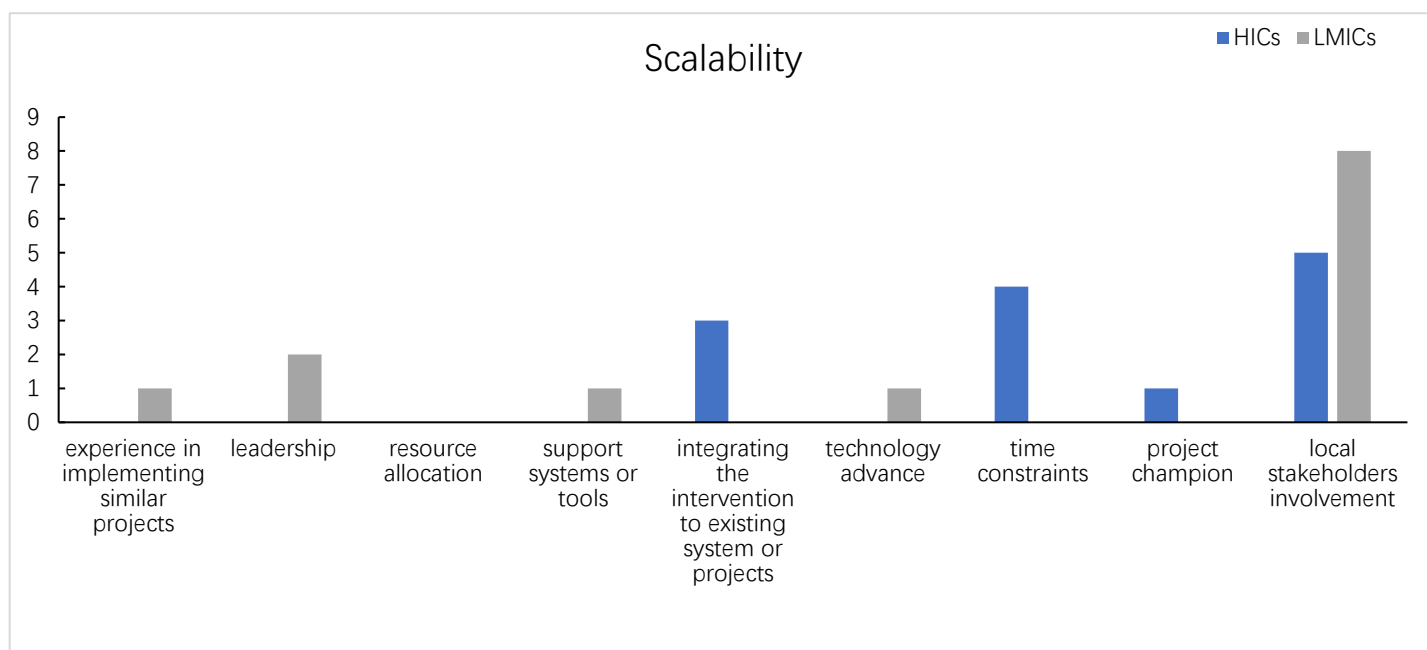
For the experts from HICs, three mentioned integrating the intervention within existing system or projects, four mentioned time constraints, one mentioned the project champion.

One expert from the LMICs focused on each of technological advances and system assistance, respectively. Also, one expert mentioned experience with similar projects. Leadership was also mentioned by two experts from LMICs group.

the experts from the LMICs emphasised leadership and experience in addition to the previous emphasis on technology, or supporting tools.

The experts from the HICs, on the other hand, put emphasis on how to integrate projects into the daily system as an influencing factor.

Figure 20: The importance of influencing factors within Theme 7 to the scalability component



Similar with the adaptability phase, local stakeholders play an equally important role in the phase of complex health intervention scalability phase.

“The stakeholders involved will be mapped on bases of Interest and influence and engaged effectively. Consider a collaborative approach where the healthcare organization has a role they can play that is interesting to them. This should start from the stage of program design, not the implementation stage as it will make them feel essential and part of your program as their opinions and sort and accommodated. Build on existing programs and structures to ensure support and sustainability(Research/ non-profit or governmental agency ----UK----HICs)”

Similarly, experts also mentioned that the issue of managing relationships with local stakeholders is also very important. In the scalability phase of complex health interventions, if there is no good communication, exchange and relationship with local stakeholders, the complex health intervention will likely be hindered. The reason for

this is similar to what was mentioned earlier, as local stakeholders often have strong relationships with the local community, and without their help, it will be difficult to scale up the intervention in the local community.

“For me it's the human aspect again - and how researchers relate to stakeholders. If the relationship is strong/robust, then it can all go well. But if not, it can be disastrous (and it probably often is, unfortunately!) (University or other Academic Institution----UK----HICs)”

In addition, the role played by the leadership of the intervention implementer in the scalability phase of a complex intervention is essentially the same as in the adaptability phase.

In terms of the resources allocation, during the scale-up phase of the intervention, as mentioned before, staffing shortages may become acute. Therefore, experts from low- and middle-income countries (LMICs) re-emphasized the potential help of technology and hoped that, through the application of technology, the shortage of local healthcare personnel could be alleviated to some extent.

However, contrary to the adaptability phase, these three factors (Experience in similar projects, integrating the intervention to the existing system, and time constraints) were all raised by the experts, especially the first two factors, which were not mentioned in the adaptability phase.

The explanation given by the experts for the possible reasons for this situation is that for the factor of Experience in similar projects, this factor is not as influential during the adaptation phase, as the intervention is small-scale and at the same time the researcher is in the process of figuring out the experience. In the case of large-scale interventions, in many cases, it is necessary to draw the experience from similar

existing projects.

For the factor of integrating the intervention to the existing system, the organic integration of the intervention into the existing system is particularly important during the scale-up phase of the intervention, as it not only makes efficient use of existing resources, but also saves a great deal of money in terms of human and material costs. This is particularly important for low- and middle-income countries, where resources are often limited and fiscal budgets are tight. By coordinating with existing health, education and social service systems, interventions can be sustainably integrated into communities and better respond to people's needs. Such integration not only improves efficiency, but can also accelerate the scaling up of interventions to reach communities more broadly and provide support and services. Unlike during the small-scale adaptation phase, where interventions can be implemented in two systems parallel to the existing system.

"Engaging with and reinforcing existing systems allows for a more cost-effective utilization of both human and material resources. This approach not only extends the reach of interventions, enabling them to benefit a wider audience, but also ensures that the support and services provided are both relevant and responsive to community needs." (University or other Academic Institution---China---LMICs)

Finally, the management and control of time in the scaling up of complex health interventions has become an issue of great concern to experts. This involves not only the time commitment of the individuals implementing the interventions but also the time constraints set by the program. This is because, to some extent, time can also be seen as a limited form of resource.

For scalability considerations, it's imperative to establish stringent management of the project's time commitments. This encompasses defining the entire project duration,

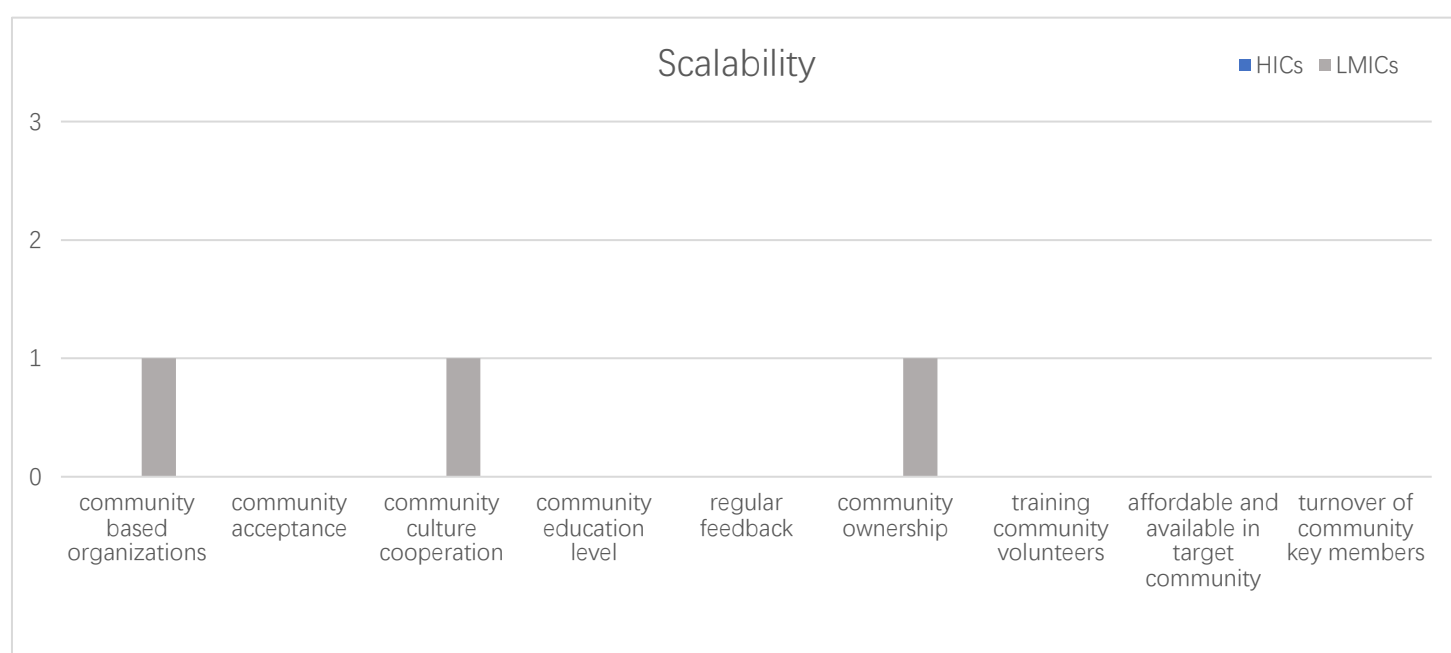
setting clear timelines for each developmental phase, and precisely scheduling feasibility studies. Effective time management is essential as it prevents delays, curtails escalating costs, and safeguards the intervention's effectiveness.

“resources and time dedicated to it.” (University or other Academic Institution----USA----HICs)

Theme 9 Embedding in communities

For scalability, only experts from LMICs referenced specific factors, including community organisation, community cultural cooperation and community ownership. (see Figure 21)

Figure 21: The importance of influencing factors within Theme 9 to the scalability component



Experts advise that if those implementing interventions can build trust with community-based organizations and gain their support by explaining the benefits of the intervention to the local community, this can help to promote the acceptance and

scalability of the intervention in the community, as community-based organizations usually have in-depth knowledge and influence in the local area, and can help the implementers to better interact and collaborate with the community.

“One key issue that affects scale up of any intervention is the understanding of the community or local institution of the core concept of the intervention.”(University or other Academic Institution----Nigeria---LMICs)

During the scale-up phase of complex health interventions, experts believe it is critical to foster a sense of community ownership among community members. If community members feel that they have ownership of their community-based interventions, they are likely to become actively involved in project decision-making and implementation. Often they will want their community to become better and therefore feel responsible for, and willing to contribute to, its success. This helps to ensure that interventions are better integrated into the local culture and social fabric and scaled up in the local community.

“Community involvement and ongoing community engagement encourages ownership of any intervention.” (University or other Academic Institution----Papua New Guinea---LMICs)

“community ownership for the programme, community participation, awareness of the community on the usefulness of the intervention”(University or other Academic Institution----Nigeria---LMICs)

In addition, experts emphasized the importance of community cultural compatibility for intervention expansion. Cultural compatibility in the community helps to reduce potential resistance and conflict, leading to better integration and success in the community, and helps to ensure that intervention programs are effectively

disseminated and implemented in different communities.

“The main thing is that the community should feel the need and find the intervention culturally compatible.” (University or other Academic Institution---- India---LMICs)

Sustainability

This document delves into the sustainability of complex health interventions, focusing on eight critical themes that are integral to maintaining long-term health initiatives across diverse settings. The themes explored include the Sociopolitical Context, Health Systems, Organizational Attributes, Human Resources, Provider Factors, Recipient Factors, Project Management, and Community Engagement.

The results showed the importance of integrating interventions within existing health and community systems to ensure continuity and effectiveness. It also highlights the need for ongoing support from both local gatekeepers and government policies, which play crucial roles in sustaining health interventions.

Human resources are underscored as a key element, particularly the training and stability of staff, to prevent turnover and maintain the quality of care. Furthermore, the sustainability of these health interventions hinges on their cultural and social acceptability, which requires aligning with local values and beliefs.

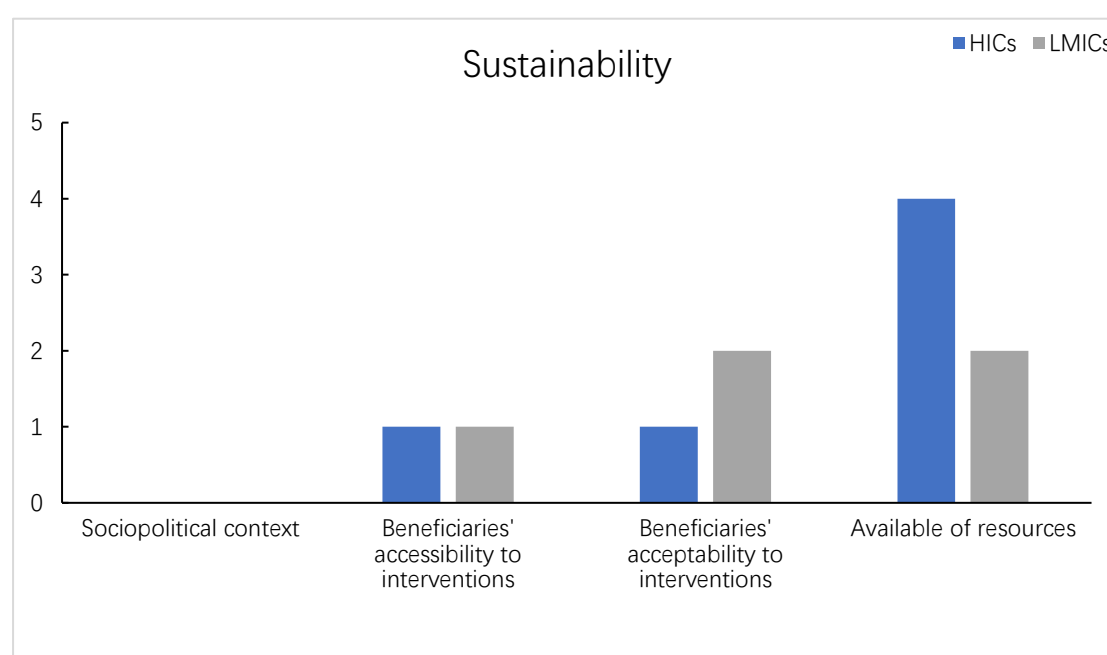
Theme 1 Context

For sustainability, experts from both LMICs and from HICs mentioned beneficiaries' accessibility to interventions; Acceptability of interventions to beneficiaries; and availability of resources. Specifically, one expert from HICs group and one from LMICs group mentioned beneficiaries' accessibility to interventions. Also, two experts from LMICs group mentioned Acceptability of interventions to beneficiaries, while one

expert in HICs group mentioned this factor.

Additionally, experts from HICs focused on availability of resources. Specifically, four experts from HICs group mentioned this factor, compared to two from LMICs group. (see Figure 22)

Figure 22: The importance of influencing factors within Theme 1 to the sustainability component



However, it is worth noting that neither experts from HICs and LMICs mentioned sociopolitical context in this part.

In contrast with the results for adaptability and scalability, experts from high-income countries mentioned available resources twice as often as experts from low-income countries in discussions related to sustainability. This observation suggests that experts from LMICs may emphasize the importance of available resources for both adaptability and scalability, whereas those from HICs may prioritize the factor of available of resources specifically in the aspect of sustainability.

Beneficiaries' accessibility to interventions

Experts stressed that the access to intervention and the economic condition of the local population are also relevant. In addition to the level of resource allocation for an intervention, the economic situation of the local population is a key factor in achieving sustainability. The affordability of intervention products and the availability of access to interventions for local people have a significant impact on the implementation and long-term effectiveness of interventions. If the local people cannot afford the cost of using an intervention, even if the intervention is well designed, it may not be implemented effectively in the long term due to a lack of funding at the local level.

“Affordability and access to the intervention product” (University researcher---South Africa---LMICs)

Beneficiaries' acceptability to interventions

Experts underscore the critical role of beneficiaries' acceptance towards interventions, along with the infrastructural prerequisites for access. The degree to which an intervention is accepted by its target population and the structural facilitators for accessibility constitute fundamental elements in determining its sustainability. Beyond merely allocating resources for an intervention, understanding and integrating the societal and cultural receptiveness to these interventions emerge as pivotal in ensuring their enduring impact.

The acceptability of health interventions among the local populace, influenced by cultural norms and perceived relevance, significantly dictates the feasibility and effectiveness of these initiatives. An intervention that aligns with the beneficiaries' values and needs is more likely to be embraced and sustained over time. Conversely, resistance or indifference towards an intervention can severely hinder its long-term viability, irrespective of the resources invested.

“First is the acceptance of the target population and related social groups, then community acceptance, and importantly and linked to it is the sustainability factor, will the system be able to sustain the intervention and not create false expectations?” (Research/ non-profit or governmental agency---Mexico---LMICs)

Availability of resources

In general, in the section on sustainability, the experts mentioned the similar factors as in the previous two sections, namely human resources and non-human resources. Adequate resource is an important factor in ensuring the long-term sustainability of an intervention.

“Availability of structures and trained personnel (available structures like good road, health centres, trained healthcare workers will help ensure sustainability) (Research/ non-profit or governmental agency---UK---HICs)

Experts also emphasized that these resources did not only include drug resources, but also covered diverse aspects such as food, water and human resources. In some cases, therefore, even if drug resources were sufficient, shortages of other resources could lead to unsustainable interventions. This situation highlights the importance of resource plurality in intervention sustainability. Therefore, the availability of different resources needs to be taken into account when designing and implementing interventions to ensure that interventions are sustained and effective in a variety of settings and contexts. This also highlights the critical role of integrated planning and resource.

To better understand this, the expert also mentioned that a study of Uganda could be used as an example. Based on the conducted by Weiser [302], in the Ugandan region,

food crises are frequent and a significant barrier to accessing healthcare and adhering to antiretroviral therapy. Factors mentioned in the study include how antiretroviral drugs can cause an increase in appetite, which can lead to intolerable hunger in situations where food is scarce. In turn, the side effects of antiretroviral drugs may become severe if food is scarce.

Additionally, experts emphasized the issue of funding and cost, as in the Ugandan study mentioned above, such that when participants were unable to afford the additional nutritional costs, they may have chosen to skip doses of the medication or simply not to start taking the antiretroviral medication at all.

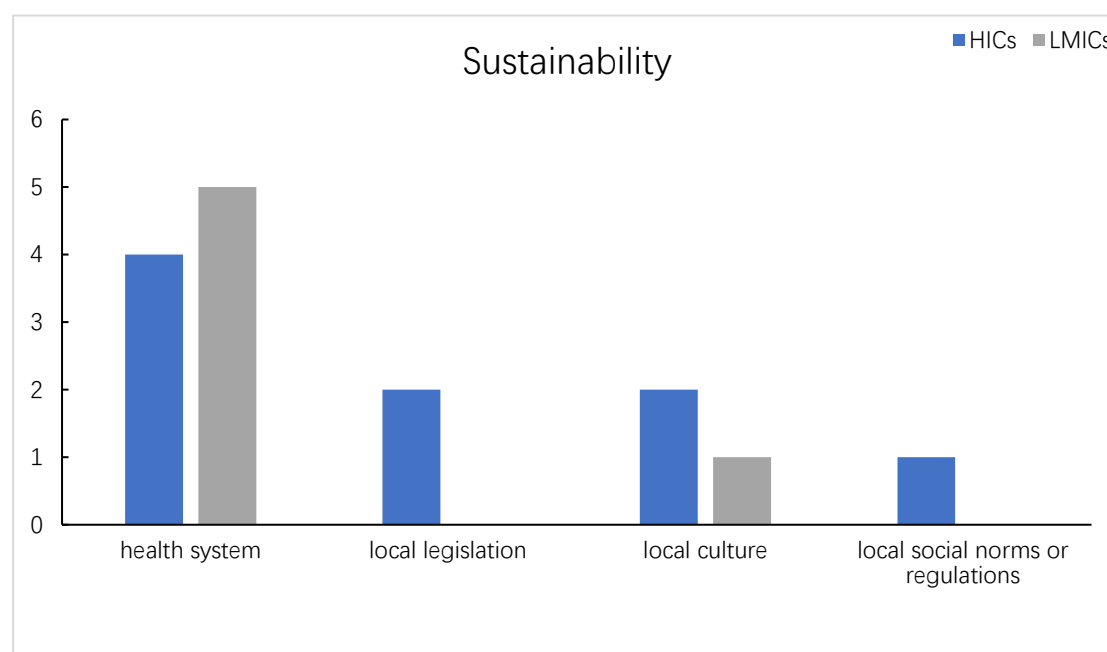
Therefore, when resources are scarce to provide adequate staff support or to meet basic material needs to make interventions sustainable, experts suggest that this may force the adoption of flexible, precise and sustainable approaches that may be needed to make the best use of limited resources in order to adapt to the realities of resource constraints.

“When resources are insufficient, interventions can be adjusted to make them as costly and resource-intensive as possible without decreasing their effectiveness too much.” (University researcher---China---LMICs)

Theme 2 Setting

The experts from the HICs mentioned all four factors in this section: health system, local legislation, local culture, local social norms or regulations. Four mentioned the health system, two mentioned local legislation, two experts mentioned local culture, and one mentioned local social norms or regulations. The experts from LMICS only mentioned two factors: health system and local culture. Five experts mentioned the health system and one mentioned local culture. (see Figure 23)

Figure 23: The importance of influencing factors within Theme 2 to the sustainability component



The health system is crucial to the sustainability phase with experts from both HICs and LMICs emphasizing the important role it plays across the whole phase of intervention implementation.

Health system

Health systems can adjust budgets through policy and other measures to facilitate the sustainability of the project. In other words, the health system often acts as a bridge between available external resources and the implementation of the intervention.

As mentioned in the scalability phase, the expansion of complex health interventions requires the support of the health system.

Experts mentioned, for example, how decades of neglect and underinvestment had

severely weakened health systems in most developing countries. Throughout the 1980s, a combination of factors, such as economic downturns, debt issues, internal conflicts, political instability, inadequate governance, and growing environmental stressors, significantly worsened poverty and inequality, with the African region being particularly affected. The implementation of structural adjustment policies aimed at stabilizing fragile economies often resulted in reductions in public health expenditure.[303]

“Policies help create budget line. Efforts should be made to draft and craft policies around the project rather than make the project a donor driven one”(University researcher---Nigeria---LMICs)

“Leadership and governance structures that are committed to intervention, and provide the legal, institutional and admin systems to support its implementation” (Independent research consultant---USA----HICs)

Culture

Experts suggested that in some regions, religion has a strong influence on the community, making the alignment of interventions with local religious beliefs one of the key determinants for the sustainability of interventions. Interventions that are compatible with local religious values and practices tend to be more readily accepted and adopted by the community. Conversely, when interventions are perceived to be in conflict with local religions, they may trigger resistance or rejection, thus threatening the sustainability of the intervention. Cultural and religious factors therefore play a key role in determining the success and sustainability of interventions and need to be properly considered and integrated in intervention plans to ensure their effectiveness and acceptability in various social and cultural contexts.

“Once it does not contravene their religious or social values, it's easier to get a community to sustain it themselves----(University researcher---Nigeria---LMICs)”

In addition, experts suggested that local cultural factors need to be further considered, as there is a strong link between them and available resources and government support. Cultural backgrounds and traditional practices in different regions may affect the allocation of resources and the level of government support for the health system. Government investment and policy support in different regions, for example, may also vary according to local cultural and social needs.

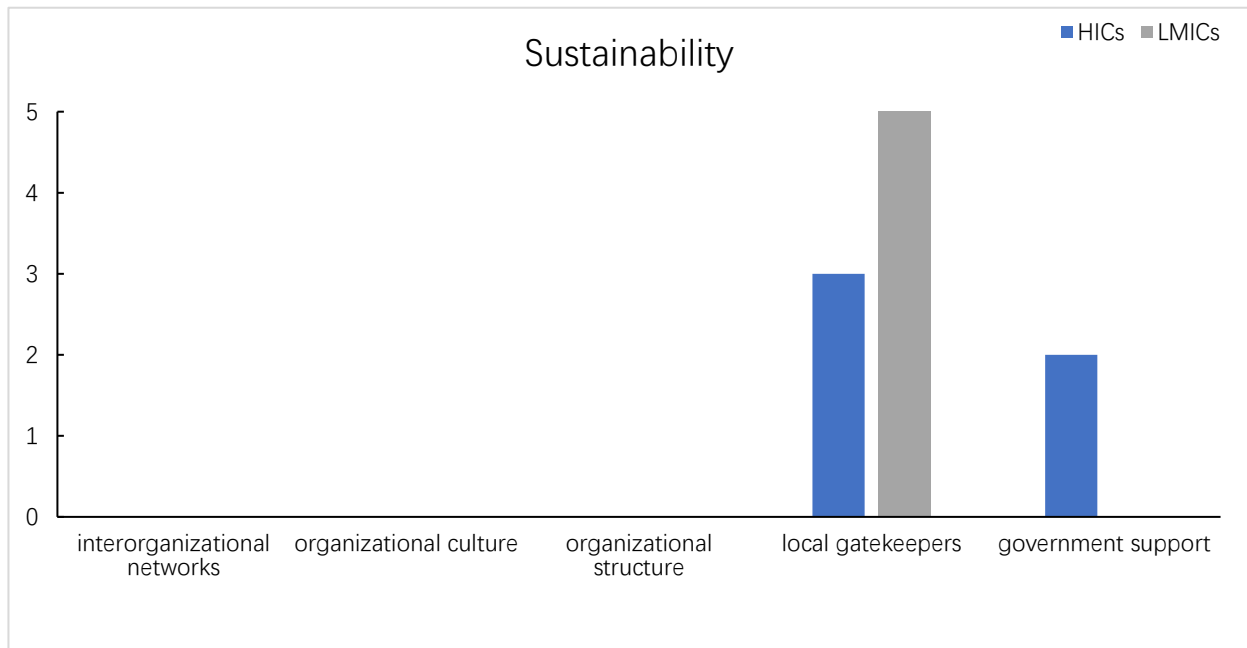
“fit with culture and have some resources and supports----(University researcher--Canada---HICs)”

Theme 3 Organizational attributes

Compared with the adaptability phase and scalability phase, the three factors of inter-organizational networks, organizational culture and organizational structure were not mentioned in the sustainability phase.

In the sustainability section, only two factors were mentioned - local gatekeepers and government support. Local gatekeepers were mentioned by three experts from HICs group and five experts from LMICs group. Also, government support was proposed by two experts from HICs group. (see Figure 24)

Figure 24: The importance of influencing factors within Theme 3 to the sustainability component



In contrast to the scalability phase, experts did not explicitly mention factors such as inter-organizational networks, organizational culture and organizational structure in the sustainability phase. These factors may relate mainly to the adaptability and scalability of the intervention. However, two factors, local gatekeepers and government support, became particularly important during the sustainability process. The involvement and support of local gateway figures can help maintain the effectiveness and sustainability of the intervention, while government support can provide the necessary resources and policy support to ensure the continuity of the intervention.

Based on the comments of experts, the role of local gatekeepers in the sustainability phase is similar to that described in the scalability phase. Local gatekeepers are familiar with the local culture, the local community, and also have some degree of control over the local allocation of resources, which affects the likelihood of the intervention being sustained in the target area.

Additionally, experts from HICs group emphasized government support. Experts described how governments could allocate sufficient resources to support the implementation of sustainable interventions. This includes financial resources, as well as human resources such as trained staff and volunteers. However, according to the experts' responses, government support may not be stable or sufficient in some low-income countries, with a negative impact on the implementation of interventions. Experts from LMICs may be accustomed to implementing health interventions without strong government support, while experts from HICs may seek to build good relationships with government and implement interventions while trying to gain support.

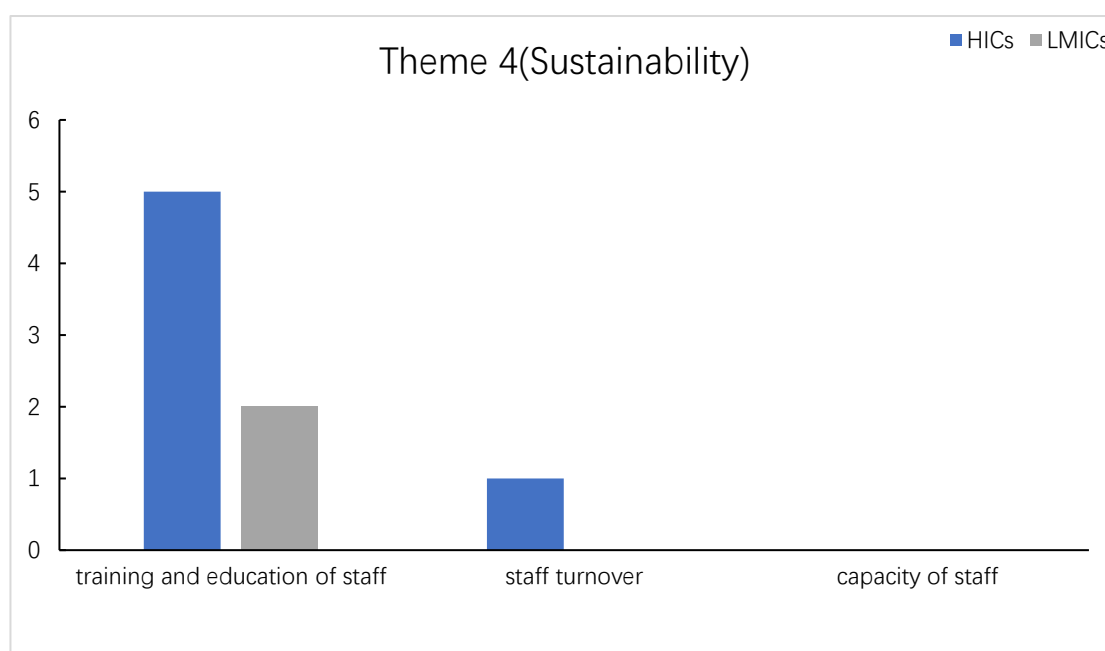
“Can the program be sustained by the government or community with need for external support (Research/ non-profit or governmental agency-----UK----HICs)”

Theme 4 Human resources

In the sustainability section, experts emphasised two factors: training and education of staff and staff turnover. The experts from LMICs mentioned the former, while those from HICs mentioned both, and more frequently. Specifically, five experts from HICs mention the factor of training and education of staff, and two from LMICs. Also, staff turnover was mentioned by one expert from HICs group. (see Figure 25)

This suggests that experts from LMICs were concerned with the scalability of the intervention, while experts from HICs were concerned with the sustainability of the intervention. This difference in focus may also reflect an underlying limitation in the sample size, suggesting that the representation from each group might not have been sufficient to capture a comprehensive view of priorities across all experts involved.

Figure 25: The importance of influencing factors within Theme 4 to the sustainability component



In the follow-up phase, ongoing education and training is a key factor in the sustainability of the intervention. Stable and continuous education not only improves local medical standards, but also allows the intervention to be implemented better according to the intended plan and direction.

“Readily available structures like good road, health centres, trained healthcare workers will help ensure sustainability” (Research/ non-profit or governmental agency-----UK-----HICs)

In the subsequent phases of the project, as for the scale-up phase, financial pressure was always a key issue. Some experts suggested that consideration could be given to minimizing the need for training of medical staff, and then the operating costs of the project would be significantly reduced, which would increase the likelihood of the project being sustained. Other experts suggested different things. First, reducing training for medical staff may reduce the quality and effectiveness of interventions to

the detriment of patients. Second, lowering training standards may lead to inadequate and insufficient quality of medical staff, which may negatively affect patient health. Therefore, researchers need to find a balance between maintaining economic efficiency and providing high-quality health care services.

“The less are the training/retraining requirements of the implementers, the more likely it is to sustain the intervention” (Research/ non-profit or governmental agency-----South Africa-----LMICs)

In addition, experts suggested that issues such as staff turnover and stress can also have a profound impact on the training of health-care workers, which in turn directly affects the effective implementation of intervention projects. Staff turnover can lead to inconsistencies in knowledge and experience, which can lead to the loss of previous training and the need for continuous re-training, increasing time and costs. At the same time, healthcare workers often face intense work environments and tight schedules, which can lead to less engagement in training and an inability for staff to fully assimilate what they have learned. This can prevent them from effectively applying the training content in the real world, thus reducing the effectiveness and outcomes of the intervention program. Managing and mitigating these people management and stress issues is therefore critical to ensure the continued effectiveness of the training and, ultimately, the success of the intervention program.

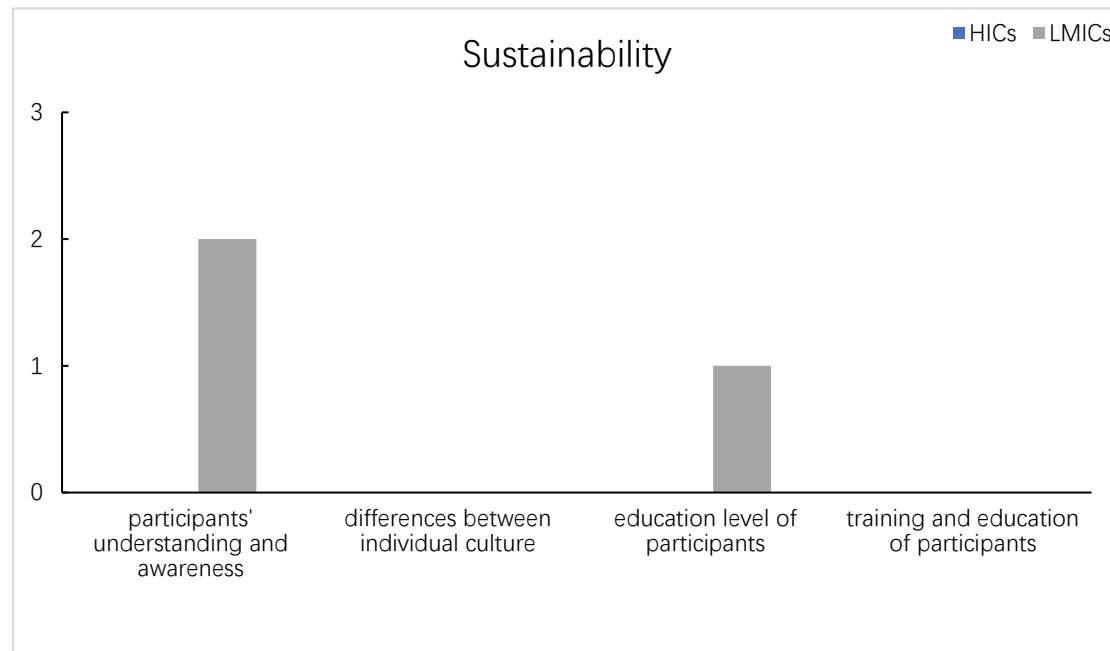
“Turnover of key members in communities that were champions of an intervention is always an issue and can have a major negative impact (University or other Academic Institution----USA----HICs)”

Theme 6 Recipient factors

The sustainability section is similar to the adaptability section. Only experts from

LMICs described influencing factors. Specifically, two experts from LMICs focused on participant understanding and awareness and one mentioned the education level of participants. (see Figure 26)

Figure 26: The importance of influencing factors within Theme 6 to the scalability component



Unlike the adaptability and scalability phases, experts believe that it is during the sustainability phase of the intervention that education levels of the local participating population becomes particularly important. This is because long-term implementation of the intervention requires that participants not only maintain their understanding of the intervention, but also continue to deepen it. By providing education and information on a regular basis, participants can be continually motivated to deepen their understanding of the goals and benefits of the intervention. This process of education and communication of information helps to ensure the long-term commitment of participants and increases their self-confidence, which in turn makes the intervention better able to be sustained. This ongoing education and communication not only helps to maintain participant motivation, but also helps to address potential problems and concerns, contributing to the sustainability and

success of the program. Ongoing education is therefore critical to ensuring the long-term effectiveness and impact of intervention programs and needs to be considered an integral component.

“The general educational level of the community members is a significant facilitator while if the illiteracy level is high, myths and misconceptions easily affect the project (University or other Academic Institution----Nigeria----LMICs)”

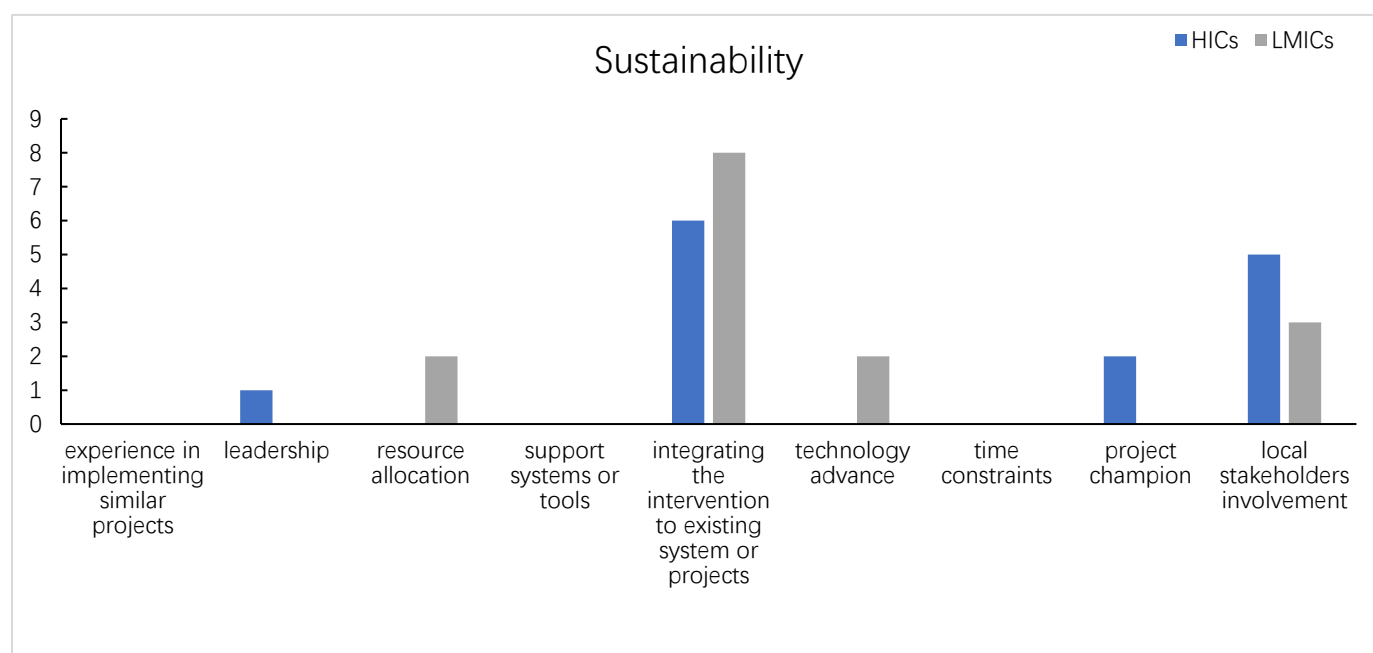
Therefore, those implementing interventions need to fully consider the cultural and educational level of the participants, as well as how to enhance their abilities and qualities, if they are to ensure the success and sustainability of the interventions.

Theme 7 Project Management processes

In the sustainability section, a total of six factors were mentioned, with the most emphasized factors being integrating the intervention to existing system or projects and local stakeholders involvement. Six experts from HICs group and eight experts from LMICs group mentioned the factor of integrating the intervention to existing system or projects. The factor of integrating the intervention to existing system or projects was mentioned by six experts from HICs and eight experts from LMICs; the factor of local stakeholders involvement was mentioned by five experts from HICs and three experts from LMICs. (see Figure 27)

In terms of the other factors, the experts from HICs group and LMICs group focused on diverse factors, with one expert from HICs mentioning leadership and two experts from HICs mentioning project champion. For the LMICs group, the factor of technology advance was highlighted by two experts, and the factor resource allocation was also mentioned by two experts.

Figure 27: The importance of influencing factors within Theme 7 to the sustainability component



Among the factors of sustainability, the one most emphasised by experts is the factor of integration of interventions into the existing healthcare system. The reason for this is similar to the reasons mentioned in the scalability phase, which also primarily involves the various resources and manpower required for the intervention. Experts indicated that if the intervention is seen as a parallel project rather than being embedded in the existing system, it is difficult to ensure stable financial support and staffing over time, which will negatively affect the sustainability of the intervention. In other words, if a project is not coordinated with existing systems, it may not be sustainable and may disappear soon after the project has been implemented.

“Incorporating it into one of the existing programs and making sure is contemplated in the yearly budget (Research/ non-profit or governmental agency ----Mexico----LMICs)”

“To make the interventions integrated with the existing health systems so that they could be self-sustained (University or other Academic Institution----China----

LMICs)”

Moreover, experts proposed that the ease of embedding complex health interventions into everyday systems also largely determines the sustainability of the intervention, as the process can be challenging and depends on such factors as the local cultural, political, economic and social context, as well as the nature and complexity of the intervention itself.

“In addition, integrating the project into existing similar projects or projects with similar target audience helps with its sustainability.” (University or other Academic Institution----Nigeria----LMICs)

“The ease of integration of the intervention within the existing system can facilitate the sustainability”(Hospital-----UK-----HICs)

The previously mentioned factors of local stakeholders involvement, leadership, etc. also play a similar role in the stage of sustainability as they did in the stages of adaptability and scalability, all centered around the desire to create a situation where all stakeholders benefit. The importance of these factors remains in this phase as they can help ensure the continued success of the intervention in the long term.

“The key factors include ongoing communication about the project, engaging leaders of organizations in the project advisory group and showing real tangible outcomes that are aligned with the strategic direction for the organization.” (University or other Academic Institution----Australia----HICs)

In contrast to the adaptability and scalability phases, in the sustainability phase, experts suggested that the need for researchers to consider issues related to monitoring and supervision may link to the integration into this existing system-

existing supervision and monitoring processes.

In terms of the technology used, similar to the role that complex health interventions discussed in the scalability phase, the use of technology can alleviate to some extent the shortage of human resources in low- and middle-income country (LMICs).

“Using technology (as opposed to human intervention) to sustain the intervention is the approach we often use (text messaging for instance)” (Research/ non-profit or governmental agency----South Africa----LMICs)

Theme 8 Monitoring and supervision

For Theme 8, neither the experts from LMICs nor the experts from HICs mentioned influencing factors for adaptability and scalability. For sustainability, factors mentioned by experts from LMICs and HICs were more diverse and less frequent. Experts from HICs group emphasized the role of existing community structures and personnel; local supervisor support; ongoing evaluation and reporting; the remote support from intervention developers; routine system; training and education of staff; and using frameworks. Experts from LMICs mentioned feedback mechanisms; actionable timelines; and empowering the state and non-state actors. (see Figure 28)

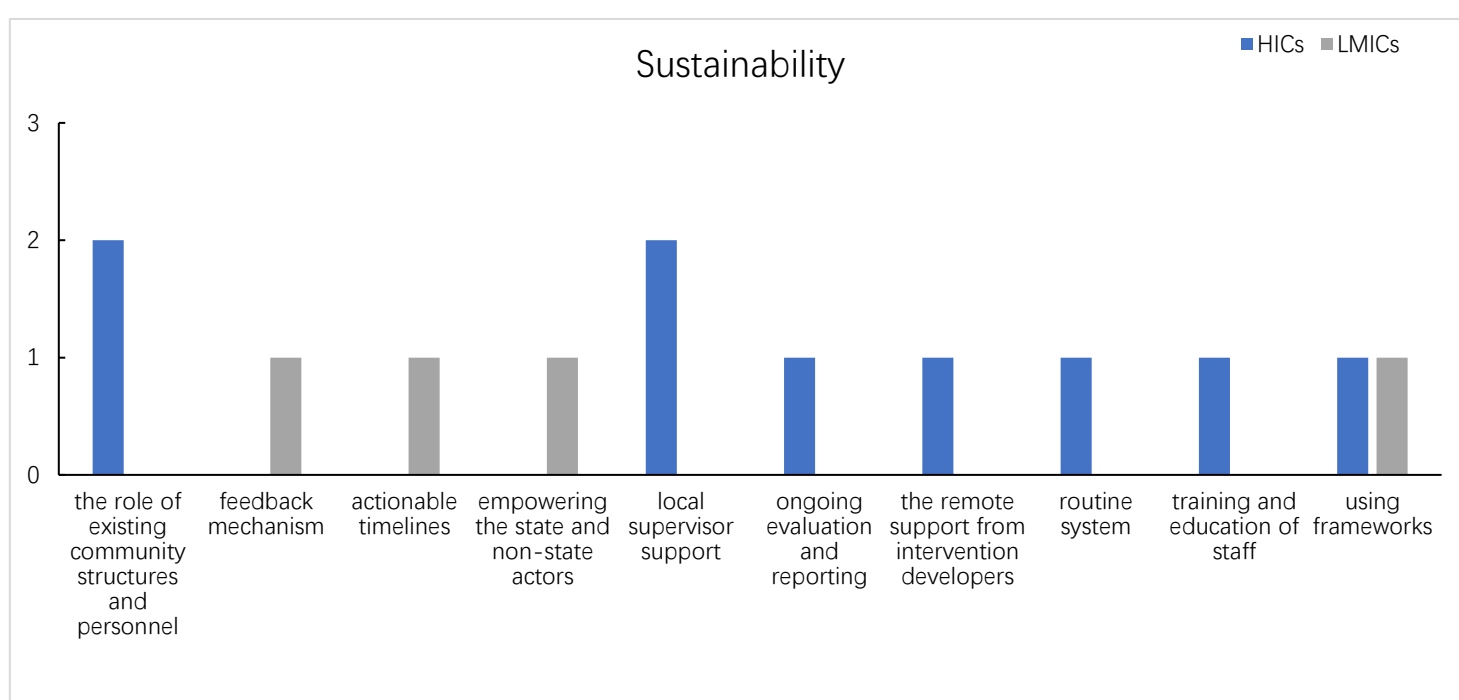
The only factor mentioned by both HICs and LMICs was use of frameworks. Considering the theme of Theme 8 is supervision and monitoring, this was indeed used less for adaptation and extension, and was only mentioned more often by experts in the later continuity phase.

Overall, it is always difficult to monitor and maintain over time since it may involve a variety of factors such as funding investment, personnel investment, and so on.

“I find long-term monitoring can be very difficult. The reason is because the

research team will no longer be actively involved. Without this presence in the community to monitor is almost synonymous with meddling. More work needs to be done on determining how this can be done effectively” (University or other Academic Institution-----Canada---HICs)

Figure 28: The importance of influencing factors within Theme 8 to the sustainability component



First, the factors most frequently mentioned by experts were the role of existing community institutions and personnel and the support of local supervisors.

Experts have proposed a promising approach to continuous supervision interventions by fully utilizing the resources available in the community. This approach not only reduces to some extent the human and material costs required, but also increases the feasibility of sustained regulatory interventions. Communities usually have their own human resources, facilities and organizations, and these resources can be rationally integrated into regulatory interventions for supporting health, education or social programs. Through effective collaboration and community involvement, these

resources can be leveraged to not only provide ongoing regulation, but also to enhance the community roots of the program. This approach not only saves money, but also helps to build sustainability, as communities are more likely to continue to support and participate in these programs.

“Using community existing structures and personnel to collect data, supervise and report. It can be a community health center, you use their staff and maybe need to support them with someone else trained from the community that they community respects. Leverage on ways the community use in monitoring previous interventions or similar projects and build on them.” (Research/ non-profit or governmental agency-----UK-----HICs)

In addition to utilizing the resources that communities themselves have, experts suggested that the sustainability of interventions could be enhanced by Empowering the Officially recognized entities that have governing authority over a specific territory and population (state actors) and non-governmental entities that operate independently of any state or government. (non-state actors) to monitor and supervise.

“We set up a technical working group on PMTCT comprising government officials, community gatekeepers, and technical partners who meet every month to analyse and review data and progress towards achieving targets. Empowering the state and non-state actors to monitor and supervise the project helped to sustain the PMTCT interventions.” (University or other Academic Institution-----Nigeria---LMICs)

Similarly, experts mentioned the role of local supervisors in monitoring, and similar to their role in the scalability phase of an intervention, local supervisors are better able to coordinate and facilitate the functioning of monitoring because they understand the local culture, social context and health system. They can effectively coordinate

intervention activities at all levels, ensuring that programs are implemented according to plan, that data collection is accurate, and that problems or challenges are responded to quickly. And building on this, experts also emphasized the need for remote support from developers may have a positive impact on the sustainability of regulatory complex health interventions. Such support could include remote technical support, data analysis, and problem solving to help ensure the stability and effectiveness of regulatory systems. Such remote assistance could fill in gaps in technology and expertise and facilitate the smooth operation of the regulatory process, thereby better supporting the implementation and success of health intervention programs.

“The Interagency Collaborative Team (ICT) model has the idea of building in a local "seed team" that does training, fidelity assessment through direct observation, and feedback and coaching for providers. The idea is to develop local expertise and decrease reliance on intervention developers for training and coaching. This has been quite successful in long-term sustainment in the US (Hurlburt et al., 2014). This long-term monitoring and supervision has been successful in Tanzania with lay community providers being supported by a local supervisor, with additional remote support/supervision from intervention developers (Dorsey et al., 2020).”(University or other Academic Institution-----USA---HICs)

Similar to the adaptability and scalability phases of interventions, the training of staff has been emphasized by experts, and staff with good knowledge and experience can contribute to the monitoring of interventions.

In addition, experts noted that the establishment of feedback mechanisms on surveillance and the practice of regular assessment reports during the monitoring process are essential to complement the monitoring system. These mechanisms help to ensure the quality and timeliness of monitoring data and provide critical feedback

to improve regulatory activities and take timely corrective measures. Therefore, in this context, experts also noted that feedback and reported data on interventions in progress would be better if the routine system could provide some assistance to monitoring. This would not only help to improve the efficiency and accuracy of monitoring, but also provide support and assurance for the continuation of the intervention.

“During the monitoring process, it is particularly important to establish feedback mechanisms to collect the views of primary stakeholders so that complex interventions can be continuously adapted to the local context, and so that complex interventions can be made more sustainable.” (University or other Academic Institution-----China---LMICs)

During the detection of interventions, experts suggested the need to consider the use of frameworks in monitoring complex health interventions. For example, the effectiveness of interventions can be evaluated with the help of some frameworks. Such an approach would help to ensure scientific and comprehensive collection of data, interpretation and evaluation of data, as well as a comprehensive understanding of the impact and effectiveness of the intervention during the monitoring process. This also allows for targeted information on the effectiveness of interventions, providing a stronger basis for decision-making and improvement.

“We generally study sustainability as part of research grants and assess using the RE_AIM framework after a period of self-running of the intervention.” (University or other Academic Institution-----Nigeria---LMICs)

Also, experts express that having a clear timetable helps to ensure that all interventions are carried out as planned. This helps avoid wastage of time and resources and ensures that each step is completed in a timely manner. Additionally, a

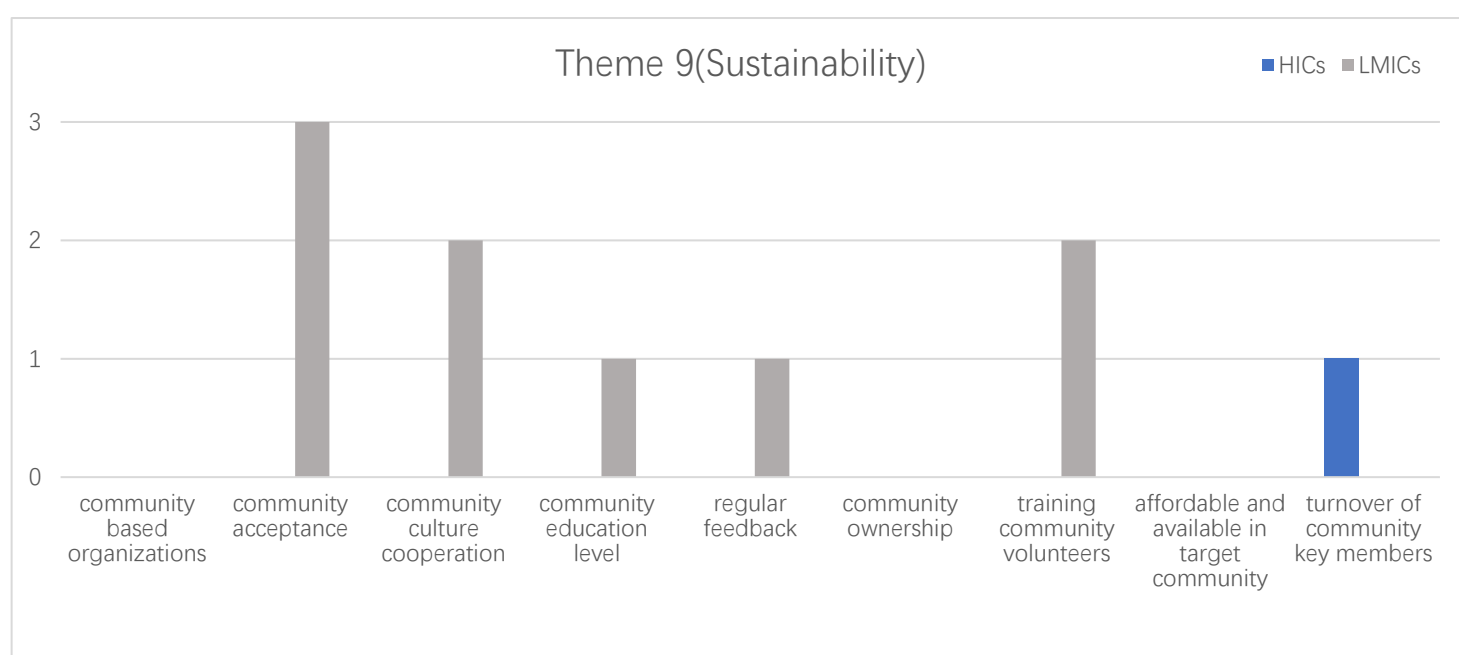
clear timeline provides transparency to project participants and stakeholders about the timeline of each stage, which enhances confidence in collaboration and communication. In addition, a timeline can help project managers monitor progress and identify and resolve potential problems in a timely manner.

“developing actionable time lines and targets help.” (University or other Academic Institution-----Nigeria---LMICs)

Theme 9 Embedding in communities

Similar to the previous two sections, in the sustainable section, one expert from the HICs raised the factor of turnover of community key members. For the LMICs experts, three raised the factor of community acceptance, two raised the factor of cultural cooperation, one raised the factor of community education level and the factor of regular feedback. (see Figure 29)

Figure 29: The importance of influencing factors within Theme 9 to the sustainability component



During the continuity phase of complex health interventions, the first thing that is

tested is the community's acceptance of the intervention. As mentioned earlier, some interventions can be enforced for a period of time, such as during the COVID-19 outbreak when communities required local residents to wear masks. However, these interventions are usually not sustainable in the long term due to a variety of factors such as culture, local economic conditions, and so on.

“Specific community factors depend on the intervention; if there are community entities that play key roles, then they need to be part of the "inner circle" - the team - as early as possible. they need to be part of planning, tailoring, adapting, designing, implementation, etc.” (Research/ non-profit or governmental agency-
---USA----HICs)

Similar to the expansion phase of complex health interventions, ensuring that complex health interventions are culturally compatible with the local community is also beneficial for sustaining the implementation of the intervention. Cultural compatibility helps maintain community engagement and support, reduces friction during the intervention process, and further enables the intervention to be sustained and scaled up effectively in different communities.

In addition, experts pointed out that in order to ensure the sustainability of the intervention, training of community volunteers as well as upgrading the level of education in the community are very useful initiatives. By training volunteers, communities can generate internal resources to support the implementation of interventions. And raising the level of education in the community helps to enhance the cognitive ability and participation of community residents, so that they are able to understand the value and goals of the intervention, and thus actively participate in and support the intervention program, contributing to its sustainability and success. These efforts help build strong community support systems and promote the long-term effectiveness of health interventions.

“The general educational level of the community members is a significant facilitator while if the illiteracy level is high, myths and misconceptions easily affect the project.” (University or other Academic Institution----Nigeria---LMICs)

Experts also noted the need to be careful to avoid the problems that can arise from frequent turnover of key personnel in the community, which can pose a threat to the continuity of complex health interventions. Maintaining the stability of key personnel helps to ensure the continuity and stability of the project, as turnover may result in a team of staff without adequate expertise and may further lead to disruption of the project.

“Turnover of key members in communities that were champions of an intervention is always an issue and can have a major negative impact.” (University or other Academic Institution----USA---HICs)

Experts support that a community's own feedback system can be very helpful in the long-term implementation of complex health interventions. This is because community feedback systems can provide real-time information about intervention effectiveness, community needs and changes. By collecting and analyzing community feedback on a regular basis, those implementing interventions can better understand the community's responses and expectations, and adjust interventions in a timely manner to adapt to changing circumstances. In addition, community feedback can increase the community's sense of participation and belonging, allowing them to feel that their voices are being heard, which can help maintain community motivation and support and promote the long-term success of the intervention.

“Important too is opportunities for communities to provide feedback and suggestions to further refine the program to suit the needs of the community.”

(University or other Academic Institution----Papua New Guinea---LMICs)

5.3 The comparison of the influencing factors of the three concepts of ASaS

Theme 1 Context

In Theme 1, the emphasis of experts on the factors of Sociopolitical Context and Availability of Resources is predominantly placed on adaptability. Specifically, regarding the Sociopolitical Context, adaptability was mentioned 12 times, scalability three times, while sustainability was not mentioned at all. For the factor of Availability of Resources, the mentions across the three aspects of adaptability, scalability, and sustainability were 20, 9, and 6, respectively.

Furthermore, the factors of Beneficiaries' Accessibility to Interventions and Acceptability of Interventions to Beneficiaries were addressed across all three aspects (adaptability, scalability, sustainability), with minimal variation in emphasis. Specifically, Beneficiaries' Accessibility to Interventions was mentioned 2, 1, and 1 times in adaptability, scalability, and sustainability, respectively. Similarly, Acceptability of Interventions to Beneficiaries was mentioned 4, 3, and 3 times across the same three aspects.

Theme 2 Setting

The factor of health system was addressed across all three aspects with particular emphasis on adaptability. The numbers of mentions by experts for adaptability, scalability, and sustainability were 11, 8, and 9, respectively. Similarly, this factor of local Legislation was considered across all three dimensions, with a notable focus on adaptability, as indicated by the mentions which numbered 3, 1, and 2 for adaptability, scalability, and sustainability, respectively.

Also, Local culture was also discussed across all aspects, receiving significant attention

in both adaptability and scalability. The mentions in these aspects were 25, 20, and 3, respectively. Local Social Norms or Regulations was noted by an expert across all three dimensions.

Theme 3 Organizational attributes

The factors of inter-organizational networks and organizational culture were only addressed in the contexts of adaptability and scalability, with no mention of their impact on sustainability. The organizational structure was specifically discussed in terms of scalability, where it was noted by four experts. In terms of the factor of local gatekeepers, this factor was discussed across all three dimensions—adaptability, scalability, and sustainability—with a particular emphasis on adaptability. The frequency of mentions by experts for each dimension was 32, 5, and 8, respectively. The factor of government support was mentioned by two experts in the contexts of adaptability and sustainability, but it was not discussed in relation to scalability.

Theme 4 Human resources

Overall, experts from Low- and Middle-Income Countries (LMICs) prioritize scalability, while experts from High-Income Countries (HICs) focus on sustainability. Within Theme 4, the following factors were analyzed: First, the factor of Training and Education of Staff was the most frequently mentioned by experts and was discussed across all three dimensions—adaptability, scalability, and sustainability—with mentions numbering 5, 9, and 7, respectively. The factor of staff turnover was not mentioned in the context of adaptability, but was noted by two experts regarding scalability and by one expert regarding sustainability. In terms of the factor of capacity of Staff, predominantly discussed during the adaptation phase by seven experts, this factor was also mentioned once in the context of scalability but not in sustainability.

Theme 5 Provider factors

Firstly, Theme 5 was addressed solely in the contexts of adaptability and scalability, without any mention in sustainability. Additionally, among the factors included within this theme, the perception of local stakeholders on the need for change was discussed. However, the factor concerning whether implementers and local stakeholders share a common language was only mentioned in the context of adaptability.

Theme 6 Recipient factors

The factor of Participants' Understanding and Awareness was mentioned across all three dimensions—adaptability, scalability, and sustainability—with mentions by experts numbering 3, 4, and 2, respectively. This factor of Differences Between Individual Cultures was only discussed in the context of scalability and was highlighted by two experts. As for the factor of Education Level of Participants, it was noted by one expert each in the contexts of adaptability and sustainability, but was not mentioned in scalability. Additionally, the factor of Training and Education of Participants was addressed by two experts, exclusively in the context of scalability.

Theme 7 Project Management processes

In Theme 7, factors such as experience in implementing similar projects, leadership, resource allocation, support systems or tools, integrating the intervention into existing systems or projects, technological advances, time constraints, project champions, and local stakeholders' involvement are examined. Leadership, technological advances, project champions, and local stakeholders' involvement are mentioned across all three dimensions—adaptability, scalability, and sustainability—with particular emphasis on local stakeholders' involvement, noted by experts with mentions of 13, 13, and 8 respectively. The integration of interventions into existing systems or projects is highly emphasized in sustainability, with 14 experts highlighting its importance, and modestly

mentioned in scalability by three experts, but not in adaptability. Support systems or tools, along with time constraints, are discussed in adaptability and scalability but omitted in sustainability. Resource allocation is considered in adaptability and sustainability, but overlooked in scalability. Lastly, the experience in implementing similar projects is referenced by one expert in scalability.

Theme 8 Monitoring and supervision

Theme 8, along with its associated factors, is discussed solely in the context of sustainability. The analysis of these factors underscores the necessity of considering multiple dimensions when striving to achieve sustainable projects. Although the emphasis on these factors may vary between High-Income Countries (HICs) and Low- and Middle-Income Countries (LMICs), there is a consensus that establishing robust community structures, effective management and feedback mechanisms, clear timeline planning, and ongoing personnel training and support are crucial.

Theme 9 Embedding in communities

Factors related to the community are primarily discussed within the context of sustainability. In adaptability, only affordability and availability in the target community are mentioned. Scalability addresses three factors: community-based organizations, community culture cooperation, and community ownership, with the first and last being exclusively mentioned under scalability. Community culture cooperation is noted under both scalability and sustainability.

In the sustainability dimension, six factors are identified, predominantly suggested by experts from Low- and Middle-Income Countries (LMICs). Experts from High-Income Countries (HICs) emphasize the role of the community but often do not specify factors beyond the turnover of key community members.

5.4 Summary

This chapter presented the first round of the Delphi survey, which engaged global experts to identify factors influencing the ASaS of complex health interventions in LMICs. The survey resulted in the identification of nine themes and 50 factors spanning various dimensions such as context, setting, organizational attributes, human resources, provider factors, recipient factors, project management, monitoring and supervision, and community embedding. Key insights revealed differences in the emphasis placed by experts from HICs and LMICs. For instance, while HIC experts focused more on resource availability, LMIC experts highlighted community-based organizations and local stakeholder involvement. The importance of training, education, and the role of local gatekeepers were consistently emphasized across all dimensions. These findings provide a foundation for the next round of the Delphi survey, where these themes and factors will be further refined and prioritized to enhance our understanding of the critical elements influencing the success of health interventions in LMICs.

Chapter 6 Results from the Second Round of Delphi survey

Building upon the insights from the first Delphi survey, Chapter 6 delves into the second round's results, where the initial findings are further refined and expanded. This chapter underscores the iterative nature of the Delphi process, vital for achieving a deeper consensus among experts on the factors critical to the ASaS of health interventions in LMICs.

In contrast to Chapter 5, the structure of this chapter differs because the first round of the Delphi survey focused on collecting factors related to each concept of ASaS (Adaptability, Scalability, and Sustainability). Subsequent Delphi rounds involved experts rating the importance of these factors across all three aspects of ASaS, rather than analyzing each aspect separately.

Introduction

The preceding chapter elucidated the procedure for conducting the first round of Delphi survey and this chapter describe the findings of second round of Delphi survey. As a result, this round identified nine themes and 50 influencing factors.

After integrating the data collected from the two reviews with the data obtained from the first round of the Delphi survey, a revised version of the nine themes with 54 factors was developed for use in the second round of expert scoring in the Delphi questionnaire.

Specifically, regarding the sources of factors within each theme, factors from the reviews in the outer context were categorized as follows: "Sociopolitical context" was placed under Theme 1 (Context), "Interorganizational networks" under Theme 3 (Organizational attributes), and "Client advocacy" under Theme 9 (Embedding in communities). "Funding," having high consensus across numerous studies, was excluded from further discussion, as previously mentioned, and "Leadership" was categorized under Theme 7 (Project Management processes).

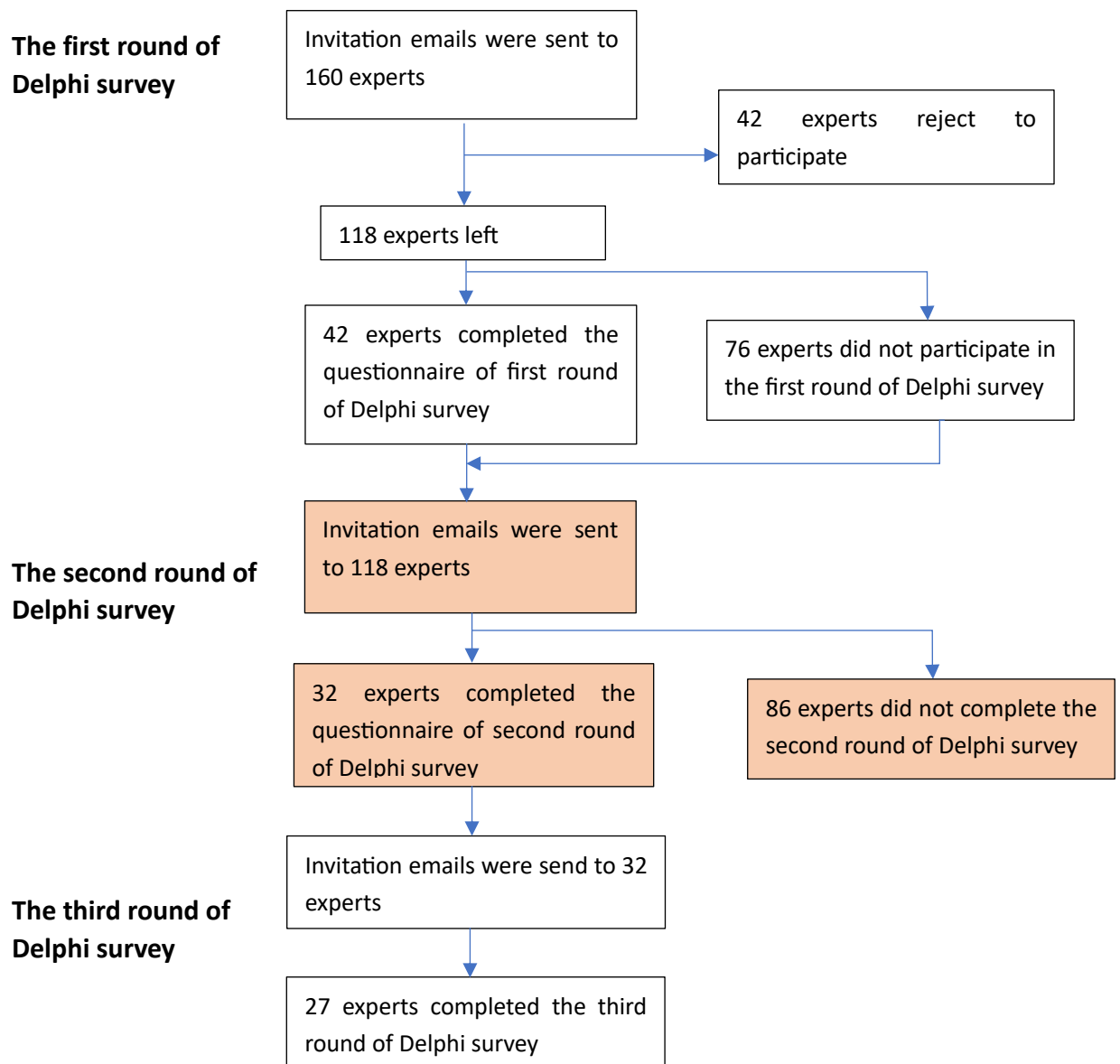
For factors in the inner context, "Organizational characteristics" was categorized under Theme 3 (Organizational attributes), and "Individual adopter or provider characteristics" was split into two parts: one part under Theme 5 (Provider factors) and the other under Theme 6 (Recipient factors). "Leadership" was again categorized under Theme 7 (Project Management processes), "Staffing" under Theme 4 (Human resources), and "Supervision, monitoring and evaluation" under Theme 8 (Monitoring and supervision).

For factors in intervention characteristics, "Communication" was categorized under Theme 5 (Provider factors) as "5b implementer and local stakeholders sharing a common language." "Quality and fidelity monitoring/support" was categorized under

Theme 8 (Monitoring and supervision), "Geographical" under Theme 2 (Setting), and "Project champion" under Theme 7 (Project Management processes). The factor "Resources" was divided: "Health services" was categorized under Theme 2 (Setting) and merged with "health system," "Human resource" under Theme 4 (Human resources), and "Infrastructure" under Theme 1 (Context). "Stakeholders involvement" was categorized under Theme 7 (Project Management processes), while "Support system or tool" and "Technology advance or environment" were kept in their respective categories. "Time" was categorized under Theme 7 (Project Management processes), and "Governance/management, supply and distribution/delivery, long-term planning and personnel management" were all integrated into Theme 7 (Project Management processes).

For bridging factors, "Community function" was categorized under Theme 9 (Embedding in communities), and "Purveyors/intermediaries" were categorized under Theme 3 (Organizational attributes) as "local gatekeeper" and under Theme 7 (Project Management processes) as "local stakeholders involvement."

This chapter presents the results of the second round of the Delphi survey and aims to evaluate the importance of the influencing factors obtained from the previous systematic review and the first round of the Delphi survey. The overall Delphi survey process is shown in the Figure 30 below.

Figure 30: The Delphi study process**Expert Panel**

In the second round of the Delphi survey, 32 experts from 15 countries (Australia, China, Ghana, India, Ireland, Kazakhstan, Kenya, Malaysia, Mexico, Nigeria, Norway, South Africa, Tunisia, UK, and USA) participated. The panel included 14 experts from

high-income countries (HICs) and 18 from low- and middle-income countries (LMICs). As for the current position, there were 25 researchers, 1 healthcare provider, 1 policymaker, and 3 others. The gender distribution was 18 males and 14 females. Regarding employment status, 23 experts were academics working in universities or other academic institutions, 2 worked in hospitals, 6 were employed in research/non-profit or governmental agencies, and 1 was from other settings. (see Table 10)

Table 10 The Basic information of the experts of the second round of Delphi survey

Category	Count	Percentage
Gender		
Female	14	43.75%
Male	18	56.25%
Area		
LMICs	20	62.50%
HICs	12	37.50%
Country		
Argentina	0	0.00%
Australia	1	3.13%
Canada	0	0.00%
Chile	0	0.00%
China	5	15.63%
Ghana	1	3.13%
India	2	6.25%
Ireland	3	9.38%
Kazakhstan	1	3.13%
Kenya	1	3.13%
Malaysia	1	3.13%
Mexico	1	3.13%

Nigeria	4	12.50%
Norway	1	3.13%
Papua New Guinea	0	0.00%
Poland	0	0.00%
Qatar	0	0.00%
South Africa	2	6.25%
Tunisia	2	6.25%
UK	4	12.50%
USA	3	9.38%
Current primary position		
researchers	25	78.13%
healthcare providers	2	6.25%
policymaker	1	3.13%
commissioner of health services	1	3.13%
others	3	9.38%
Place of work		
universities (or other academic institutions)	23	71.88%
hospitals	2	6.25%
research/ non-profit or governmental agencies	6	18.75%
other settings	1	3.13%

6.1 Questionnaire Dissemination and Data Collection

In Delphi research, some studies may suggest that working with the same group of

individuals is advantageous for the reliability and validity of the study, [304], while others support that Delphi research is in greater need of increased richness and attractiveness[284].

Inviting group members who missed the previous round of the Delphi questionnaire to participate in subsequent rounds a Delphi survey allows for better representation of the views of the group initially invited to participate in previous rounds [284]. Boel et al argues that this also reduces the likelihood of reaching the wrong consensus, without affecting the final outcome of the Delphi session.

As a result, in the second round of Delphi survey, the invitation emails were sent to the 118 experts including 42 experts who have completed the questionnaire of first round of Delphi survey and 76 experts who did not participate in the first round of Delphi survey. Of these experts, 32 experts completed the second round of the survey, and 86 experts dropped out in this round. Of the 32 experts, 22 experts completed the first round of the survey, and 10 experts did not.

Reminder emails were sent to experts who did not complete the survey by the deadline. The experts were required to submit their questionnaires within a four-week timeframe, and they were notified that an initial 'reminder email' would be dispatched to those who hadn't responded after two weeks.

6.2 Analysis of the Second Round of Delphi survey

In accordance with the methods mentioned in the Chapter 4, the aggregated ratings of the nine themes obtained in the first round and the corresponding 54 factors were analysed individually. The priori consensus rule employed in this study supported that influencing factors with consensus rate scores of 70% or more would be retained and not sent to the next round for re-rating. actors with a consensus rate between 50% and 70% would be sent to the next round for re-rating[305]. Influencing factors with less than 50% consensus would be grouped together for further discussion in a third

round of the Delphi questionnaire and would be discarded if consensus still cannot be reached.

For scoring themes across ASaS dimensions (adaptability, scalability, and sustainability): (1) A consensus rate of 50% or below in any dimension indicates a lack of consensus on some factors; (2) A consensus rate between 50% and 70% in any dimension also indicates a lack of consensus; (3) A consensus rate of 70% or higher across all dimensions suggests most factors have reached consensus. Experts can still suggest improvements in the third round and the consensus meeting.

6.3 Results

The overall response rate[306] for this round of the survey was 27% (32/118). Specifically, 52.4%(22/42) were respondents of the first round, and 13.2%(10/76) were new invitees. Respondents included 14 from HICs and 18 from LMICs. Of the 54 influencing factors, 39 influencing factors reached consensus; 15 influencing factors did not reach the a priori consensus, and the 15 influencing factors to be sent through to the next round.

The degree of concentration of experts' comments

The exploration of the Likert scale responses across 54 influencing factors yields valuable insights into the nuanced perceptions of experts. The observed range of mean values from 6.16129 to 8.07407 signifies varying degrees of importance attributed to these factors within the context of the study. This dispersion indicates that experts hold divergent viewpoints regarding the relative significance of these factors.

Delving deeper, the mode range of 6 to 9 implies a mix of consensus and divergence among experts, indicating that certain factors enjoy widespread agreement, while others exhibit disparities in opinions. The standard deviation range spanning from 0.776819 to 2.17667 further underscores the diversity in expert ratings. Higher

standard deviations may reflect contentious or polarized perspectives on specific factors.

The coefficient of variation (CV), ranging from 10.36% to 28.31%, adds an additional layer of interpretation. A lower CV suggests less variability around the mean and points to a higher level of agreement among experts. Conversely, a higher CV indicates greater dispersion and potential differences in expert opinions.

Furthermore, the dominance of mean or mode values above 7 signifies that a significant portion of these influencing factors is collectively regarded as important. The narrow range of standard deviations, predominantly within 1-1.5, underlines a consistent level of agreement, implying a shared understanding of the factors' relevance. In sum, this detailed analysis underscores the complex interplay of perceptions among experts. The combination of mean values, modes, standard deviations, and coefficients of variation illuminates the dynamics of consensus and divergence within the expert group. The mean, mode, standard deviation (SD), and coefficient of variation for each influencing factor and theme across the three aspects of adaptability, scalability, and sustainability (ASaS) are presented in Table 11 below.

Table 11: The result of the second round of Delphi survey

Theme	Question	Mean	Mode	Standard deviation (SD)	Coefficient of variation
Theme 1 (Context)	1a sociopolitical context	7.40	7	1.18	16.03%
	1b participant's accessibility to interventions	7.97	8	0.96	12.13%
	1c participant's acceptability to interventions	7.69	9	2.17	28.31%
	1d available of resources	7.69	8	1.12	14.57%
	Adaptability	7.66	9	1.47	19.23%
	Scalability	7.94	9	1.13	14.29%
	Sustainability	8.16	8	1.02	12.50%
Theme 2 (Setting)	2a health system	7.61	8	1.12	14.66%
	2b local legislation	7.27	8	1.39	19.10%
	2c geographical location of implementing interventions	6.74	6	1.52	22.65%

	2d local culture	7.42	8	1.32	17.24%
	2e local social norms or regulations	7.55	7	1.15	15.24%
	Adaptability	7.97	8	0.96	12.92%
	Scalability	8.06	8	0.81	10.09%
	Sustainability	7.90	8,9	1.10	14.00%
	3a interorganizational networks	7.13	7	1.30	18.53%
	3b organizational culture	7.29	8	1.27	17.42%
	3c organizational readiness	7.58	7	1.06	13.95%
	3d organizational structure	7.03	8	1.58	22.48%
	3e local gatekeepers	7.26	7,9	1.64	22.51%
	3f government support	8.35	8	1.11	14.42%
Theme 3	Adaptability	7.23	7,8	1.43	19.78%
(Organizational	Scalability	7.30	7	1.53	21.02%
attributes)	Sustainability	7.90	9	1.35	17.06%
	4a training and education of staff	7.97	8	1.11	13.93%
	4b staff turnover	7.45	7	1.72	23.80%

Theme 4 (Human resources)	4c capacity of staff	7.84	9	1.16	14.77%
	Adaptability	7.57	7	1.10	14.59%
	Scalability	7.80	8	1.03	13.21%
	Sustainability	7.83	9	1.21	15.39%
Theme 5 (Provider factors)	5a credibility and reputation of the provider or implementer	7.35	8	1.14	15.52%
	5b implementer and local stakeholders sharing a common language	7.71	8	1.07	13.89%
	5c local stakeholders perception of the need for change	7.84	9	1.34	17.15%
	Adaptability	7.23	7	1.45	20.11%
	Scalability	7.63	8	1.19	15.57%
	Sustainability	7.80	9	1.29	16.63%
Theme 6 (Recipient factors)	6a participants' understanding and awareness	7.71	8	1.04	13.48%
	6b differences between individual culture	7.16	8	1.66	23.11%
	6c education level of participants	6.16	6	1.66	26.86%

	6d training and education of participants	7.03	8	1.25	17.79%
	Adaptability	7.00	8	1.59	22.74%
	Scalability	7.12	8	1.61	22.54%
	Sustainability	6.97	7,9	1.99	28.82%
	7a experience in implementing similar projects	6.80	7	1.42	20.94%
	7b leadership	7.97	9	1.03	12.97%
	7c resource allocation	7.63	7	0.99	13.09%
	7d support systems or tools	7.50	8	0.78	10.36%
	7e integrating the intervention to existing system or projects	7.50	8	1.57	20.94%
	7f technology advance	6.23	7	1.43	22.95%
	7g time constraints	7.03	7	1.19	16.90%
	7h project champion	7.30	8	1.21	16.54%
Theme 7	7i local stakeholders involvement	7.97	8	0.89	11.17%
(Project	Adaptability	7.34	8	1.39	19.00%
Management	Scalability	7.59	8	1.32	17.44%
processes)	Sustainability	8.03	9	1.21	15.05%

	8a the role of existing community structures and personnel	6.80	6,8	1.75	25.73%
	8b feedback mechanism	7.70	9	1.42	18.41%
	8c actionable timelines	7.38	8	1.21	16.36%
	8d empowering the state and non-state actors	7.07	5,8	1.51	21.33%
	8e local supervisor support	7.47	8	1.59	21.32%
	8f ongoing evaluation and reporting	7.87	9	1.46	18.51%
	8g the remote support from intervention developers	6.70	6,7,8	1.70	25.45%
	8h routine system	6.67	7	1.62	24.39%
	8i training and education of staff	7.40	9	1.71	23.16%
Theme 8	8j using frameworks	6.76	8	1.77	26.13%
(Monitoring	Adaptability	7.24	9	1.62	22.35%
and	Scalability	7.51	8,9	1.29	17.28%
supervision)	Sustainability	7.89	9	1.42	18.02%
	9a client advocacy	7.40	8	1.31	17.67%

Theme 9 (Embedding in communities)	9b community based organizations	7.56	8	1.19	15.72%
	9c community acceptance	8.07	9	1.04	12.82%
	9d community culture cooperation	7.78	9	1.12	14.41%
	9e community education level	6.29	7	1.69	26.73%
	9f regular feedback	7.85	8	0.99	12.59%
	9g community ownership	7.81	9	1.13	14.50%
	9h training community volunteers	7.48	9	1.67	22.36%
	9i affordable and available in target community	7.67	9	1.24	16.18%
	9j turnover of community key members	7.33	8	1.14	15.59%
	Adaptability	7.89	8,9	1.01	12.84%
	Scalability	7.59	9	1.47	19.29%
	Sustainability	8.22	9	1.12	13.63%

Overall, therefore, there was a consensus among the experts on most issues (39/54).

Theme 1 (Context)

Within Theme 1, for these four influencing factors, the mean scores ranged from 7.4 to 8. The percentage of experts who gave a score of 7 or above was 100%, and the consensus rates for these four factors were, from highest to lowest, participant's acceptability to interventions (96.9%); participant's accessibility to interventions (90.6%); availability of resources (87.5%); and sociopolitical context (78.1%). This indicates consensus on all four influencing factors within theme 1 with no need to enter into a third round of further discussion.

Theme 2 (Setting)

For the five influencing factors within Theme 2, the means ranged from 6.74 to 7.61. The mean is 6.74 and the mode is 6, except for the factor 2c geographical location of implementing interventions (consensus rate of 54.8%). The rest of the influencing factors have reached consensus, from highest to lowest, local culture (90.3%); local social norms or regulations (80.6%); health system (80.6%); local legislation (76.7%).

Theme 3 (Organizational attributes)

Within theme 3, six influencing factors were shown in the table, with the mean ranging from 7.03 to 8.35 and the mode ranging from 7-9. For the consensus rate, two influencing factors, interorganizational networks and organizational structure, did not reach 70%, at 64.5% and 61.3% respectively. For the other four influencing factors, the consensus rates were, in descending order, organizational readiness (87.1%); government support (77.4%); local gatekeepers (74.2%); and organizational culture (71.0%). For Theme 3, 66.7% of the factors have reached consensus. For Concentration, both the mean and mode were greater than 7, indicating a high degree of concentration. Although some factors needed to proceed to the third round of the Delphi questionnaire because the consensus rate did not reach 70%, their consensus

rate still reached over 60%, indicating that a high level of consensus was still achieved.

Theme 4 (Human resources)

Within Theme 4, three factors were mentioned, with means ranging from 7.45 to 7.96 and the mode ranging from 7 to 9. For the consensus rate, all three factors reached consensus, with the highest to lowest consensus rates being training and education of staff (93.5%), capacity of staff (90.3%), and staff turnover (77.4%). This indicates that the concentration of experts' opinions in theme 4 is very high, with the mean and mode greater than 7 and the consensus rate exceeding 70% in all cases.

Theme 5 (Provider factors)

Within theme 5, three factors were mentioned, with the mean ranging from 7.35 to 7.84 and the mode ranging from 8 to 9. For the consensus rate, all three factors reached consensus, with the highest to lowest consensus rate being implementer and local stakeholders sharing a common language (87.1%); local stakeholder perceptions of the need for change (80.6%); credibility and reputation of the provider or implementer (77.4%).

Theme 6 (Recipient factors)

For theme 6, a total of four factors were proposed, with the mean ranging from 6.16 to 7.7 and the ranging from 6 to 8. Both the mean and the mode, in some cases, were below 7, and neither the mode nor the mean was greater than 8. This indicates that the concentration of expert opinion on some of the influencing factors was not that high. Specifically, the consensus rate for the factor education level of participants was as low as 41.9%, with a mean of 6.16, and the consensus rate for the factor education of participants was 67.7%, a relatively high level but still not 70%, which would enter the third Delphi round for further exploration.

Theme 7 (Project Management processes)

Within Theme 7, a total of nine factors were presented, with means ranging from 6.8 to 7.96 and mode ranging from 7-9. The degree of concentration was good, specifically in terms of consensus rate, the factor technology advance had a consensus rate of only 50%, but its significance had a mean of 6.23 and a mode of 7. Therefore, the experts' judgement of its degree of importance was not as low as the consensus rate showed, so this factor went forward to the third round of Delphi research for further discussion to see if consensus could be reached.

Other factors, from highest to lowest consensus, were leadership (93.3%); local stakeholders involvement (90.0%); resource allocation (90.0%); and support systems or tools (90.0%). integrating the intervention to existing system or projects (80.0%); project champion (70.0%); time constraints (66.7%); experience in implementing (66.7%); experience in implementing similar projects (66.7%). Except for the factors of time constraints; experience in implementing similar projects, the mean scores for all other factors were above 7.3, and for these two factors, the mean scores were 6.8 and 7.03 respectively, indicating that the experts assessed their importance at around 7, and therefore these two factors also entered the third round of the Delphi study for final validation.

Theme 8 (Monitoring and supervision)

Within theme 8, 10 factors were presented with means ranging from 6.67 to 7.86 and mode ranging from 5 to 9, indicating that the data were concentrated around 7 and that the data were more discrete and not particularly concentrated. Specifically, the role of existing community structures and personnel; the remote support from intervention developers; routine system; using framework all had mean values less than 7. Take the factor of empowering the state and non-state actors as an example, the mode of this factor is 5 and 8, meaning that experts rate the importance of this factor as a more diffuse amount.

In terms of the consensus rate, from highest to lowest consensus, ongoing evaluation and reporting (83.3%); feedback mechanism (76.7%); local supervisor support (76.7%); actionable timelines (75.9%); training and education of staff (73.3%); empowering the state and non-state actors (66.7%); routine system (63.3%); the role of existing community structures and personnel (60.0%); using frameworks (58.6%); and the remote support from intervention developers (56.7%). In the process of this round of Delphi survey, factors that achieved a consensus rate lower than 70% were carried forward into the third round for further discussion and analysis.

Theme 9 (Embedding in communities)

Within Theme 9, a total of 9 factors are mentioned, with means ranging from 6.29 to 8.07 and the mode ranging from 7 to 9. Among these factors, all of them have a mean greater than 7, except for the factor community education level, which has a mean of 6.29, indicating that the importance ratings of experts for all factors except this factor are concentrated above 7. In terms of consensus rate, as with the mean, the consensus rate for the factor community education level was particularly low, at 48.1%. The consensus rate for all other factors was above 74%. In descending order, community acceptance (92.6%); community cultural cooperation (88.9%); regular feedback (88.9%); community ownership (88.5%); training community volunteers (81.5%); client advocacy (77.8%); community based organizations (77.8%); turnover of community key members (77.8%). affordable and available in target community (74.1%).

The consensus rate of the nine themes

In terms of themes, all of the themes in this study, with the exception of Theme 6 (Sustainability), achieved a satisfactory level of consensus.

For Theme 6 (Sustainability), the mean was 6.96 and the mode was 7 and 9, which indicates that for this section, the experts' scores were less concentrated and more dispersed. The reason for this outcome might be that the consensus rate for the factor

"6c education level of participants" within theme 6 was below 50%. Additionally, Theme 6 only includes four factors, and if one of these factors has a low consensus rate, it may influence the experts' perception of the theme's importance. This could ultimately result in a slightly lower importance rating for theme 6 compared to the other themes.

For the other themes, the mean for adaptability ranges from 7 to 7.89. theme 9 (Embedding in communities) has a mean of 7.89, while theme 6 (Recipient factors) has a mean of 7. Only theme 6 has a mean of 7. The consensus for adaptability did not reach 70% at 58.1%, and given its high concentration, adaptability for theme 6 went into the third round alone for further exploration. This indicates that the concentration of these factors for adaptability is above 7 and the mode is also above 7, indicating that the experts generally consider all these themes to be important for adaptability. For the scalability component, the lowest value of Theme 6 (Recipient factors) was 7.12 and the highest value was 8.06. Like adaptability, the mode were above 7 and the concentrations were above 7. Similarly, for the section on sustainability, the mean has a minimum value of 6.97 and a maximum value of 8.22, with a minimum value of Theme 6 and a maximum value of Theme 9, and the mode range is also above 7. The highest value is Theme 9, and the mode is also above 7.

From the above it can be seen that Theme 6 has a slightly lower concentration and importance rating than the other Themes, while Theme 9 rated as highest importance among these Themes.

The degree of coordination of experts' comments

Consistency of participant opinions in a Delphi study is measured by the coefficient of concordance (Kendall's W). In the second round of the Delphi questionnaire, the Kendall's W coefficients for Adaptability, scalability, sustainability and influencing factors were 0.386, 0.403, 0.47 and 0.635 respectively. (See Table 12)

Table 12: The degree of coordination of experts' comments

	Importance		
	W	χ^2	P
The second round of Delphi survey			
Adaptability	0.386	83.349	<0.001
Scalability	0.403	86.962	<0.001
Sustainability	0.47	101.619	<0.001
Influencing factors	0.635	867.842	<0.001

Overall, the Kendall coefficients range from 0 to 1, with values closer to 1 indicating greater consistency in expert ratings. In the second round of the Delphi questionnaire, experts showed a high degree of consistency in scoring the importance of these factors in complex interventions, with a Kendall's coefficient of 0.635 and a p-value of <0.001, which indicates that these results are statistically significant. Overall, therefore, there was relative agreement among experts on the importance scoring of these factors in complex interventions, although some disagreement and divergent views on some factors remained.

However, the Kendall coefficient of 0.386 in assessing the importance of these factors for the adaptability component suggests that there is a large degree of inconsistency in the experts' ratings in this area, and that further discussion of these factors are needed in the next round of the Delphi survey. Similarly, the same was true for the ratings of the scalability section and the sustainability section, with Kendall's coefficients of 0.403 ($P<0.001$) and 0.47 ($P<0.001$), respectively, which suggests that there is still a degree of disagreement and divergence of opinion in these areas (See Table 12). It is therefore necessary to discuss and study some of these factors influencing the ASaS of CHI in greater depth in order to reach a broader consensus in the third round of Delphi survey and consensus meeting.

Based on the categorization in the previous Methods section, this study counted the

scores from the experts in the HICs group separately from the scores from the experts in the LMICs group.

Table 13: The degree of coordination of experts' comments of HICs group

	Importance		
The second round of Delphi survey	W	χ^2	P
Adaptability	0.127	9.126	0.332
Scalability	0.268	19.31	0.013
Sustainability	0.375	27.03	0.001
Influencing factors	0.247	177.88	<0.001

As a whole, for the experts in the HICs group, overall, the Kendall coefficient for the experts' scoring of the importance of the influencing factors was 0.247 ($p < 0.001$), which indicates a lack of consistency in the experts' scores, with differing insights and opinions on the importance of some of these factors. In addition, there was no apparent consistency in the experts' scoring of the importance of these factors in the SCALABILITY stage and the SUSTAINABILITY stage. Specifically, the Kendall's coefficient for the experts' scoring of the importance of these factors at the SCALABILITY stage was 0.268 ($p < 0.05$), while the Kendall's coefficient for the importance of these factors at the SUSTAINABILITY stage was 0.375 ($p < 0.05$). This also indicates a lack of consistency in the expert's scoring in both phases and the existence of different perceptions and opinions. (see Table 13)

However, in the adaptability stage, the experts' scores showed a relatively low Kendall's coefficient of 0.127 ($p > 0.05$). This suggests that there is a degree of inconsistency between expert perceptions of the importance of these factors in the adaptability stage, but based on the p-value, this inconsistency may also be a possibility of chance occurrence.

Table 14 The degree of coordination of experts' comments of LMICs group

	Importance		
The second round of Delphi survey	W	χ^2	P
Adaptability	0.147	25.88	0.03
Scalability	0.093	15.68	0.047
Sustainability	0.283	4751	<0.001
Influencing factors	0.232	333.87	<0.001

As a whole, for the experts in the LMICs group, there is a trend of inconsistency in their importance ratings of these factors. The Kendall's coefficient was 0.232 ($p < 0.001$), which indicates that there are different perceptions and opinions among experts on the importance of some factors. (see Table 14)

In a similar trend to this, the Kendall's coefficient for experts' scoring of the importance of these factors in the SUSTAINABILITY stage was 0.147 ($P < 0.05$), the Kendall's coefficient for scoring of the importance of these factors in the SCALABILITY stage was 0.283 ($P < 0.05$), and the Kendall's coefficient was 0.093 ($p < 0.05$). This suggests that there is still a large inconsistency in the experts' importance of certain factors at different stages, which may reflect differences in their professional backgrounds and experiences in these areas.

Overall, experts showed some degree of inconsistency within the LMICs group regarding the importance of these factors, with differing perceptions and opinions, especially in the SUSTAINABILITY and SCALABILITY stages. This inconsistency may need to be addressed in further research and discussions to better understand and address these complex interventions.

The modification of the influencing factors and themes

There were 54 influencing factors in total, of which 39 sub-themes met the a priori consensus and these items had already reached consensus from the Delphi survey at this stage and did not need to go to the third round of the Delphi questionnaire; in addition, 12 influencing factors would go to the third round of the Delphi questionnaire. Three influencing factors had a consensus rate of less than 50%, so these three factors were presented in the third round of the Delphi questionnaire for the experts to discuss them, and if consensus could still not be reached, they were discarded according to predetermined rules.

In Theme 6 (Recipient factors), the unity of the factor 6c (education level of participants) was only 41.9% indicating that most experts agree that this factor is of relatively low importance for complex health interventions. Similarly, the consensus rate of the factor 7f (technology advance) and 9e (community education level) is 50% and 48.1% respectively. Therefore, these three factors were provisionally identified as factors that could potentially be discarded. All three factors were referred to the third round for a final expert verdict.

On the other hand, of all the themes, only one theme 6 (Recipient factors) had a consensus rate of 58.1% for the adaptability section, requiring further exploration in the third round of Delphi survey, while all the others had a consensus rate of at least 70%. The scalability section in Theme 2 (Setting) achieved the highest consensus rate, namely 96.8%.

6.4 Summary

For the 54 influencing factors covered in the second round of the questionnaire, 39 of them have reached a priori consensus and do not need to enter the third round of the Delphi questionnaire; in addition, there are still 12 influencing factors that will enter the third round of the Delphi questionnaire. Three influencing factors had a consensus

rate of less than 50%, so these three influencing factors will be presented in the third round of the Delphi questionnaire for discussion by experts, and discarded according to a predefined rule if consensus still cannot be reached. The results of the third and final round of the questionnaire are discussed in the next chapter.

Chapter 7 The Results of the Third Round of Delphi survey

Chapter 7 presents the findings from the third and final Delphi survey round, aiming to solidify the consensus on ASaS factors and finalize the list for framework development. This chapter reflects the culmination of the Delphi process, where the iterative refinement of expert insights seeks to establish a robust basis for the METRO framework.

Introduction

The previous chapter presented the results of the second Delphi survey. The experts scored these influencing factors in the second round using a 9-point Likert scale. Overall, 39 factors reached consensus (the consensus rate >70%), with a further 12 influencing factors having a consensus rate between 50% and 70%, and three influencing factors achieving a consensus rate of less than 50%.

This section presents the data analysis and results of the Delphi questionnaire third round. In the third round, experts further scored the factors that did not reach a consensus and provided their comments. Finally, three influencing factors reached a consensus, but 12 factors still did not reach a consensus and required further discussion within a consensus session.

Expert Panel

In the third round of the Delphi survey, 27 experts from 13 countries (Australia, Canada, China, India, Ireland, Kenya, Mexico, Nigeria, Papua New Guinea, South Africa, Tunisia, UK, and USA) participated. The panel included 10 experts from high-income countries (HICs) and 17 from low- and middle-income countries (LMICs). As for the current position, there were 21 researchers, 2 healthcare providers, 1 policymaker, and 2 others. The gender distribution was 14 males and 13 females. Regarding employment status, 22 experts were academics working in universities or other academic

institutions, 1 worked in a hospital, 3 were employed in research/non-profit or governmental agencies, and 1 was from other settings. The detailed information can be found in the Table 15.

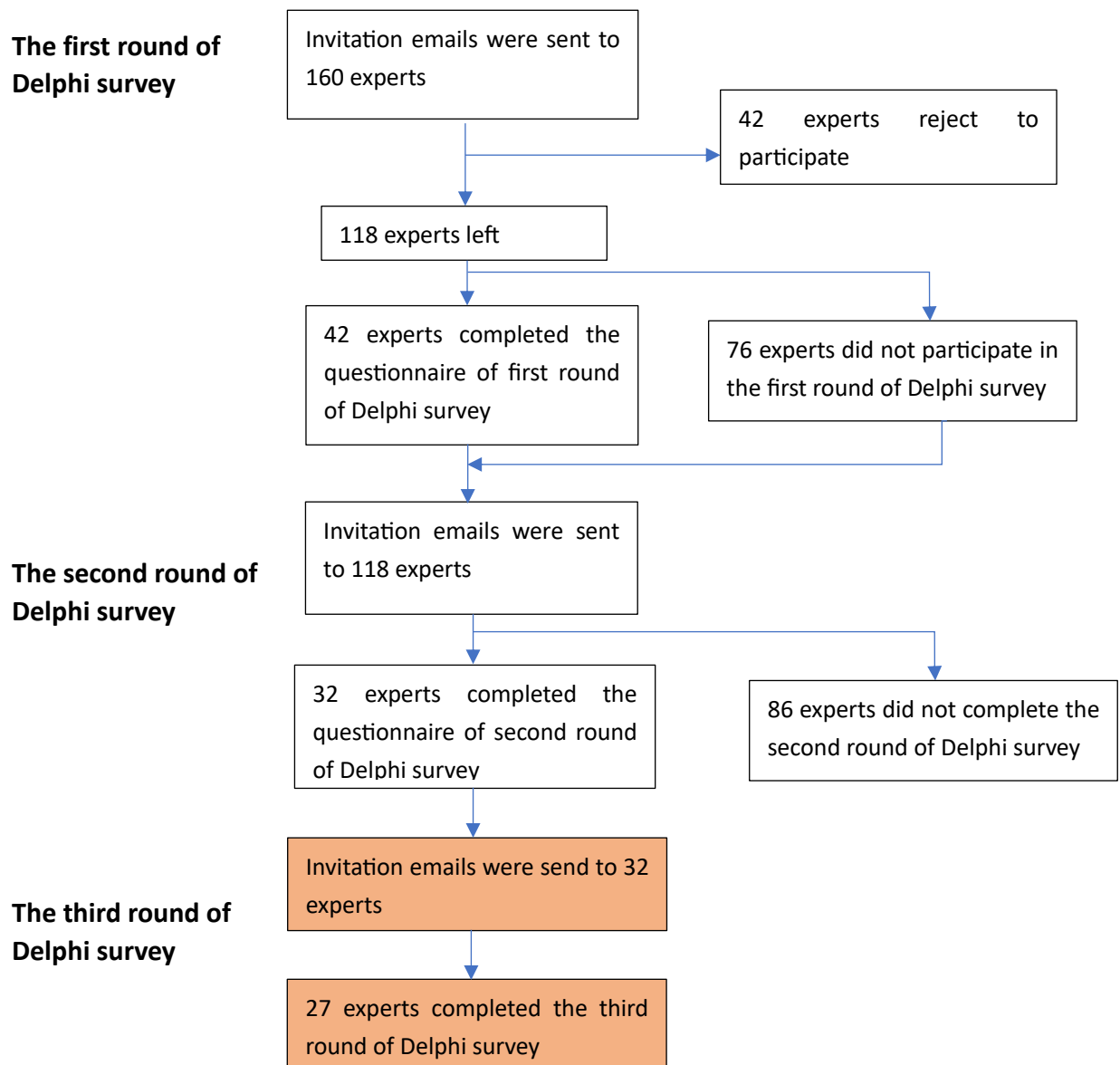
Table 15 The Basic information of the experts of the third round of Delphi survey

Category	Count	Percentage
Gender		
Female	13	48.10%
Male	14	51.90%
Area		
LMICs	17	63.00%
HICs	10	37.00%
Country		
Argentina	0	0.00%
Australia	2	7.41%
Canada	1	3.70%
Chile	0	0.00%
China	4	14.81%
Ghana	0	0.00%
India	2	7.41%
Ireland	2	7.41%
Kazakhstan	0	0.00%
Kenya	1	3.70%
Malaysia	0	0.00%
Mexico	1	3.70%
Nigeria	4	14.81%
Norway	0	0.00%
Papua New Guinea	1	3.70%

Poland	0	0.00%
Qatar	0	0.00%
South Africa	2	7.41%
Tunisia	2	7.41%
UK	3	11.11%
USA	2	7.41%
Current primary position		
researchers	21	77.78%
healthcare providers	2	7.41%
policymaker	1	3.70%
commissioner of health services	1	3.70%
others	2	7.41%
Place of work		
universities (or other academic institutions)	22	81.48%
hospitals	1	3.70%
research/ non-profit or governmental agencies	3	11.11%
other settings	1	3.70%

The overall Delphi study process is shown in the Figure 31 below.

Figure 31: The Delphi study process



7.1 The Third Round of Delphi Questionnaire

The questionnaire used in round three was based on the results of round two. Based on the feedback from the second round of the Delphi survey, experts did not express any objections regarding the naming and categorization of the influencing factors. This is likely because their focus in the second round was primarily on rating the importance of these factors.

At the same time, it was more specific and streamlined than the second round; experts were asked to re-score items that did not reach consensus and to give their comments accordingly. Therefore, the workload in this round was less than in the first and second rounds of the Delphi questionnaire. Overall, in the third round, the experts discussed the 12 influencing factors under the five themes and gave their reasons for giving this score.

7.2 Questionnaire Dissemination and Data Collection

In line with the second round of the Delphi questionnaire, invitations were sent to all 118 experts. In the third round of the Delphi questionnaire, 27 experts completed the third round, and 91 experts did not participate in this round of questionnaires.

The experts were requested to submit the questionnaire within a four-week timeframe and were also notified that a first 'reminder email' would be dispatched to those who hadn't responded after 14 days.

In the third round, the format of the questionnaire differs from that of the second Delphi round, given the fewer factors requiring consideration at this stage. Consequently, in this phase of the study, each factor is evaluated for its importance from the three perspectives of ASaS (Adaptability, Scalability, and Sustainability).

7.3 Analysis of the Third Round of Delphi survey

In the third round of the Delphi questionnaire, similar to the second round of the Delphi questionnaire, the 9-point Likert scale was applied to score the importance of the influencing factors.

In the third round, 12 factors that did not reach a consensus were further discussed. For this round of a priori consensus rules, after our discussions with experts and

reference to similar studies and literature[276, 292, 294, 307], in this round, a consensus rate of 65% on influencing factors is considered to be reached. Influencing factors with a consensus rate score of 65% or higher were retained and did not require discussion at the consensus meeting. Influencing factors with a consensus rate between 50% and 65% were referred to the consensus meeting for discussion. Factors with a consensus rate below 50% were dropped.

7.4 Results

The overall response rate for this survey round was 22.9% (27/118). Respondents included 27 experts, 12 from HICs and 15 from LMICs.

For the 12 influencing factors that failed to reach a consensus in the second Delphi questionnaire, consensus was subsequently achieved for seven factors, and five factors did not reach a consensus in this round.

Influencing factors reaching the a priori consensus

The table below provides the values of the mean and mode of the influencing factors reaching the a priori consensus.

In summary, the experts used a 9-point Likert scale to score the 12 influencing factors on which there was no consensus in the second round, and in the end, consensus was reached on seven factors, while consensus was not yet reached on five factors. The influencing factors reaching the a priori consensus is shown in the Table 16 below.

Table 16 Influencing factors reaching the a priori consensus

Theme	Influencing factor	Consensus rate			
		Mean	Mode		
Theme 2 (Setting)	the geographical location	Adaptability	7.14	8	71.4%
		Scalability	7.28	8	80.9%
		Sustainability	7.38	7	85.7%
Theme 3 (Organizational attributes)	the interorganizational networks	Adaptability	6.75	6	65.0%
		Scalability	7.05	7	70.0%
		Sustainability	7.20	7	80.0%
	organizational structure	Adaptability	6.65	7	70.0%
		Scalability	6.65	7	70.0%
		Sustainability	7.25	8	75.0%
	the differences between individual culture			8	80.0%
		Adaptability	7.55		

Theme 6 (Recipient factors)		Scalability	7.30	8.9	75.0%
		Sustainability	7.30	8	75.0%
	training and education of participants	Adaptability	7.40	8	80.0%
		Scalability	7.10	8.9	65.0%
		Sustainability	7.35	8	75.0%
Theme 8 (Monitoring and supervision)	the role of existing community structures and personnel	Adaptability	7.15	7.9	70.0%
		Scalability	7.30	8.9	70.0%
		Sustainability	7.35	8.9	75.0%
	empowering the state and non-state actors			7	68.4%
		Adaptability	6.84		
		Scalability	7.47	7.8.9	84.2%
		Sustainability	7.53	9	84.2%

Geographical location

Experts used the 9-point Likert scale to rate the importance of geographical location as a factor for all three ASaS concepts. All three concepts scored an average of 7 or more, with most scores above 7 and a consensus rate of 65% or more. These figures indicate a high overall level of consensus among the experts on this factor.

The main comments from experts are as follows. First, requirements for implementing complex interventions vary according to geographical location, including rural versus urban areas, different continents and specific environmental conditions. In addition, even within the same state or country, differences exist for culture, population, policy and environment, especially in remote and rural areas. Geographical location, therefore, has important implications for the scalability and sustainability of complex interventions.

In addition, experts discussed the relevance to geographical location of such factors as national income levels, infrastructure, culture, availability of medical staff, disease prevalence and environmental conditions, which influence the feasibility and sustainability of complex health interventions. Particularly in underdeveloped countries, the need for health resources combined with limited access to health services limit the adaptability, scalability and sustainability of interventions. Therefore, Geographic location significantly impacts the ASaS of complex health interventions.

“Geographical location impacts ASaS of complex health interventions due to factors like infrastructure, cultural aspects, health workforce availability, disease prevalence, and environmental conditions. Each of these factors may influence the effectiveness, adaptability, and sustainability of interventions in different regions.” (University or other Academic Institution----UK----HICs)

“Geographical locations have an impact of these factors as resources differ and government focus differs. This can impact how scalable an intervention is and how sustainable it will be. For example, if an intervention is being delivered in a lower socioeconomic area the motivation and feasibility may be significant barriers to the implementation of that intervention.” (University or other Academic Institution----India----LMICs)

Some experts hold different views. With increasing numbers of interventions being delivered remotely with the advent of technology geographical factors have diminishing impact on the intervention.

“Geographically remote areas face more challenges to deliver a complex health intervention such as infrastructure and facilities. However, complex health interventions can vary from in-person interventions to blended or online interventions. If the intervention is delivered online, the geographical location will have fewer influences on ASaS.” (University or other Academic Institution----China----LMICs)

Interorganizational networks

For the element of the inter-organizational networks in Theme 3, networks involving government agencies, non-governmental organizations (NGOs), private companies and community groups facilitate collaboration, resource sharing and knowledge exchange in implementing complex interventions.

However, the type of collaboration that researchers might expect is not common to implementation of every intervention. For example, in low- and middle-income countries, areas persist which have no organisation to fall back on, being therefore in

a state of organisational isolation.

Organizational structure

For the factor of organizational structure in theme 3, all three ASaS concepts achieved an importance rating of between 6.65 and 7.25, the mode is above 7, and the consensus rate is above 65%, indicating a high degree of consensus among the experts on this factor.

According to expert feedback, an effective organisational structure is critical to successful implementation, scaling up and sustainment of health interventions. It enables organisations to respond to change, allocate resources and coordinate efforts, and achieves an impact on decision-making, communication and collaboration.

However, while the importance of the role of organisational structure may vary from project to project, ensuring appropriate resourcing and staffing remains critical to organisational structure in implementing interventions.

Organisational structure is influenced by diverse influencing factors. Academic consensus suggests that a complex organizational structure, characterized by multiple layers of hierarchy, diverse functional units, and specialized departments, can significantly enhance the organization's sustainability. This enhancement is attributed to the structure's ability to distribute responsibilities across various segments, thereby fostering a robust and resilient framework that can withstand external pressures and internal challenges.

However, this complexity introduces a critical paradox in organizational design: while it bolsters sustainability by creating a sturdy and comprehensive structure, it simultaneously hampers the organization's agility and adaptability. The intricate web of departments and layers can slow down decision-making processes, complicate

communication channels, and introduce bureaucratic hurdles that make it difficult for the organization to respond swiftly to emerging opportunities or threats. This scenario necessitates modifications or interventions which, due to the complex nature of the structure, might be less efficiently implemented.

In addition, experts mentioned how organisational structure links to other influencing factors, including local policies, economic conditions and culture. For example, in low- and middle-income countries, organisations of a local government nature may be influenced by bureaucracy or administrative costs, which in turn may further affect the scalability and sustainability of interventions.

“An effective structure allows organizations to respond to changes, allocate resources efficiently, and coordinate efforts. It can also influence decision-making, communication, and collaboration, which are essential for successful implementation, scaling, and sustaining health interventions.” (University researcher---South Africa---LMICs)

“the complexity of the organisational structure contributes to the readiness for upscaling/sustainability, a more complex organisation may be able to support sustainability but may be less adaptable to changes required to implement a different way of doing things.” (University researcher---India--- LMICs)

The differences between individual culture

For the factor “differences between individual cultures” within theme 6, the mean importance of all three ASaS concepts ranged from 7.3 to 7.55, and the mode were all above 8. The consensus rates were all above 75% (reaching the prior consensus rate), indicating a high level of consensus among the experts on this factor.

As a factor, culture has a vital role in all three aspects of ASaS for complex health interventions. Specifically, complex interventions often involve individual behavioural changes, making cultural differences crucial[71]. However, culture is a vague concept that is understood differently by different researchers. Cultures can exist across countries or form diverse sub-cultures within a single country[308]. Individual reference points and experiences also influence perceptions of culture[309].

Understanding and respecting cultural nuances, tailoring interventions to local contexts, and taking into account cultural values, norms and practices can contribute to the successful implementation of health interventions.

“This may depend on location of practice and cultural context. For instance, in Africa, cultural perceptions are key modifiers of actions even among persons in the same organisation.” (University researcher---Nigeria--- LMICs)

“Cultural factors can influence the acceptance, implementation, and effectiveness of interventions. Understanding and respecting cultural nuances is crucial for tailoring interventions to local contexts, ensuring their relevance, and fostering community engagement, all of which contribute to the success of health interventions in diverse settings.” (University researcher---Nigeria--- LMICs)

Training and education of participants

For the factor training and education of participants in theme 6, the mean for all three ASaS concepts is above 7 and the mode is above 8, indicating a high degree of concentration. The consensus rate for the concepts of adaptability and sustainability was over 70%, and over 65% for the concept of scalability.

These arguments emphasise the importance of training and education for

interventions. Appropriate training and education ensure that those involved in intervention delivery possess the necessary skills and knowledge to deliver interventions effectively. Training and education help to improve knowledge, change attitudes and behaviour, and provide the basis for successful scale-up and long-term sustainability of interventions.

“Proper training and education ensure that those involved in implementing interventions have the necessary skills, knowledge, and understanding to effectively deliver the intervention. This can lead to better outcomes, increased buy-in from stakeholders, and a higher likelihood of successful scaling and long-term sustainability.” (University or other Academic Institution----Australia----HICs)

“Training and education of participants can influence ASaS, but the difference caused by training and education could be mitigated by providing additional training or instructions to those who have lower educational level.” (University or other Academic Institution----Nigeria----LMICs)

Some experts have different views, supporting the importance of education and training and yet seeing its prominent role in the adaptation phase. Conversely, when scaling up and sustaining complex interventions, the support of organisational experience and change management skills was considered more necessary.

“It depends on the training requirements of the complex intervention. Scalability and sustainability do not necessarily require training, rather it requires organisational experience and change management skills.” (University or other Academic Institution----USA----HICs)

The role of existing community structures and personnel

Experts reached consensus on the role of existing community structures and personnel in theme 8. The mean importance of the three ASaS concepts was 7.15 for Adaptability, 7.3 for Scalability and 7.35 for Sustainability. For the mode, all three sections scored above 7. For the consensus rate, all three sections have a consensus rate of over 70%.

Experts emphasized the importance of community structures and people in project implementation.

“Community structures in Africa are critical backbones for implementing projects. They help with linkages as well as context specific roles for the project.” (University or other Academic Institution----South Africa----LMICs)

“Engaging and collaborating with local community structures and personnel can lead to better understanding of local needs, increased community buy-in, and more effective tailoring of interventions.” (University or other Academic Institution----China----LMICs)

“Without the support of community personnel and structures the likelihood of an intervention being sustainable, adaptable and scalable is small. An intervention that has the backing of trusted local personnel is more likely to be trusted by the community.” (University or other Academic Institution----UK----HICs)

Empowering the state and non-state actors

Experts achieved consensus regarding the factor empowering the state and non-state actors in theme 8. The mean importance of the three sections of ASaS is 6.84 for Adaptability, 7.47 for Scalability, and 7.53 for Sustainability, with the mode of all three components above 7.

The consensus rate for Adaptability reached 68.4%, and the consensus rate of both scalability and sustainability was 84.2% (All reached the prior consensus rate).

By developing and strengthening the capacity of stakeholders, collaboration, enhanced resource allocation and improved decision-making can be promoted, which contributes to effective implementation of health interventions and better responsiveness to local needs and priorities.

“involving and strengthening the capacity of these actors, you can foster collaboration, enhance resource allocation, and improve decision making. This can lead to more effective implementation of health interventions, better alignment with local needs and priorities.” (University or other Academic Institution----Canada----HICs)

Influencing factors not reaching the a priori consensus

The table below provides the values of the mean and mode of the influencing factors not reaching the a priori consensus. (see Table 17)

Table 17 Influencing factors not reaching the a priori consensus

Theme	Influencing factor	Consensus rate		
		Mean	Mode	
Theme 7 (Project Management processes)	experience in implementing similar projects	Adaptability	6.90	6
		Scalability	6.65	6
		Sustainability	6.75	6
	time constraints	Adaptability	6.50	7
		Scalability	6.90	7
		Sustainability	7.15	7.8
Theme 8 (Monitoring	the remote support from intervention developers	Adaptability	6.75	7
		Scalability	6.50	7

and supervision)		Sustainability	6.50	7	55.0%
	Routine system	Adaptability	6.32	5.7	57.9%
		Scalability	6.63	7	68.4%
		Sustainability	6.79	7	73.7%
	Using frameworks	Adaptability	6.70	6	50.0%
		Scalability	6.50	5	45.0%
		Sustainability	6.45	5	50.0%

Experience in implementing similar projects

The factor experience in implementing similar projects occasioned some controversy among the experts. The mean importance of the three ASaS concepts is 6 for Adaptability, 6.65 for Scalability and 6.75 for Sustainability. The mode for all three components is 6. For the consensus rate, Adaptability rated 60%, Scalability rated 45% and Sustainability rated 55%.

Overall, the experts found that prior experience of being involved in similar projects is helpful for new interventions. Previous experience can provide valuable insights, and lessons learned that can be applied to new interventions. This knowledge serves to assist organisations to be better at anticipating and addressing potential challenges.

“Previous experience can provide valuable insights, lessons learned, and best practices that can be applied to new interventions. This knowledge can help organisations to better anticipate and address potential challenges.” (University or other Academic Institution----UK----HICs)

Experts had differing opinions on this. While a wealth of experience can provide transferable knowledge and experience, the experience in implementing similar projects may also limit the willingness to explore options that have not been tried before. At the same time, while lessons learned from experience are essential for future implementation, not all experiences apply to every project, and complex interventions may require rethinking previous experiences.

“implementation of similar projects may be helpful, but may also be a hindrance restricting the willingness to explore other options not previously explored when implementing other projects.” (University or other Academic Institution---Australia----HICs)

“While experience will help projects that are well devised and well run it is not the main factor.” (University or other Academic Institution----Mexico----LMICs)

Time constraints

Time constraints achieved a mean importance of 6.5 for Adaptability, 6.9 for Scalability and 7.15 for Sustainability. The mode of all three components is above 7. In terms of aspects not achieving consensus, the main unachieved consensus is for Adaptability, with a consensus rate of 55% for Adaptability, 65% for Scalability and 75% for Sustainability.

According to expert feedback, tight deadlines or limited timeframes can impact on the quality of implementation and limit the ability to adapt interventions to local contexts and scale them up. In addition, the sustainability of complex interventions may be hampered by insufficient time to achieve routinisation and adaptation of interventions due to insufficient time for monitoring, evaluation and responding to unexpected challenges.

“Time constraint is very determining, particularly for the adaptation.” (University or other Academic Institution----UK----HICs)

“Tight deadlines or limited time frames can affect the quality of implementation, limit the ability to adapt interventions to local contexts, and constrain efforts to scale up interventions. Additionally, insufficient time for monitoring, evaluation, and addressing unforeseen challenges may hinder long-term sustainability.” (Research/non-profit or governmental agency----Nigeria----LMICs)

“Sufficient time is needed for intervention to be routinised, adjusted and

especially for scaling up and sustainability.” (University or other Academic Institution----Canada----HICs)

Some experts suggested a need for further clarification of the meaning of “time constraints” to avoid it being potentially vague and open to disagreement.

“It would be helpful to clarify whether it's about the time constraints of the research team, or those of the team carrying out the complex health interventions, such as general practitioners or community doctors or nurses.” (Hospital----UK----HICs)

Remote support from intervention developers

Remote support from intervention developers in Theme 8 is a factor that generated disagreement among experts.

The mean importance of the three ASaS concepts was 6.75 for Adaptability, 6.5 for Scalability and 6.5 for Sustainability. The mode for all three components was 7. For the consensus rate, only Adaptability reached consensus, with a 65% rate. The consensus rates for the scalability and sustainability are 55%. These two components were further discussed in the consensus meeting.

In the questionnaire, experts explained that remote support includes guidance, technical assistance and troubleshooting to help local implementers overcome challenges and ensure that interventions are tailored to the local context. Remote support can facilitate knowledge sharing, capacity building and continuous improvement. Remote support is particularly important when working in resource-limited settings, especially in interventions that require innovation and problem-solving.

Experts also mentioned the relevance of remote support to other factors. Remote support requires internal organisational and leadership support, as well as the trust and support of the community and participants.

Some experts agree that remote support is important, but mainly to improve the initial stages of an intervention, and less so in the subsequent stages. In other words, remote support is primarily related to the adaptation phase, while it has a lower correlation with the scalability and sustainment phases.

“Such support can include guidance, technical assistance, and troubleshooting, which can help local implementers to overcome challenges and ensure the intervention is tailored to the local context. Remote support can also facilitate knowledge sharing, capacity building, and continuous improvement.” (University or other Academic Institution----China----LMICs)

“remote support from intervention developers may in the initial instance improve adaptability, scalability and sustainability.” (University or other Academic Institution----Kenya----LMICs)

“Remote support and support from developers may have different impacts. It depends on how useful the support is. Scalability and sustainability may require more internal organisational and leadership support.” (Research/non-profit or governmental agency----Nigeria----LMICs)

Routine Systems

The factor of routine systems within Theme 8, provoked disagreement among the experts.

The mean importance of the three components of ASaS is 6.32 for Adaptability, 6.63 for Scalability and 6.79 for Sustainability. The mode for Adaptability is 5 and 7, while the mode for the other two components is 7.

The consensus rate for adaptability was 57.9%, while the consensus rate for scalability was 68.4% and sustainability was 73.7%. Therefore, it can be considered that it reached a consensus for both scalability and sustainability. However, controversy surrounds this factor in relation to adaptability.

Experts argued that the existence of a routine system is essential for the long-term sustainability of complex interventions. However, the role of the routine system in the adaptation phase of a new intervention in a new area is disputed by experts.

“The fit between the new intervention and the routine system is important for shaping feasibility and uptake and routinising of the new intervention.”
(Research/non-profit or governmental agency----China----LMICs)

“Not convinced that routine system has a significant impact, it is important from an implementation perspective, not sure how it influences the other aspects.”
(University or other Academic Institution----India----LMICs)

Using frameworks

Experts continued to debate the value using a framework within Theme 8. The mean importance of the three components of ASaS is 6.7 for Adaptability, 6.5 for Scalability and 6.45 for Sustainability. For the mode, all three components are scored between 5 and 6, and the consensus rate for all three sections is between 45% and 50%.

Some experts agreed that frameworks provide structured guidance to help

organisations plan, implement, monitor and systematically evaluate interventions. However, the use of frameworks alone can be limiting. The combination of systematically collected evidence and its use and dissemination is key to making a difference in impact.

“It’s the use and dissemination of the systematically collected evidence alongside the frameworks that would make a difference in impact. The use of framework alone can be limited.” (University or other Academic Institution----India----LMICs)

It was also suggested that while frameworks are useful, whether or not to use them is simply a matter of choice for different researchers and can be balanced by their experience.

“frameworks are useful, but not all people like them; I think it is a personal preference to some degree and can be balanced out by experience.” (University or other Academic Institution----China----LMICs)

The frameworks will assist with the implementation and scalability, but there are other variables that will have a greater impact on the adaptability and sustainability.

Discarded influencing factors

Technology advance

In the second round of the Delphi questionnaire, a consensus rate of 50.0% was reached by experts for this factor. However, since this consensus rate was lower than the 70% a priori consensus rate set in the second round of the Delphi questionnaire, this factor was categorized as a topic that needed to be discussed further and went into the third round of the Delphi survey. In the third round of the Delphi questionnaire, while the consensus rate for this factor improved to 55.0%, it still fell

short of the 65% a priori consensus rate criterion required for the third round.

It is important to note that some experts supported that advances in technology may be helpful for interventions, as the continued development of technology can increase the flexibility of intervention implementation.

“As technology evolves, it can offer new tools and capabilities for implementing, monitoring, and evaluating interventions. This can lead to more effective, personalised, and data-driven solutions.” (University (or other Academic Institution)-----Ireland-----HICs)

More experts believe that advances in science and technology have a limited impact on the implementation of interventions. In LMICs areas, especially in some resource-poor places, many advanced scientific and technological tools may not be fully utilized. For example, telemedicine may be difficult to implement in some remote areas where basic communication infrastructure is lacking and residents may not have sufficient financial means to purchase the relevant electronic equipment.

“Unless the advance is really disruptive, it may worsen inequality and inequity. (University (or other Academic Institution)-----India-----LMICs)

Therefore, after final consideration of the experts' opinions and in view of the fact that the consensus rate was only 55%. This influence factor was dropped.

Education level of participants

In the second round of the Delphi questionnaire, the consensus rate among experts for this factor was 41.9%. Since the consensus rate failed to reach the 70% a priori consensus rate mentioned in the method part, this factor was further discussed in

the third round of Delphi survey. However, it is interesting to note that in the third round of the Delphi questionnaire, the consensus rate among experts for this factor dropped to 35.0%, which is also lower than the 65% a priori consensus rate set in the third round of Delphi survey.

Experts also noted that differences in education levels may have different impacts on interventions. Although participants may have different levels of education, and some may even have lower levels of education, researchers and local healthcare workers can use different approaches to compensate for these differences. For example, experts suggest that information can be conveyed using vivid imagery, such as images, as an alternative to traditional educational methods that rely solely on words. This approach can help ensure that interventions are communicated to participants, regardless of their level of education, in a way that is understandable and acceptable.

“in LMIC in particular the education level of participants should not be a significant factor for implementation success.” (University (or other Academic Institution)----- Papua New Guinea-----LMICs)

In addition, experts recommend combining this factor with other factors.

“I would change this to capacity for participation (awareness, skills, education, understanding. level of engagement, dmaking power etc).” (Independent research consultant-----USA-----HICs)

Community education level

In the second round of the Delphi questionnaire, the expert consensus rate for this particular factor was 48.1%. The 70% a priori consensus rate set in the second round of the Delphi survey could not be reached, so this factor was included in the third

round of the Delphi survey. However, it is interesting to note that in the third round of Delphi questionnaire, the consensus rate of experts for this factor dropped to 30.0%, which is also lower than the 65% a priori consensus rate set in the third round of Delphi survey.

On the other hand, experts also pointed out that, similar to the level of education of the individual participant, the level of education of the local community, while it may influence the intervention to a certain extent, is not significant and this potential gap can be remedied by conveying information through graphic methods, such as images.

“in LMIC in particular the education level of the community should not be a significant factor for implementation success.” (University (or other Academic Institution)----- Papua New Guinea-----LMICs)

The Overall results of the third round of Delphi survey is shown in the Table 18 below.

Table 18: Results of the third round of Delphi survey

Theme	Influencing factor		Mean	Mode	Consensus rate
Theme 2 (Setting)	the geographical location	Adaptability	7.142857143	8	71.4%
		Scalability	7.285714286	8	80.9%
		Sustainability	7.380952381	7	85.7%
Theme 3 (Organizational attributes)	the interorganizational networks	Adaptability	6.75	6	65.0%
		Scalability	7.05	7	70.0%
		Sustainability	7.2	7	80.0%
	organizational structure	Adaptability	6.65	7	70.0%
		Scalability	6.65	7	70.0%
		Sustainability	7.25	8	75.0%

Theme 6 (Recipient factors)	the differences between individual culture	Adaptability	7.55	8	80.0%
		Scalability	7.3	8.9	75.0%
		Sustainability	7.3	8	75.0%
	training and education of participants	Adaptability	7.4	8	80.0%
		Scalability	7.1	8.9	65.0%
		Sustainability	7.35	8	75.0%
	Theme 7 (Project Management processes)	experience in implementing similar projects	Adaptability	6.9	6
Scalability			6.65	6	45.0%
Sustainability			6.75	6	55.0%
time constraints		Adaptability	6.5	7	55.0%
		Scalability	6.9	7	65.0%
		Sustainability	7.15	7.8	70.0%

Theme 8 (Monitoring and supervision)	the role of existing community structures and personnel	Adaptability	7.15	7.9	70.0%
		Scalability	7.3	8.9	70.0%
		Sustainability	7.35	8.9	75.0%
	empowering the state and non- state actors	Adaptability	6.84	7	68.4%
		Scalability	7.47	7.8.9	84.2%
		Sustainability	7.53	9	84.2%
	the remote support from intervention developers	Adaptability	6.75	7	65.0%
		Scalability	6.5	7	55.0%
		Sustainability	6.5	7	55.0%
	Routine system	Adaptability	6.32	5.7	57.9%
		Scalability	6.63	7	68.4%
		Sustainability	6.79	7	73.7%
	Using frameworks	Adaptability	6.7	6	50.0%
		Scalability	6.5	5	45.0%
		Sustainability	6.45	5	50.0%



Table 19: The degree of coordination of experts' comments

	Importance		
The third round of Delphi survey	W	χ^2	P
Adaptability	0.074	21.17	0.03
Scalability	0.087	24.87	0.01
Sustainability	0.066	13.8	0.08
All items	0.086	78.67	<0.001

It is important to note at the outset that, unlike the second round of Delphi's questionnaire, the third round was designed to allow experts to rate and discuss the importance of each of the remaining 12 factors for which consensus had not yet been reached at each of the three different stages of ASaS.

Overall, in the third round of the Delphi questionnaire, the value of the Kendall coefficient was 0.086 ($p < 0.001$) for all these entries. This implies that there was a greater degree of inconsistency among experts in rating the importance of these factors in complex interventions, with some triggering greater disagreement. (see Table 19)

Similarly, for the rating of the importance of these factors in the ADAPTABILITY section, the Kendall's coefficient was 0.074 with a p-value of 0.03 (<0.05). The situation is similar for the scaling of the SCALABILITY stage, with a Kendall's coefficient of 0.087 and a p-value of 0.01 (<0.05) (see Table 19). This indicates that there is a large difference between the experts' ratings of certain factors in these two phases, and the Kendall's coefficient is close to 0, indicating the existence of this inconsistency.

However, in the SUSTAINABILITY stage, the Kendall's coefficient for the experts' importance ratings of these factors was 0.066 with a p-value of 0.08 (>0.05) (see Table 19). Although the ratings at this stage also showed inconsistency, based on the p-value,

this inconsistency may have been due to chance. Therefore, the factors that trigger disagreement need to be explored and discussed in greater depth in subsequent consensus conferences to better understand and address these issues.

Table 20: The degree of coordination of experts' comments of HICs group

	Importance		
The third round of Delphi survey	W	χ^2	P
Adaptability	0.068	6.69	0.82
Scalability	0.09	8.93	0.63
Sustainability	0.089	8.8	0.64
All items	0.103	32.47	0.59

Overall, there was inconsistency in the third round of the Delphi questionnaire, including the HICs group's experts' ratings of the importance of these factors at each stage of ASaS. Specifically, the Kendall's coefficients for the experts' importance ratings for all entries, the importance ratings of these factors at the ADAPTABILITY stage, the importance ratings at the SCALABILITY stage, and the importance ratings at the SUSTAINABILITY stage were 0.103, 0.068, 0.09, and 0.089, respectively, with p-values of more than 0.05 (see Table 20).

This implies that there is a large variation in the importance ratings of these factors by experts from HICs. However, it is important to note that these differences may have arisen by chance rather than systematically. Therefore, there is a need to continue discussing the factors did not reach consensus in subsequent consensus conferences to better understand the inconsistencies among experts and work toward consensus.

Table 21: The degree of coordination of experts' comments of LMICs group

	Importance		
The third round of Delphi survey	W	χ^2	P
Adaptability	0.124	23.16	0.02
Scalability	0.153	28.55	0.003
Sustainability	0.191	35.68	<0.001
All items	0.146	86.66	<0.001

Overall, in the third round of the Delphi questionnaire, all experts showed inconsistency in their importance ratings of these factors at all stages of ASaS. Specifically, the Kendall's coefficients for the experts' importance ratings for all items, the importance ratings of these factors at the ADAPTABILITY stage, the importance ratings at the SCALABILITY stage, and the importance ratings at the SUSTAINABILITY stage were 0.146, 0.124, 0.153, and 0.191, respectively, and the p-values were all less than 0.05 (see Table 21).

This suggests that the experts differed on the ratings of certain factors, and that there is a need to continue to discuss and delve deeper into these factors in subsequent consensus meetings in order to better understand the differences between them and strive for consensus.

7.5 Summary

This study obtained a large amount of qualitative data from the first round of the Delphi survey, which formed the basis of our analysis and research. At the end of the third round of the Delphi survey, this study obtained consensus on a total of 46 factors, which were widely recognized as influencing factors on complex interventions, and were unanimously endorsed by experts for their importance at different stages. Three factors failed to achieve a consensus rate of 50% in the second round of the Delphi survey and did not reach 65% in this round, leading to their exclusion. At the same

time, five factors failed to achieve the consensus threshold of 65% but exceeded a 50% agreement rate. Consequently, these five factors necessitate further in-depth discussion and exploration at a consensus meeting. (see Table 22)

The next chapter will detail the results of the consensus meeting This will include the views of the experts on these factors, especially further discussion on these non-consensus factors and finalizing whether they should be included in the theoretical framework.

Table 22. The summary of the three Rounds of Delphi survey

Round 1 Influencing factors obtained n=50
Round 2 Further modified the obtained factors in accordance with comments from experts and supervisors n=54 39 influencing factors reached consensus 15 influencing factors did not reach the a priori consensus and sent through to the next round.
Round 3 Of the 15 influencing factors unreached the a priori consensus in the Round 2 Delphi survey. In this round. 7 influencing factors reached consensus, three influencing factors were discarded, leaving 5 influencing factors to be sent through to the consensus meeting.

Delphi outcome

In the second round, a priori consensus was reached on 39 factors, and in the third round a further 7 factors reached a consensus.

After three rounds of the Delphi questionnaire, a total of 46 influencing factors reached a consensus, 3 influencing factors were dropped and 5 influencing factors went into the consensus meeting for final discussion.

Chapter 8 The Results of the Consensus Meeting

Following the Delphi surveys, Chapter 8 captures the essence of the consensus meeting, where experts convene to deliberate and finalize the factors and themes for the METRO framework. This chapter represents a critical juncture in transforming collective expert insights into a coherent and practical framework for LMICs.

8.1 Introduction

The previous chapter presented the results of conducting the third round of the Delphi study.

In the third round, the experts used a 9-point Likert scale to score the 12 influencing factors on which there was no consensus in the second round, and in the end, consensus was reached on seven factors, while consensus was not yet reached on five factors.

This chapter presents the results of the consensus meeting, in which the experts discussed the five factors that did not reach consensus in the third round, and also discussed whether the labels assigned to the nine Themes and their factors needed to be changed and whether the influencing factors needed to be added or deleted, and finally reached a consensus.

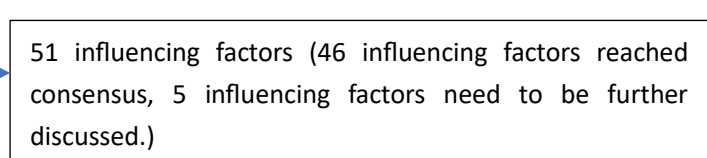
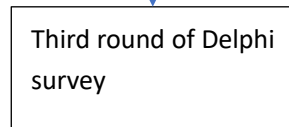
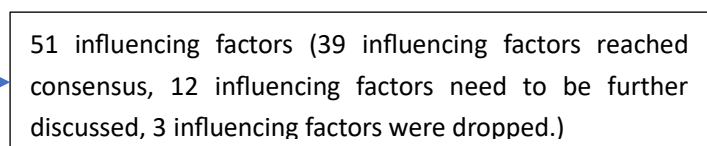
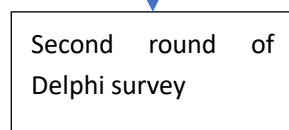
The whole process of Delphi questionnaire survey and consensus meeting is shown in Figure 32 below.

Figure 32: The Flowchart of the whole Delphi questionnaire survey and consensus meeting process

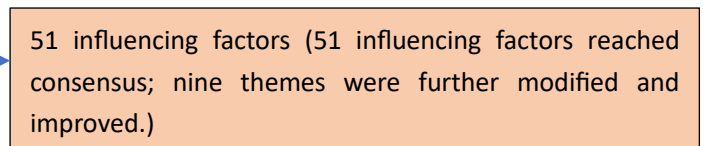
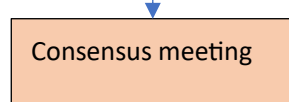
Step 1



Step 2



Step 3



Participants' information

Twelve experts participated in the consensus meetings, of which eight experts participated in the online consensus meetings, two experts participated via interview and two experts participated in the discussions via email.

8.2 Results from the Consensus Meeting

The consensus meeting was divided into two parts, the first being discussion on the five influencing factors that did not reach consensus in the previous Delphi

questionnaire, and the second being suggested amendments provided by the experts on the nine themes and their associated factors.

8.2.1 The discussion of the five influencing factors

In the first part, five influencing factors were discussed, all of which were considered by the experts in the previous Delphi questionnaire to be relatively important, but for which no consensus had been reached. During the consensus meeting, all five factors were agreed upon for eventual incorporation within the subsequent framework. However, some factors required modification, improvement or clearer definition, according to the experts' suggestions. (The voting result is shown in the Table 23)

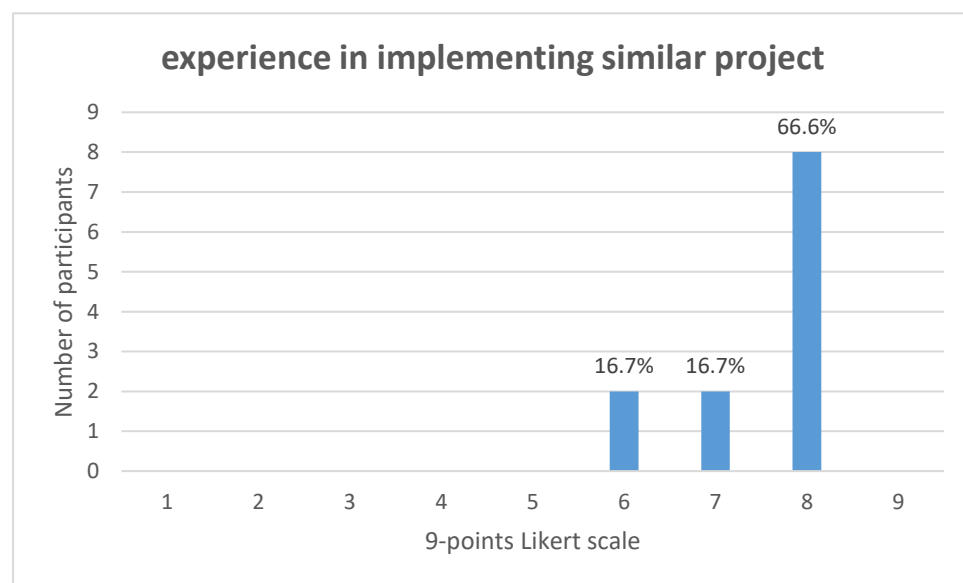
Table 23. Summary of consensus meeting voting results

Influencing factor	% of meeting participants voting as very important	% of meeting participants voting as relatively important	% of meeting participants voting as not important
7a experience in implementing similar projects	83.3%	16.7%	0%
7g Time constraints	83.3%	16.7%	0%
8g the remote support from intervention developers	91.6%	8.4%	0%
8h routine system	75%	25%	0%
8j Using frameworks	75%	25%	0%

Experience in implementing similar projects

Overall, consensus was reached on the importance of “Experience in implementing similar projects”, with 83.3% (10/12) of experts considering it to be very important. (see Figure 33)

Figure 33: The importance of the influencing factor of experience in implementing similar project (Using 9-point Likert scale).



Total number of experts voting: 12

This factor was considered important by the majority of experts in the consensus meeting.

At the same time, the experts suggested some modifications of the influencing factors. First, experts argued that a precise description of experience as an influencing factor was needed, as unfavourable experiences can be misleading to the implementer and can hinder the implementation of the intervention.

It was also suggested that experience needs clearer definition. The future framework

should make clear whether the experience relates to experience of implementing similar projects or experience used in organizational activities.

Future documentation will clarify that experience in this context refers to the experience of the implementer of the intervention on similar projects.

Experts had differing views on this. Some experts believe that experience in implementing similar projects plays less of a role in the process of implementing interventions which is influenced by other factors such as culture.

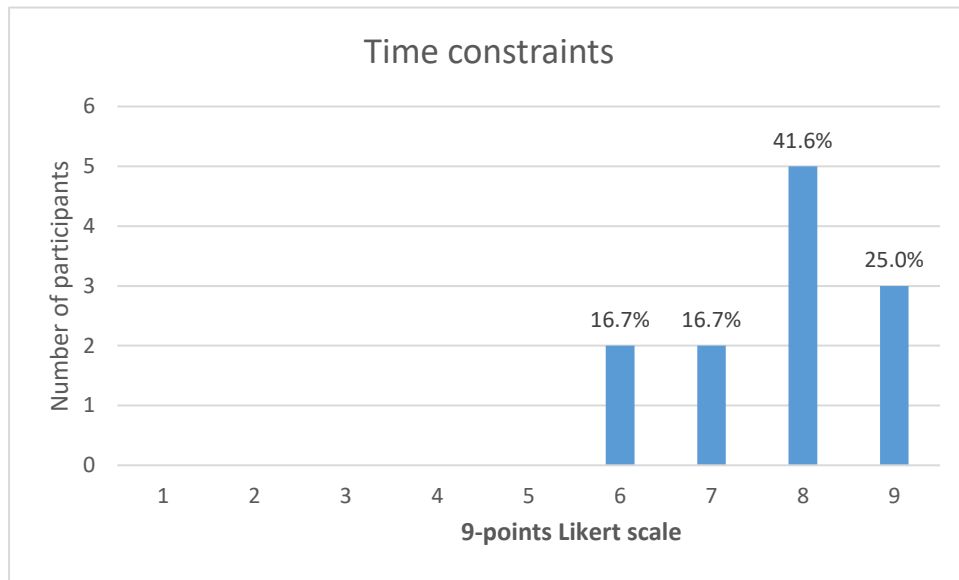
In other words, some experts believe that other influencing factors, such as culture, exert a much greater impact on complex interventions than experience in implementing similar projects unless the implementer needs to carefully identify and anticipate such differences before considering experience in implementing similar projects.

The future documentation will therefore describe this influence in detail, specifying it as the Experience of implementing similar complex interventions by those implementing interventions.

Time constraints

Overall, consensus was reached on this factor, with 83.3% (10/12) of experts considering it to be very important. (see Figure 34)

Figure 34: The importance of the influencing factor of time constraints (Using 9-point Likert scale).



Total number of experts voting: 12

Overall, recognition of time constraints was considered necessary by experts. Although some experts may not consider it particularly important, it is still recognised as playing an essential role in intervention implementation.

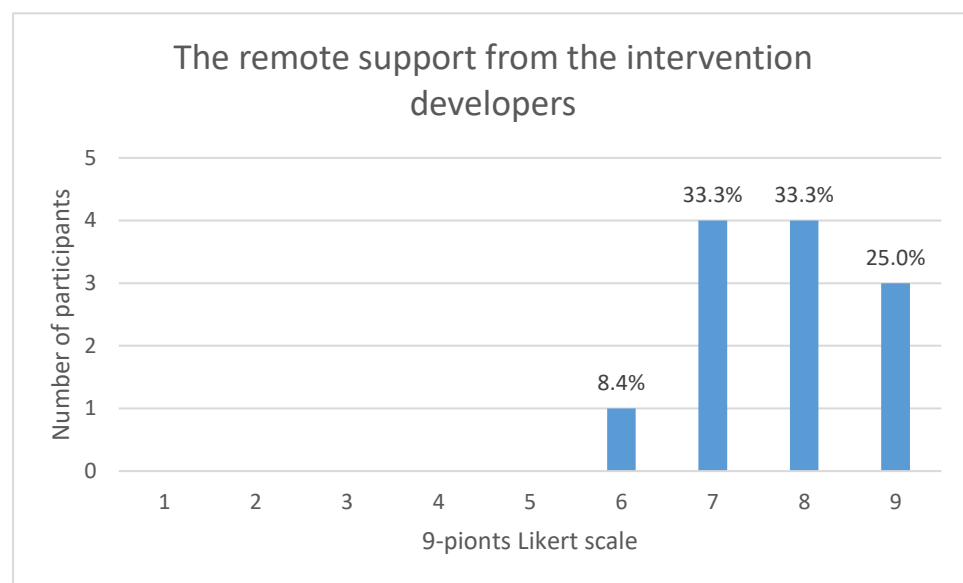
Some experts hold a slightly different view, even though considering that recognition of time constraints with a score of 6. Specifically, they described how other factors can hinder the project in LMICs, such as bureaucratic factors and corruption, which can affect the intervention. Conversely, giving a clear timeline can facilitate the intervention.

According to expert comments in the meeting, this factor should be retained within the framework. More importantly, the final framework should make apparent what factors specifically influence time constraints, such as the fact that bureaucracy affects the project timeline.

The remote support from intervention developers

Overall, there is a consensus on the importance of remote support from intervention developers, with 91.6% (11/12) of experts considering it very important. (see Figure 35)

Figure 35: The importance of the influencing factor of the remote support from intervention developers (Using 9-point Likert scale)



Total number of experts voting: 12

In general, the value of remote support from intervention developers has been recognised and valued by experts.

Based on feedback from experts at the consensus meeting, future documentation will provide an explicit description of what support (such as teleconferencing) entails, making it clear that this remote support is primarily technical rather than financial.

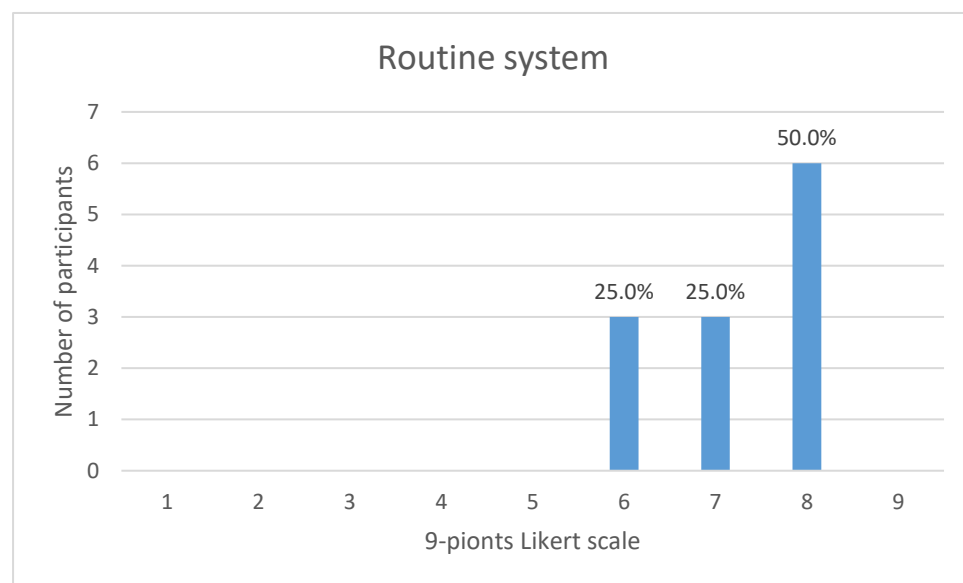
In addition, some experts commented that remote supporters may need to acquire

knowledge of the local context. They observed that remote supporters may not even be good at or have experience with this intervention, which may actually hinder implementation of the intervention.

Routine systems

Overall, there is a consensus on the importance of routine systems, with 75% (9/12) of experts considering it to be very important. (see Figure 36)

Figure 36: The importance of routine systems as an influencing factor (Using 9-point Likert scale).



Total number of experts voting: 12

In the third round, experts argued that routine systems are essential for the long-term sustainability of complex interventions. However, they disagreed on the extent to which routine systems impacted other aspects.

During the consensus meeting, the experts reached a consensus on this factor.

However, at the same time, the experts also elaborated on scenarios that need to be considered and the problems that may be encountered.

Specifically, the experts felt that the poor quality of some routine systems prevented them from being suitably functional.

Another expert expressed a similar opinion that this factor is generally applicable. A possible impediment is that in primary health care systems, for example, if the burden on the routine system is increased excessively, this may, in turn, affect the delivery of the intervention. This is particularly the case because health care resources in countries with LMICs are often limited and have to be allocated as rationally as possible to ensure the health status of the local population as much as possible.

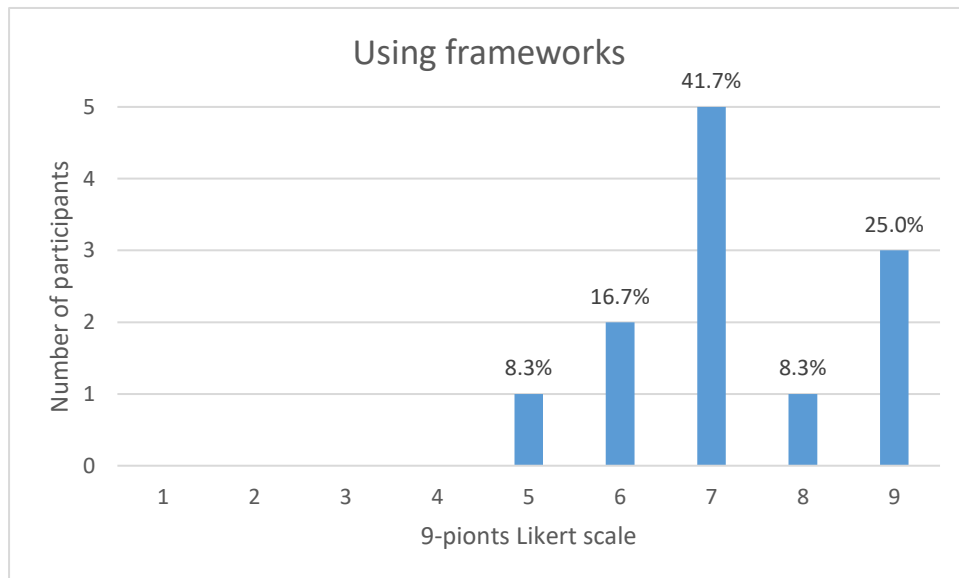
According to the expert responses, the quality of the conventional system itself and the local resources need to be considered in combination. However, there is no denying that this factor still plays an essential role in interventions. Especially in LMICs, resources have to be taken into account.

Therefore, after the discussion in the consensus meeting, the experts concluded that the factor relating to routine systems should be retained. However, more importantly, in the preliminary theoretical framework will need to establish the relationship between routine systems and local resources as well as the burden of staff and resources to be borne by the implementation project itself.

Using frameworks

Overall, experts reached consensus on this factor, with 75% (9/12) of experts considering it to be very important. (see Figure 37)

Figure 37: The importance of the influencing factor of using frameworks (Using 9-point Likert scale).



Total number of experts voting: 12

The consensus meeting achieved the intended consensus among experts on the importance of this factor. However, experts held different opinions on its exact role. While they agreed that this factor was relatively important, they also said that the theoretical framework was a matter of personal preference, and that it could be balanced by experience.

In the consensus session, the experts addressed this issue by emphasising the importance of the framework in the intervention. They stated that, while there is also the issue of personal preference, what is more important is the context in which it is applied, when and where it is applied, and how it can be adapted to the local context.

Therefore, in the planned ASaS framework, the potential differential roles of frameworks in implementation will be specified, and the scenario and timing of its application will be specified.

8.2.2 The discussion of the nine themes

For the discussion of the nine Themes and the modifications to the influencing factors, the theme most discussed by the experts was how to classify stakeholders.

Based on the comments from the experts, the stakeholders involved in complex interventions were divided into three categories, namely primary, secondary, and tertiary stakeholders.

Primary stakeholders are the direct beneficiaries such as the local community members; secondary stakeholders would include the service providers; and the tertiary stakeholders would be policy-makers, decision-makers, or funders.

Based on the categories shown above, within Theme 1, factor **1b (participant access to interventions)** changed its name to **(primary stakeholder access to interventions)**; factor 1c **(participant acceptability of interventions)** changed its name to **(primary stakeholder acceptability of interventions)**. Furthermore, experts suggested that the label for Theme 5 (Provider factors) be changed to secondary stakeholders' factors.

The new label for Theme 6 (Recipient factors) is suggested to change to primary stakeholder factors. Factor of 6a **(participant understanding and awareness)** changed its label to 6a **(Primary stakeholder understanding and awareness)**; and the factor 6c **(training and education of participants)** changed its name to 6c **(training and education of primary stakeholders)**.

Within Theme 7, as mentioned previously in relation to factor 7i, local stakeholder involvement, experts suggested that this be specified in detail, indicating which level of stakeholder it refers to. In this case, it would refer to secondary and tertiary stakeholders.

“Because in our environment, we need a kind of politician, or sometimes I have people like that, so that we involve them in making sure that this health intervention moves forward to accommodate, especially among the recipients.”

“But whenever we think about the process in the planning process, sometimes we need to get local stakeholders involved, engaged, including politicians. To ensure that the process is smooth and successful.”

In addition to the question about the classification of stakeholders, experts were asked whether Theme 8 needs to be split. Some experts felt monitoring and supervision should be divided into two separate sections. Others had a different opinion, questioning the need to separate monitoring and supervision because monitoring and supervision are integral. In fact the category combines monitoring, assessment and learning and proves to be all-encompassing.

Following discussions with experts, it was decided not to split theme 8. Instead theme 8 was discussed as a whole since in most complex interventions, monitoring and supervision are typically considered integral, often with a dedicated working group or department responsible for the process.

Regarding Theme 9, Experts suggested the need for a clearer distinction between factor 9f “regular feedback” and factor 8b “feedback mechanism” (Theme 8). Following discussion, factor 9f (regular feedback) refers to feedback to the targeted *community*. In contrast, factor 8b (feedback mechanism) refers to feedback for continuous improvement of the quality of the *project*.

8.3 The Final themes and influencing factors

Upon conclusion of the consensus meeting, a priori consensus had been achieved on

51 influencing factors. Consensus rates for these factors in the second round of the Delphi survey and the third round Delphi survey are summarised below (see Table 24).

Table 24 Final Influencing Factors Reaching the a priori Consensus

	Round 2	Round 3
Theme 1 (Context)		
1a sociopolitical context	(25/32) 78.10%	NA
1b primary stakeholders' accessibility to interventions	(29/32) 90.60%	NA
1c primary stakeholders' acceptability to interventions	(31/32) 96.90%	NA
1d available of resources	(28/32) 87.50%	NA
Theme 2 (Setting)		
2a health system	(25/31) 80.60%	NA
2b local legislation	(23/30) 76.70%	NA
2c geographical location of implementing interventions	(17/31) 54.80%	• Adaptability (15/21) 71.4% • Scalability (17/21) 80.9% • Sustainability (18/21) 85.7%
2d local culture	(28/31) 90.30%	NA
2e local social norms or regulations	(25/31) 80.60%	NA
Theme 3 (Organizational attributes)		
3a interorganizational networks	(20/31) 64.50%	• Adaptability (13/20) 65.0% • Scalability (14/20) 70.0% • Sustainability (16/20) 80.0%
3b organizational culture	(22/31) 71.00%	NA

3c organizational readiness	(27/31) 87.10%	NA
3d organizational structure	(19/31) 61.30%	• Adaptability (14/20) 70.0% • Scalability (14/20) 70.0% • Sustainability (15/20) 75.0%
3e local gatekeepers	(23/31) 74.20%	NA
3f government support	(24/31) 77.40%	NA
Theme 4 (Human resources)		
4a training and education of staff	(29/31) 93.50%	NA
4b staff turnover	(24/31) 77.40%	NA
4c capacity of staff	(28/31) 90.30%	NA
Theme 5 Provider factors (Secondary stakeholders' factors)		
5a credibility and reputation of the provider or implementer	(24/31) 77.40%	NA
5b implementer and local stakeholders sharing a common language	(27/31) 87.10%	NA
5c local stakeholders perception of the need for change	(25/31) 80.60%	NA
Theme 6 Recipient factors (Primary stakeholders' factors)		

6a Primary stakeholders' understanding and awareness	(25/31) 80.60%	NA
6b differences between individual culture	(21/31) 67.70%	• Adaptability (16/20) 80.0% • Scalability (15/20) 75.0% • Sustainability (15/20) 75.0%
6c training and education of primary stakeholders	(21/31) 67.70%	• Adaptability (16/20) 80.0% • Scalability (13/20) 65.0% • Sustainability (15/20) 75.0%
Theme 7 (Project Management processes)		
7a experience in implementing similar projects	(20/30) 66.70%	• Adaptability (12/20) 60.0% • Scalability (9/20) 45.0% • Sustainability (11/20) 55.0%
7b leadership	(28/30) 93.30%	NA
7c resource allocation	(27/30) 90.00%	NA
7d support systems or tools	(27/30) 90.00%	NA
7e integrating the intervention to existing system or projects	(24/30) 80.00%	NA
7f time constraints	(20/30) 66.70%	• Adaptability (11/20) 55.0% • Scalability (13/20) 65.0% • Sustainability (14/20) 70.0%
7g project champion	(21/30) 70.00%	NA
7h local stakeholders involvement	(27/30) 90.00%	NA
Theme 8 (Monitoring and supervision)		

8a the role of existing community structures and personnel	(18/30) 60.00%	• Adaptability (14/20) 70.0% • Scalability (14/20) 70.0% • Sustainability (15/20) 75.0%
8b feedback mechanism	(23/30) 76.70%	NA
8c actionable timelines	(22/29) 75.90%	NA
8d empowering the state and non-state actors	(20/30) 66.70%	• Adaptability (13/19) 68.4% • Scalability (16/19) 84.2% • Sustainability (16/19) 84.2%
8e local supervisor support	(23/30) 76.70%	NA
8f ongoing evaluation and reporting	(25/30) 83.30%	NA
8g the remote support from intervention developers	(17/30) 56.70%	• Adaptability (13/20) 65.0% • Scalability (11/20) 55.0% • Sustainability (11/20) 55.0%
8h routine system (feedback for continuous improvement of the quality of the project)	(19/30) 63.30%	• Adaptability (11/19) 57.9% • Scalability (13/19) 68.4% • Sustainability (14/19) 73.7%
8i training and education of staff	(22/30) 73.30%	NA
8j using frameworks	(17/29) 58.60%	• Adaptability (10/20) 50.0% • Scalability (9/20) 45.0% • Sustainability (10/20) 50.0%
Theme 9 (Embedding in communities)		
9a client advocacy	(21/27) 77.80%	NA
9b community-based organizations	(21/27) 77.80%	NA
9c community acceptance	(25/27) 92.60%	NA

9d community culture cooperation	(24/27) 88.90%	NA
9e regular feedback (feedback to the affected community)	(24/27) 88.90%	NA
9f community ownership	(23/26) 88.50%	NA
9g training community volunteers	(22/27) 81.50%	NA
9h affordable and available in target community	(20/27) 74.10%	NA
9i turnover of community key members	(21/27) 77.80%	NA

8.4 Summary

After three rounds of consensus meetings and consensus sessions, 51 influencing factors of ASaS of complex health interventions reached a priori consensus and three did not. The final list of influencing factors (including those that did not reach a priori consensus) was disseminated to the entirety of the expert panel, comprising individuals who had completed all or a portion of the surveys (n=62). This communication was accompanied by an expression of gratitude for their valuable contributions to the research. The next chapter will further explore the resulting data and generate a preliminary theoretical model to describe these influencing factors.

Chapter 9 Overall Delphi survey results

9.1 Introduction

Chapter 9 meticulously collates and presents the overarching results derived from the comprehensive Delphi survey process, encapsulating three rounds of iterative expert feedback. It lays the empirical groundwork necessary for constructing the METRO framework by systematically analyzing and summarizing expert insights.

This study explored multiple influencing factors in a literature review that covered multiple dimensions. Initially, the study was inspired by the MRC framework, which consists of four stages: develop intervention/identity intervention, feasibility, evaluation, and implementation. In this context, the study introduced three key concepts: adaptability, scalability and sustainability. **Adaptability** is closely related to “Develop intervention/identity intervention”, **Scalability** is related to the “feasibility” stage, and **Sustainability** is very relevant to subsequent “implementation”. With this in mind, the next step was to explore other frameworks to examine the extent to which they had incorporated these three stages.

A systematic review explored other frameworks such as the EPIS framework and the CFIR framework. It found that these frameworks mentioned all three ASaS concepts. However, the review suggested to date no existing theoretical framework can fully explain the interrelationships among these three concepts. Therefore, the primary task of the study was to further explore the association between these three ASaS concepts.

In addition, the study aims to explore factors that influence the three ASaS concepts. Although many frameworks describe factors that affect one or two of the three concepts, no theoretical framework has comprehensively described all the factors that affect the three concepts. In summary, while existing frameworks partially cover the ASaS concepts, further research and synthesis is needed to develop a comprehensive

theoretical framework.

Therefore, this study collects, analyzes and summarizes the factors affecting the three ASaS concepts through two reviews as well as a Delphi survey. The ASaS framework (now conceived as the METRO framework) is described in detail in the next section. Additionally, this chapter further explores challenges encountered during the Delphi research process as well as the consensus meeting. The chapter also reflects on limitations associated with the research design and its execution.

Finally, similarities and differences between the framework developed in this research and other related theoretical frameworks are also discussed. In addition, future applications of this theoretical framework are discussed.

9.2 Summary of the findings from the Delphi survey and consensus meeting

After three rounds of Delphi survey and one round of consensus meeting, 9 themes and 51 influencing factors were obtained. Furthermore, the relationship among these influencing factors is not simply linear, but interactive and non-linear.

In the Delphi survey process, it was observed that the least number of barriers to consensus were encountered in Themes 1, 2, 4, 5, and 9. The vast majority of the influencing factors contained in these Themes were already agreed upon in the second round of the Delphi questionnaire. They therefore did not require further discussion in the third round of Delphi survey and consensus meeting.

More specifically, many of the factors mentioned within these themes have been previously documented and substantiated in diverse literature sources, such as sociopolitical context, available resources, organizational structure, interorganizational networks, and so on. In Theme 9 (Embedding in Communities),

different studies consistently underscores the role of communities, and this study primarily offers a more detailed description of the factors encompassed within this theme.

The main influencing factors requiring discussion centred on Themes 3, 6, 7, and 8. The influencing factors contained in these themes remained moderately controversial following completion of the three rounds of the Delphi survey, and required further in-depth discussion and research in order to achieve a more comprehensive consensus.

Regarding some factors within Theme 3, experts held differing perspectives. For instance, initially, the researcher consolidated the culture factor with social norms or regulations into one. However, some experts argued that this was inappropriate because culture was closely associated with religion and local traditional customs, while social norms or regulations pertained to universal values and governance regulations in the intervention areas. Consequently, these two factors were subsequently separated.

The names of Theme 6 (Primary stakeholders' factors) and Theme 7 (Secondary stakeholders' factors) have been modified because this study further differentiates and defines stakeholders to enhance reader comprehension. Specifically, this study changed the previous "recipient factors" to "Primary stakeholders' factors" and "provider factors" to "Secondary stakeholders' factors" to minimize the potential for confusion resulting from inappropriate terminology for readers and users.

As a result, the final obtained themes and factors are:

- **Theme 1 (Project Management processes)**
 - 1a Experience of implementing similar complex interventions by those implementing interventions;
 - 1b leadership;

- 1c local stakeholders involvement;
- 1d integrating the intervention to existing system or projects;
- 1e support systems or tools;
- 1f project champion;
- 1g time constraints;
- 1h resource allocation;

Theme 2 (Context)

- 2a sociopolitical context;
- 2b availability of resources;
- 2c primary stakeholders' accessibility to interventions;
- 2d primary stakeholders' acceptability to interventions;

Theme 3 (Setting)

- 3a geographical location of intervention implementation;
- 3b health system;
- 3c local legislation;
- 3d local social norms or regulations;
- 3e local culture;

Theme 4 (Organizational attributes)

- 4a organizational readiness;
- 4b organizational culture;
- 4c organizational structure;
- 4d interorganizational networks;
- 4e local gatekeepers;
- 4f government support;

Theme 5 (Human resources)

5a training and education of staff;

5b capacity of staff;

5c staff turnover;

Theme 6 (Primary stakeholders' factors)

6a Primary stakeholders' understanding and awareness;

6b training and education of primary stakeholders;

6c differences between individual culture;

Theme 7 (Secondary stakeholders' factors)

7a local stakeholders perception of the need for change;

7b implementer and local stakeholders sharing a common language;

7c credibility and reputation of the provider or implementer;

Theme 8 (Monitoring and supervision)

8a the role of existing community structures and personnel;

8b training and education of staff;

8c empowering the state and non-state actors;

8d routine system (feedback for continuous improvement of the quality of the project);

8e ongoing evaluation and reporting;

8f feedback mechanism;

8g local supervisor support;

8h the technical remote support from intervention developers;

8i actionable timelines;

8j using frameworks;

Theme 9 (Embedding in communities)

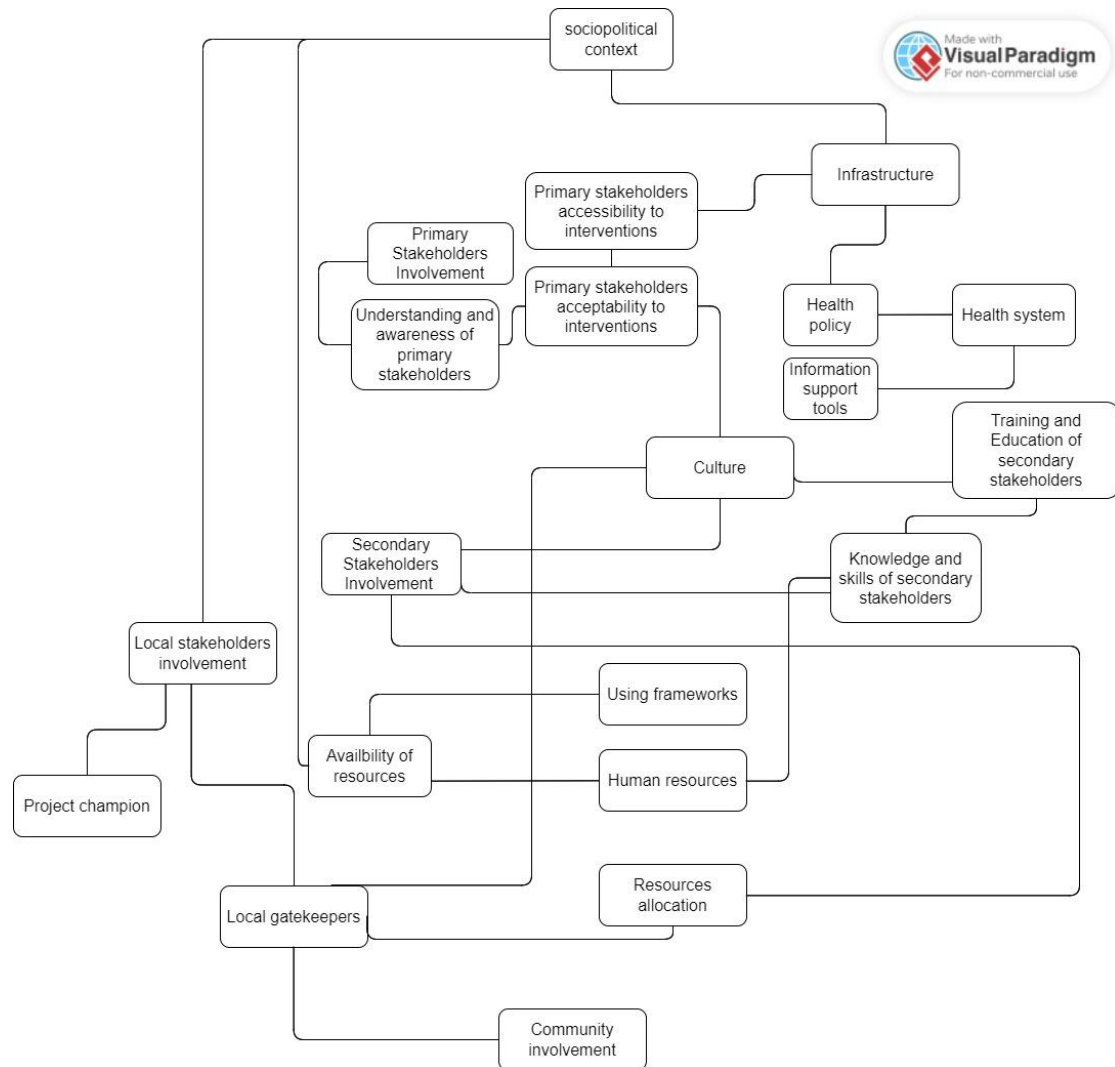
9a community-based organizations;

- 9b community acceptance;
- 9c community ownership;
- 9d client advocacy;
- 9e training community volunteers;
- 9f affordable and available in target community;
- 9g community culture cooperation;
- 9h turnover of community key members;
- 9i regular feedback (feedback to the affected community).

The following section describes the linkages between the factors in terms of adaptability, scalability and sustainability. First, it is important to note that all of the factors mentioned are linked to each other, with different degrees of strength. All the linkages mentioned below are ones that experts have specifically emphasized as having a direct linkage. In addition, it is also important to note that funding plays a role in all of the influencing factors on complex health interventions, so is not specifically illustrated in the figure 38.

Linkages among factors in the Adaptability phase

Figure 38: Linkages among factors in the Adaptability phase



Links were primarily established based on the expressions, summaries, analyses, and collections from the questions of free-text responses provided by experts across the three rounds of the Delphi survey.

First, the accessibility of interventions to primary stakeholders is constrained by multiple factors, of which the condition of local infrastructure is a major constraint. For example, as Canada researcher mentioned in the Delphi survey, good road conditions and available public transportation systems can help make health interventions accessible to primary stakeholders.

According to a university researcher from Canada, without basic infrastructure, health interventions cannot even begin. Another researcher from Kenya highlighted that the state of infrastructure is influenced by the socio-political context, noting that regions with stable socio-political climates and strong economies have better infrastructure.

At the same time, the state of the infrastructure also influences health policymaking, as policymakers tailor health policy to the condition of the local infrastructure. A policymaker from Mexico emphasized that it is essential to consider existing infrastructure when designing health policies, focusing not only on the health services to be provided but also on what is feasible given the infrastructure.

Furthermore, experts delved into the complex interplay between health policy and the health system, underscoring how policies serve as the blueprint for health systems, influencing their structure, efficiency, and capacity to deliver care. A university researcher from Nigeria pointed out the lack of policy support, such as the absence of a service package describing the elements of HIV and PHC services that needed to be integrated during the implementation of HIV services within PHC in Nigeria.

Thus, there is a strong correlation between infrastructure, health policy, and health systems. Health policy relates to the health system, and the state of infrastructure affects the formulation and implementation of health policy. Together, these factors influence the accessibility and effectiveness of health interventions by primary stakeholders.

In addition, primary stakeholder accessibility to interventions and the acceptability of interventions to primary stakeholders generally influence each other. In Nigeria, due to transportation limitations, individuals in some remote areas are often unaware of their opportunities to receive medical assistance. Acceptability of interventions is

related to the level of understanding that primary stakeholders have of the interventions. In general, primary stakeholders will accept the implementation of interventions if they have a deeper understanding of the intervention.

As noted by a university researcher from Nigeria, people's general awareness of their health needs and the potential health benefits they stand to gain will influence the acceptability of the health intervention. The level of understanding and awareness, in turn, is often closely related to the local level of education. According to a researcher from China, it is necessary to consider the education level of local residents and their cultural values or beliefs.

Typically, in areas with higher levels of education, local residents also have a higher level of understanding of the intervention. They are therefore likely to accept the implementation of the intervention locally. These factors are intertwined and together influence the level of participation and acceptance of the intervention by primary stakeholders.

In addition, the acceptability of the intervention to the primary stakeholders is also influenced by culture. For example, experts mentioned that in Nigeria, women in some areas are culturally influenced and can only participate in the intervention program with the permission of their husbands. Culture plays a very important role in the adaptation of the intervention and is strongly linked to many other factors such as the sociopolitical context.

Secondary stakeholders need to take into account the influence of the local culture when intervening in the intervention. It is also necessary to emphasize the need to pay attention to the impact of the local culture when training secondary stakeholders, and to carry out interventions under the premise of respecting the local culture, so as to reduce the resistance encountered by the intervention in the process of adapting to it.

As noted by a researcher from Malaysia, understanding and respecting local culture is not just a courtesy; it's a strategic element of successful interventions.

Additionally, it is crucial to respect local culture during the training of health care workers. The availability of skilled manpower is crucial for the success of the intervention, as emphasized by a university researcher from Nigeria. The movement of materials, drugs, and even human resources entails adequate logistics planning, as noted by a policy maker from the UK.

Another factor, closely related to the others, is the availability of resources. The availability of local resources is influenced by the local socio-political context. Where the local economic situation is better, available medical and human resources tend to be plentiful. However, in many low-income countries, medical and human resources are relatively limited. Therefore, it has been suggested that where resources are limited, there is a greater need to optimize the available resources. The application of frameworks can help in optimizing the use of resources.

According to a researcher from South Africa, the staff number and level of training can also pose challenges to the uptake of interventions. A reduced number of staff implies adding more tasks to existing staff when a new intervention has to be introduced, and non-experienced staff necessitates training as a priority prior to implementing the intervention.

Particularly in terms of human resources, healthcare workers with a high degree of professional knowledge and skills are essential for effective utilization of resources. These healthcare workers can better utilize the resources and improve the efficiency and quality of healthcare services. Therefore, fully utilizing healthcare resources, especially relying on healthcare practitioners with professional knowledge and competence, is important to effectively address the challenge of limited resources.

This is also closely related to the application of a framework, which helps guide how to maximize the use of limited resources to support the implementation of interventions.

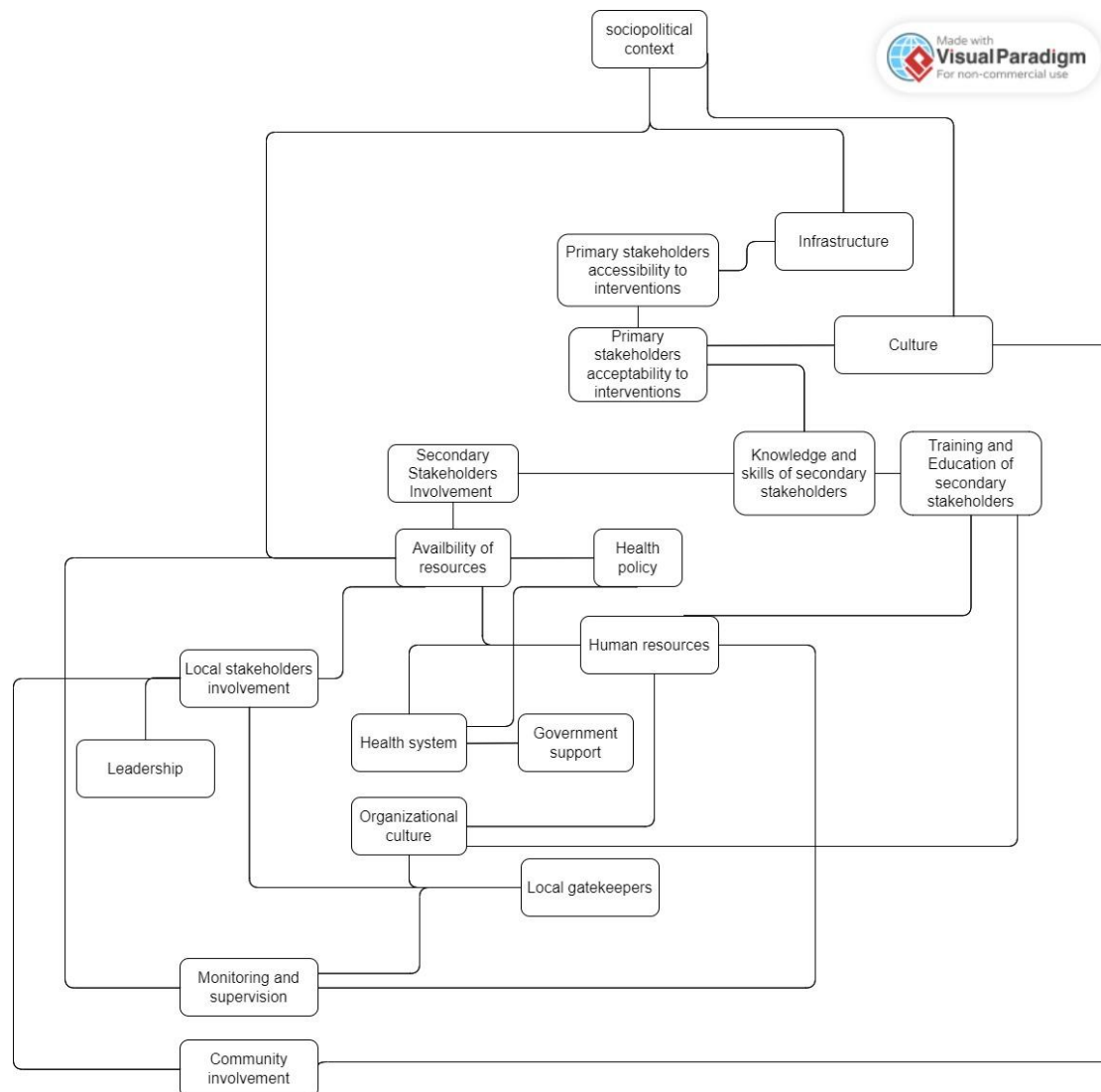
Finally, two other factors are widely implicated: the involvement of local stakeholders and the local gatekeeper. The two are closely related. Local gatekeepers are usually knowledgeable about the local cultural and social environment. Their assistance helps to ensure that the intervention is better integrated into the local environment. Local gatekeepers have strong ties to the local community and can assist the researcher in gaining a deeper understanding of the community, which can help the intervention adapt in the community.

A university researcher from China suggested that the optimal approach would involve engaging communities and local gatekeepers prior to the trial's formulation, enabling them to determine their own priorities. These priorities could then serve as the foundation for crafting the intervention.

In turn, local stakeholders, including local gatekeepers, tend to better adapt the intervention to the local environment when under the strong leadership of the project champion. In this process, the leadership of the project champion is critical in coordinating collaboration, motivating team members, and ensuring the success of the intervention on the ground. Complex health interventions are thus often better adapted and integrated into the local culture when local stakeholders and local gatekeepers are coordinated by strong leadership from the project champion.

Linkages among factors in the Scalability phase

Figure 39: Linkages among factors in the Scalability phase



Similar to the adaptability phase, experts emphasized the need for the intervention to be accessible to primary stakeholders during the scalability phase. This factor is influenced by infrastructure.

A university researcher from South Africa highlighted the importance of access roads and communication methods to contact participants. Typically, interventions are scalable in areas with better infrastructure. Good road conditions, public

transportation, and other infrastructure can increase the reach and efficiency of an intervention and reduce wasted resources. For instance, in West Africa, poor road conditions in some areas result in medications taking weeks to be delivered to designated regions, as noted by a researcher from Nigeria.

However, it is important to note that the state of infrastructure is often influenced by the socio-political context. Generally, areas with better economic conditions usually have better infrastructure, while economically challenged areas may have relatively weak infrastructure. This further affects the scalability of interventions. A researcher from China pointed out that socio-economic development levels and health beliefs often impact the acceptability and engagement in the program.

Moreover, favorable economic conditions lead to better infrastructure, which in turn makes it easier for participants to access interventions. Consequently, accessibility is closely linked to the primary stakeholders' acceptability of intervention measures. If participants do not have easy access to the intervention, their acceptability of the intervention will also be affected. The multicultural nature of Nigeria necessitates considering how each cultural setting will accept the intervention, as noted by a Nigerian researcher.

Similar to the adaptability stage, the acceptability of the intervention to primary stakeholders in the scalability stage can also be affected by cultural factors. Experts cited how a salt intake study in China factored in the fact that adults would often listen to children. Therefore, local scaling up of this particular intervention could be successful if children are targeted with effective sensitization and education.

In addition, the acceptability of the intervention by the primary stakeholders is also influenced by the secondary stakeholders. The professional competence and knowledge of health workers play an important role. While secondary stakeholders

with sufficient capacity are better able to contribute to the scaling up of interventions, experts note that in low-income countries and territories (LMICs), secondary stakeholders often face shortages and lack of capacity. For example, a researcher from Ghana emphasized the critical nature of having staff with the required skills for scaling up interventions. If there are staff without the required skills, they can be trained, but if there are no staff, the Ministry of Health may need to recruit new staff, which can be complex due to funding issues.

In many LMICs, health workers are underrepresented and lack sufficient expertise and skills to effectively scale up interventions. To address this problem, training and education need to be provided to increase the capacity of secondary stakeholders. These training and education programs can help them better understand the rationale and goals of the intervention and participate effectively in the scale-up process.

Availability of resources also has numerous linkages with other factors. First, policy preferences determine access to resources. Experts reflected that government policies can affect the distribution of resources on the ground. The implementation of some policies may encourage resources to be invested in intervention programs, thus affecting the expansion of interventions.

In the scalability phase, unlike the adaptability phase, experts also emphasized the role of organizational culture. When the organizational culture encourages cooperation, collaboration, and resource sharing, coordination and implementation within the organization may be enhanced, and in turn, medical and human resources are deployed and utilized appropriately. Experts highlight a crucial gap in strategies for effectively maintaining oversight without direct involvement, suggesting the need for innovative approaches to balance effective monitoring with respect for community autonomy.

A researcher from Canada mentioned the difficulty of long-term monitoring, as the research team will no longer be actively involved. Without the presence of the research team, monitoring can be seen as meddling, and more work needs to be done on determining effective monitoring methods.

In the scale-up phase, similar to the adaptability phase, monitoring and surveillance are affected by several factors. First, a shortage of human resources can directly affect the quality of monitoring and surveillance. When there is a shortage of manpower, it is difficult to monitor and supervise effectively, which may result in problems not being identified and resolved in a timely manner, thus affecting the effectiveness and sustainability of the intervention.

In addition, local gatekeepers play an important role in the monitoring process. Due to their in-depth knowledge of the local context, they can take on some of the monitoring responsibilities, especially after the researcher's departure, helping to ensure ongoing monitoring and maintaining the quality and effectiveness of the intervention. According to a UK researcher, the human aspect and the relationship between researchers and stakeholders are crucial. If the relationship is strong, the project can go well, but if not, it can be disastrous.

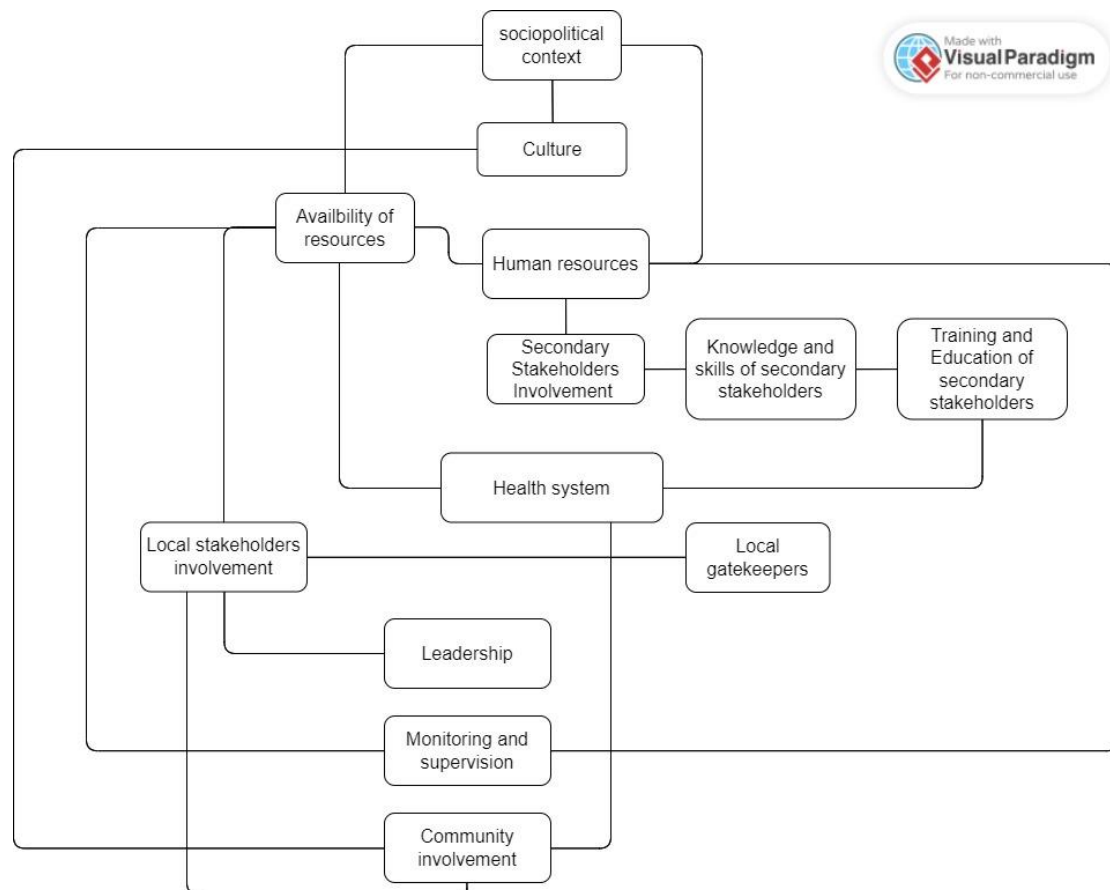
Likewise, as in the adaptability phase, the involvement of local stakeholders is influenced by the leadership of the leader and project champion. A strong leader is often better able to coordinate collaboration, facilitate monitoring and oversight activities, and promote the expansion and sustainability of the intervention. A researcher from Qatar noted that the input of local stakeholders is very important as it indicates the level of local collaboration and support the project may receive.

As for the last mentioned factor of community, both local culture and local stakeholders impact it. Local stakeholders understand the local situation and have a

deep connection with the local community.

Linkages among factors in the Sustainability phase

Figure 40: Linkages among factors in the Sustainability phase



Unlike for adaptability and scalability, when discussing sustainability, the experts did not explicitly mention the link between the primary stakeholders' accessibility and acceptability of the intervention and other factors. This may be because, in the sustainability stage, having already proceeded through adaptation and scaling up, issues of primary stakeholders' accessibility and acceptability of the intervention have already been adequately taken into account and measures have been taken to address these issues.

A university researcher from Canada suggested that cultural fit and availability of

resources and support are critical for sustainability. In the sustainability phase, as for adaptability, cultural factors remain broadly and directly linked to other factors. First, culture is profoundly influenced by the socio-political context. In general, culture is likely to be less resistant to interventions in economically privileged areas. Affluent societies are usually receptive to new ideas and practices, whereas cultures in poorer areas may be conservative and skeptical of change. Culture is also influenced by a variety of factors, such as level of education, religious beliefs, and historical traditions, which can significantly affect the acceptance of interventions by the local population.

Another factor closely linked to the others was the availability of resources, particularly human resources, especially healthcare providers. Experts emphasized the importance of readily available structures like good roads, health centers, and trained healthcare workers in ensuring sustainability. Secondary stakeholders are influenced by their knowledge and skills. Generally, health workers with good knowledge and skills are better able to contribute to the long-term continuation of the intervention on the ground. Conversely, interventions are difficult to sustain if professional capacity is inadequate. It was noted that the fewer training or retraining requirements of the implementers, the more likely it is to sustain the intervention.

Similar to the scalability component, in low- and middle-income countries (LMICs), local health workers are often too busy or ill-equipped to effectively deliver interventions, and therefore need to be trained and educated to enhance their role in the implementation of interventions. A university researcher from Nigeria highlighted that policies help create budget lines and emphasized the need to draft and craft policies around the project rather than making the project donor-driven.

In addition, available resources are closely linked to the health system. Local resources are also relevant to monitoring and surveillance, which will be difficult to sustain if medical and human resources are scarce. The general educational level of the

community members is a significant facilitator, while high illiteracy levels can lead to myths and misconceptions that easily affect the project.

In addition, similar to the scalability component, community participation is influenced by cultural factors. If the intervention design is well adapted to the culture of the community, the likelihood that the intervention will take place in the community is higher. Availability of resources is also a key factor in sustainability. Complex health interventions are likely to be sustained in resource-rich areas. Experts noted that if communities can provide timely data feedback to the health system, this can also help guarantee the sustainability of the intervention. Finally, as mentioned for the scalability phase, interventions are likely to be sustained locally when there is a deep understanding of the local context by local stakeholders. Together, these factors influence the success and sustainability of the intervention.

Differences and similarities in linkages between factors at different stages of the complex interventions process

Factors associated with primary stakeholders and the links between these factors were mentioned in both the adaptability and scalability phases of complex health interventions. However, in the sustainability phase, experts did not specifically emphasize linkages between these factors. Issues that primary stakeholders mainly need to address may have already been addressed in the adaptation and scalability phases and so no longer represent the main conflicts to be addressed in the intervention process.

Linkages between monitoring and supervision of interventions and community participation and other factors were mentioned much in the adaptability phase, despite having received focused attention in the scalability and sustainability phases. This difference can be explained by the fact that experts perceive these two factors to play a major role mainly in the scalability and sustainability phases, and therefore

there are direct and broader linkages between these two phases and other factors. The role of finance, on the other hand, affects all of these factors and is therefore considered a universal factor that cuts across the different phases.

It may be concluded that the adaptive phase of interventions is often small-scale and therefore subject to relatively fewer constraints in terms of staff, resources and funding. However, in the scalability and sustainability phases, especially for low- and middle-income countries, human and financial resources pose a challenge for long-term interventions. Implementers of interventions therefore need to carefully consider how to address these issues before implementing the intervention.

9.3 Observations on the collected data

Changes in consensus rates

For each round, the consensus rate gradually increased round by round. In the second round, 12 influencing factors did not reach the consensus. In the third round, the consensus rate for the 12 factors that didn't reach consensus in the second round increased, with 7 factors reaching 65% or more, meeting the consensus criteria set for the third round. For the remaining five influencing factors, consensus was also reached in the consensus meeting.

Assessment of inputs from experts from HICs and experts from LMICs

In the first round of the Delphi questionnaire, experts from LMICs and HICs proposed a total of 54 factors, but with slightly different emphases. As an example, Recipient factors (primary stakeholders) are factors that are emphasised by experts from LIMCs, and in Theme 8, both groups of experts mentioned different influencing factors. In Theme 9, most influential factors were suggested by the experts from the LMICs group.

In the second round of the Delphi questionnaire, 23 experts from Low- and Middle-Income Countries (LMICs) and 11 experts from High-Income Countries (HICs)

participated. However, in this round, notable differences persisted in the ratings of influencing factors between the two groups of experts. Specifically, experts from HICs tended to give slightly higher scores compared to those from LMICs. Across 81 questions, rated on a 9-point Likert scale, a total of 31 questions in the HICs expert group had an average score below 7, whereas in the LMICs expert group, only 5 questions had an average score below 7. Furthermore, in terms of consensus rates, 29 questions did not reach consensus among the HICs expert group, while the LMICs expert group had 8 questions without consensus.

The reason for the reduction in scoring discrepancies can be attributed to several factors. The Delphi process provided experts with analyses and feedback from previous rounds, helping them understand how their opinions influenced overall trends and the formation of consensus. This likely motivated them to evaluate and consider factors more systematically. Additionally, refinements made to question explanations based on expert feedback ensured accurate conveyance of research objectives, reducing misunderstandings and scoring disparities. Repeated review and scoring of questions prompted experts to focus on significant factors, minimizing arbitrariness and unnecessary differences.

As the questionnaire progressed, experts likely experienced enhancements in their understanding and cognitive clarity concerning the questions. Initial disparities in scoring might have stemmed from misunderstandings in question formulation or interpretation. Overall, the experts did not raise many concerns about this issue. For example, In the second-round questionnaire, researchers did not provide examples to explain the factor of "empowering state and non-state actors," which may have led to varying degrees of misunderstanding among experts from high-income countries (HICs) and low- and middle-income countries (LMICs). Without clear examples, experts likely interpreted this factor based on their own backgrounds and experiences, causing discrepancies in their scoring and feedback. In accordance with the questionnaire, HIC

experts focused on governance and policy implementation, while LMIC experts emphasized grassroots and NGO involvement. The lack of unified explanations resulted in differing assumptions and standards, contributing to the observed disparities. The researcher provided the definition and related examples of this factor in the feedback email. Finally, this factor reached consensus in the third round of Delphi survey. Additionally, for the factor of "time constraints," some experts were confused about what specific time limitations were being referred to. Similarly, the researcher clarified in the feedback emails that it referred to the time constraints related to the implementation of complex health interventions.

However, as experts gained clearer insights into the questions, these discrepancies diminished. Consequently, the observed reduction in disparities is likely due to the inherent effects of the Delphi process itself, including information sharing, discussion, and gradual convergence towards consensus. By the third round, the scoring disparities between the two subgroups had significantly decreased, resulting in minimal differences.

9.4 Summary

Through a literature review and Delphi survey, the study identified and assessed 51 influencing factors. This process reflects the combination of qualitative and quantitative research methods, resulting in the construction of the METRO framework, which is practical and comprehensive, providing strong support for the implementation of complex health interventions.

Chapter 10 The final framework

In Chapter 10, the focus shifts towards the unveiling of the Managing the Environment for Transferability, Relationships and Outcomes (METRO) framework, a synthesis of the rigorous Delphi survey findings. This chapter is dedicated to articulating the structure, components, and utility of the METRO framework, reflecting the convergence of expert consensus into a cohesive model designed to guide the implementation of complex health interventions in LMICs. It serves as the thesis's capstone, translating the empirical data and expert insights into a practical and theoretical tool for researchers, policymakers, and practitioners.

10.1 introduction to METRO framework

Based on systematic reviews, Delphi surveys, and consensus meetings, these nine themes and factors were further reorganized and eventually developed into the current METRO framework to describe these factors.

As shown below, the theoretical framework of ASaS, henceforth called the “METRO framework”, is analogous to an underground route map. It is divided into two main routes, the inner and outer rings.

The Development process of METRO framework

The development of the METRO framework was a collaborative effort, grounded in the outcomes of two systematic reviews, alongside the Delphi survey and consensus meetings. This process involved not only endeavours of the researcher but also the collective efforts of numerous experts and mentors. Initially, after identifying research gaps and the absence of suitable Theoretical Models and Frameworks (TMFs) from the reviews, I embarked on the journey of constructing a framework. Before building this framework, it was essential to gather the building blocks – the factors influencing Adaptability, Scalability, and Sustainability (ASaS). This task was beyond the scope of a solo effort; the factors identified in the reviews served merely as a starting point, as

they influenced one or a few concepts, but not all three comprehensively.

To better collect and validate the factors impacting ASaS, the researcher employed Delphi surveys and consensus meetings. Their contributions were pivotal, essentially laying down the foundational components of the METRO framework by identifying critical influencing factors. These factors, deemed relevant, were slated for further examination.

With the foundational information in place, the moment to construct the model arrived. Several core principles guided this construction process: the model needed to be non-linear, implying that the progression from adaptability to scalability to sustainability was not linear but could follow various paths, while still considering the basic steps of intervention.

Hence, the intervention process, despite being non-linear, adhered to a certain sequence, echoing sentiments found in the EPIS framework and other existing TMFs. This consideration was pivotal in establishing the basic procedural flow of the study.

Integrating the flow with the factors presented a challenge due to the relevance of these factors across all ASaS concepts, albeit with slight variations in emphasis. Thus, in the design phase, it became necessary to highlight the relationship between certain factors and specific concepts or stages more strongly.

This led to several key requirements for the model: a comprehensive set of factors, a non-linear relationship, clear delineation of the intervention process, and the prioritized relationship between certain factors and concepts.

These elements reminded the researcher of the subway system that he normally rides. Whenever someone takes the Tube in London, he needs to change at different Tube

stations, and although the final destination is the same, in the process he can choose different routes as needed to avoid the rush hour crowds. In addition, by simply switching directions within a subway station, he can change the direction of travel so that the end station becomes the new starting station. These situations evoke the processes associated with implementing complex interventions.

Progress starts from the initial conceptualization and design of the intervention (i.e., the inception phase) as the starting station. Once the intervention design is complete, it goes through the initial adaptation and expansion of two staging stations.

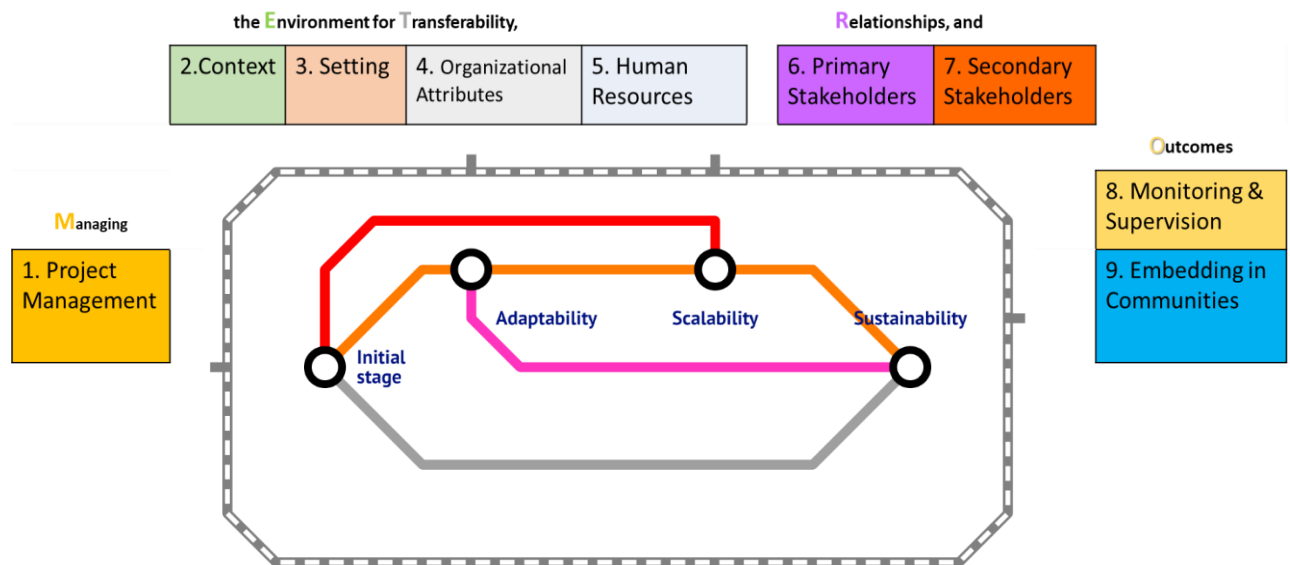
Finally, ongoing implementation of the intervention becomes the terminal station, where the implementer can choose the path to be taken during the intervention based on their preferences and needs, much like choosing a subway line. This analogy helps to better understand the nonlinear nature of complex interventions.

In seeking to organise the factors affecting adaptability, scalability and sustainability of complex health interventions, after several attempts to formulate them, it occurred to me that resources need to be rationally deployed during the intervention process, or you could say during the operation of the METRO. Each METRO station requires different types and amounts of resources, such as power, energy, personnel, etc. Similarly, the process of complex interventions requires resource support from various sources. The factors we have identified influence the whole intervention process, but have different impacts and different degrees of effect on each stage. Thus, we can analogize these factors to the resources required for a subway; just as different stations require varying proportions of resources, so too different factors exhibit different degrees of impact at different intervention stages. This analogy helps us to better understand how these influencing factors work.

Ultimately, a metro map emerged as an apt metaphor due to its representation of

numerous non-linear routes, encompassing a wide array of information (factors) and the distinct allocation of resources at each station. This analogy inspired the naming of our theoretical model – the METRO framework, symbolizing the model’s capability to navigate the complex pathways of health interventions. (see Figure 41)

Figure 41: METRO Framework



Managing the Environment for Transferability, Relationships and Outcomes (METRO)

In the inner loop, the framework involves three key concepts: Adaptability, Scalability and Sustainability. These three concepts correspond to the three main phases of intervention implementation, the Adaptability phase, the Scalability phase and the Sustainability phase.

In the outer loop, the METRO framework describes the factors that influence the three ASaS concepts and the complex intervention process. To further illustrate this, the factors affecting each phase are likened to four material supply sites that influence the smooth implementation of the intervention. The first entity is closest to the initial phase station, the second entity is closest to the adaptive station, and the scalability station, and the third entity is closest to the continuity station. The distance of the

material site from the METRO station represents the amount of influence it has on the intervention process.

The “METRO framework” allows researchers to understand the implementation process of complex interventions systematically, taking into account key factors such as adaptability, scalability and continuity, thus providing theoretical support and guidance for the development and implementation of intervention programs. Such a framework facilitates the effective planning and implementation of interventions in complex intervention environments to achieve desired outcomes and goals.

The first entity (Managing) contains

- Theme 1 (Project management processes)

The second entity (Environment for transferability) contains

- Theme 2 (Context)
- Theme 3 (Setting)
- Theme 4 (Organizational attributes)
- Theme 5 (Human resources)
- Theme 6 (Primary stakeholders’ factors)
- Theme 7 (Secondary stakeholders’ factors)

The third entity (Outcomes) contains

- Theme 8 (Monitoring and supervision)
- Theme 9 (Embedding in communities)

In the following section, the inner ring and outer ring in the METRO framework and the contents contained in them are introduced in detail, and the relationship between the inner ring and outer ring is also introduced. The reason for starting with the inner ring is that the inner ring is closely related to the implementation process of complex

interventions, which can facilitate the researcher to better understand the main processes and key points in the implementation process of the intervention. Then the outer ring will be introduced. The outer ring contains a series of factors that have been obtained from two reviews and the Delphi survey, and the extent to which these factors affect the different phases of the intervention varies. Therefore, introducing the inner ring followed by the introduction of the outer ring will allow the reader to understand the main processes of the intervention before further introducing the reader to the main factors that influence each process of the intervention and the relationship between these factors.

10.1.1 Introduction to the inner ring

Overall, this theoretical framework describes complex interventions from the initial phase to the adaptive phase of the intervention to the expansion phase of the intervention and finally to the continuation phase of the intervention.

Implementation of complex interventions comprises three key processes from the inception of the intervention to the subsequent continuation of the intervention, which are closely linked and interact with each other, constituting the overall structure of the theoretical model of complex interventions. First, the adaptation phase of the intervention requires flexibility to adapt to different situations at the beginning of the intervention practice. In this phase, the implementers are required to fully understand and adapt to the target group, the intervention strategy, and the intervention context to ensure the effectiveness of the intervention.

This is followed by the expansion phase of the intervention. After the initial success of the adaptation phase of the intervention, the intervention often needs to be scaled up to cover a wider audience group or a comprehensive intervention programme[310]. Interventionists need to collect data and feedback in practice, building on prior experience to achieve optimal outcomes while avoiding unnecessary conflict and

disruption.

Finally, there is the sustainability phase of the intervention. During this phase, interveners need to continually track the effects of the intervention, assess its long-term impact, and make adjustments as needed[17]. The sustainment phase is often key to the entire intervention process as it relates to the sustainability and long-term success of the intervention. Interventionists need to maintain close collaboration with the audience to gather feedback and ensure effective implementation of the intervention.

Just as the METRO has multiple routes to reach the endpoint, the routes for the implementation of complex interventions are not fixed from the starting “station” to the intervention's adaptation of this interchange, to the intervention's extension of this interchange, and finally to the intervention's continuation of this endpoint, but rather, there are multiple routes.

In the case of the inner ring, the theoretical model depicts four main routes for the complex intervention that lead to different endpoints of the intervention implementation:

1. Orange Line: from the starting station of the intervention to the adaptability interchange, to the scalability interchange, and finally to the sustainability terminal station. This represents a common complex intervention model with a complete implementation process. (The EPIS framework, and MRC framework support this[17, 28])
2. the Grey Line: proceeds directly from the start of the intervention to the sustainability terminus, which is common where mature interventions are used and there is practical experience in similar areas. (e.g. The intervention moved directly to the sustainability phase because the CCM is a well-established model with significant

practical experience in managing chronic diseases.[311])

3. From Orange Line to Pink Line: from the starting station to the adaptability interchange, and then to the sustainability terminus. This is mostly seen in the phase of small-scale experiments.(e.g. The NASSS framework support this[108]).

4. From Red Line to Orange Line: from the intervention's starting station to the scalability interchange and then to the sustainability terminus. This scenario occurs mostly in the phase of interventions where a small-scale feasibility validation has been completed and a large-scale experiment is planned. (The Framework for Spread developed by the Institute for Healthcare Improvement (IHI) demonstrates how mature interventions can be scaled quickly to achieve sustainability by leveraging previous success and established practices[312].)

The implementation of complex interventions is therefore similar to travel planning in a complex METRO network. Interveners have the flexibility to choose their routes in different situations according to their needs and to adjust their strategies at any time in order to achieve the desired long-term outcomes.

10.1.2 Introduction to the outer ring

Just as METRO transport managers need to consider the resources that are most needed at each station, researchers need to focus on the impact of different influencing factors on different intervention stages when referring to complex implementing interventions routes.

As mentioned earlier, the process of implementing interventions is influenced by factors within a total of nine themes (themes) that all have a significant impact on the overall intervention process.

In the intervention "METRO framework" shown in the figure, the distance of each material site (that is, each THEME) relative to a particular METRO site (that is, INITIAL

STAGE, ADAPTABILITY, SCALABILITY, and SUSTAINABILITY)

In the figure, the closer the entity (theme) is to the METRO site (concept), the more direct and potentially influential the entity (theme) is to the METRO site (concept). However, this does not mean that the entity (theme) has no influence on other METRO stations (concepts). As the "METRO Map" shows, the Outer Ring is interconnected, and these entities impact on all METRO sites, just to varying degrees.

10.1.3 Order of Themes

The nine Themes are sequenced according to the process logic of complex intervention implementation, regarding expert responses and recommendations.

When designing a complex health intervention, the project management processes (Theme 1) will be taken into account.

In the adaptability phase and scalability phase of the intervention it progressively covers the foundational elements of the intervention such as context, setting, organisational attributes, and human resources. The context provides the background information for intervention implementation, the intervention setting is concerned with the design and planning of the intervention, the organisational attributes and human resources are concerned with the institutional and human capacity for intervention implementation, and the involvement of stakeholders is critical to the success of the intervention.

Also, the relationships among stakeholders and complex health interventions are needed to be considered, which includes primary and secondary stakeholder factors. In this phase, the efficient operation of the project management process and the effective implementation of monitoring and supervision play an important role in the scaling up and effectiveness of the intervention.

In the sustainability phase of the intervention, it mainly influenced by the factors associated with the outcome of the complex intervention (Outcomes) including monitoring and supervision, and embedding the intervention in the community.

Community embedding refers to the process of integrating the intervention into the local community and receiving support from the community, which is crucial for the long-term sustainability of the intervention. At the same time, sustainability and impact of the intervention is considered to ensure that the intervention has a lasting impact and benefit in the long term.

Such a logical sequence and thematic ordering helps to systematically understand the various key elements of the implementation process of a complex intervention and enables the impact of the themes to be considered and responded to in a targeted manner at different stages. By integrating these elements, interveners are able to formulate strategies and measures effectively to ensure the successful implementation and sustainability of the intervention. At the same time, this ranking also provides guidance and a basis for the evaluation and optimisation of intervention implementation.

10.1.4 The summary of the nine themes

After a summary of expert opinions and a comprehensive analysis of the literature, the following nine themes were defined in detail, with a clear statement of the factors included in each theme (see Table 25).

Table 25. The summary of the nine themes

Stage of complex intervention	Name of the theme	Name of the Influencing factors	Definition
Initial stage	Theme 1 (Project Management processes)	Collection of factors that influence the successful implementation of complex interventions. Each factor is briefly defined below along with its corresponding literature source:	
		1a Experience of implementing similar complex interventions by those implementing interventions	Refers to the previous experience and expertise of the individuals or teams responsible for carrying out the complex intervention. They should have experience in successfully implementing similar interventions in the past, which can positively impact the current project's success.[313]
		1b leadership	Refers to the quality of leadership exhibited during the implementation of the complex intervention. Effective leadership involves providing clear direction, motivation, and support to the team, fostering collaboration, and ensuring that the project stays on track.[314]
		1c local stakeholders involvement	Involves engaging and involving local stakeholders throughout the implementation process. Local stakeholders, such as community members, organizations, or government representatives, play a crucial role in understanding the context, contributing local knowledge, and ensuring the

			intervention's relevance and sustainability.[315]
		1d integrating the intervention to existing system or projects	Refers to the degree to which the complex intervention is aligned and integrated with existing systems, projects, and workflows. Integration can enhance the intervention's effectiveness and reduce duplication of efforts.[316]
		1e support systems or tools	Relates to the availability and utilization of appropriate support systems, technologies, or tools that can facilitate the implementation process. These may include data management systems, communication platforms, or training resources.[317]
		1f project champion	Refers to an individual or group that advocates for the complex intervention and takes ownership of its successful implementation. Project champions play a vital role in gaining support, overcoming barriers, and ensuring sustained commitment to the intervention.[318]
		1g time constraints	Represents the limitations posed by time, deadlines, and schedules during the implementation process. Adequate time management and adherence to timelines are essential for successful project execution.[319]
		1h resource allocation	Involves allocating the necessary resources (such as finances, manpower, materials, etc.) required for the successful

			implementation of the complex intervention. Proper resource allocation is critical to ensure smooth execution.[320]
Adaptability & Scalability	Theme 2 (Context)	Foundation for the implementation of complex interventions, involving various aspects of the overall social, political, and cultural conditions and constraints. Before initiating any intervention, it is essential to understand and consider the contextual background to ensure the intervention's adaptability and effectiveness.	
		2a sociopolitical context	Refers to the social and political conditions, structures, and dynamics that influence the implementation of the complex intervention. This includes factors such as government policies, regulations, social norms, political stability, and power dynamics within the community or society.[321]
		2b availability of resources	Involves assessing the availability and accessibility of necessary resources required for the successful implementation of the complex intervention. These resources may include financial resources, skilled workforce, infrastructure, equipment, and supplies.[322]

		2c primary stakeholders' accessibility to interventions	Refers to the extent to which the primary stakeholders (e.g., target beneficiaries, communities, or individuals) can access and engage with the complex intervention. Accessibility is influenced by factors such as geographic location, cultural barriers, and availability of information.[323]
		2d primary stakeholders' acceptability to interventions	Represents the willingness and receptiveness of the primary stakeholders to accept and engage with the complex intervention. Acceptability is influenced by factors such as cultural appropriateness, perceived benefits, and alignment with stakeholders' values and beliefs.[324]
	Theme 3 (Setting)	Refers to the specific geographical location or place where the intervention will take place. Choosing an appropriate setting is crucial for the successful implementation and effectiveness of the intervention, as different settings may have varying impacts on the intervention outcomes.	
		3a geographical location of intervention implementation	Refers to the physical location or geographic area where the complex intervention will be implemented. The characteristics of the location, such as urban or rural, coastal or inland, developed or developing regions, can influence the feasibility and suitability of the intervention.[325]
		3b health system	Encompasses the overall health infrastructure, services, and organizations

			in the specific setting where the intervention is taking place. The health system's capacity, resources, and efficiency can impact the intervention's delivery and sustainability.[326]
		3c local legislation	Refers to the laws, regulations, and policies established by the local government or authorities that may have implications for the implementation of the complex intervention. [327]
		3d local social norms or regulations	Involves the cultural norms, social practices, and community regulations that may influence the acceptance and adoption of the complex intervention. [328]
		3e local culture	Refers to the beliefs, values, customs, traditions, and behaviors of the people in the specific setting. [329]
	Theme 4 (Organizational attributes)	Involves the characteristics and capabilities of the organization or team responsible for implementing the intervention. The professionalism, experience, resources, and other attributes of the organization can significantly impact the quality and effectiveness of the intervention.	
		4a organizational readiness	Refers to the preparedness and willingness of the organization or team to implement the complex intervention successfully.[330]
		4b organizational culture	Encompasses the shared values, beliefs, norms, and behaviors within the organization that influence its functioning and decision-making. [331]

		4c organizational structure	Refers to the formal and informal arrangement of roles, responsibilities, and relationships within the organization. [332]
		4d interorganizational networks	Involves the connections and collaborations between different organizations involved in the implementation of the complex intervention. [333]
		4e local gatekeepers	Refers to individuals or groups within the local community who control or regulate access to resources, information, or decision-making processes. Engaging and obtaining support from local gatekeepers can facilitate intervention implementation.[334]
		4f government support	Involves the level of support and involvement from the government or relevant authorities in the implementation of the complex intervention. Government support can provide resources, legitimacy, and sustainability to the intervention.[335]
	Theme 5 (Human resources)	Critical element in the implementation of interventions. The expertise, skills, and experience of the personnel involved play a crucial role in the success of the intervention.	
		5a capacity of staff	Encompasses the skills, knowledge, and competencies of the personnel responsible for implementing the complex intervention.[336]
		5b training and	Refers to the level of training, education,

		education of staff	and professional development provided to the personnel involved in implementing the complex intervention. [337]
		5c staff turnover	Represents the rate at which personnel leave their positions and are replaced by new employees. [338]
	Theme 6 (Primary stakeholders' factors)	Refers to the degree of acceptance and engagement of the target population in the intervention. The support and involvement of primary stakeholders directly influence the intervention's sustainability and successful implementation.	
		6a Primary stakeholders' understanding and awareness	Refers to the level of comprehension and consciousness among the target population regarding the complex intervention. [339]
		6b training and education of primary stakeholders	Involves providing necessary training and education to the target population to enhance their knowledge and skills related to the intervention. [340]
		6c differences between individual culture	Refers to the variations in cultural beliefs, values, and practices among the individuals within the target population.[329]
	Theme 7 (Secondary stakeholders' factors)	Refers to factors involving other relevant stakeholders apart from the target population. Their attitudes and support also influence the intervention's outcomes.	
		7a local stakeholders perception of the need for change	Refers to how other stakeholders in the community or local context perceive the necessity for the proposed intervention or change. [104]

		7b implementer and local stakeholders sharing a common language	Involves the effective communication and understanding between the those implementing interventions and local stakeholders. [341]
		7c credibility and reputation of the provider or implementer	Refers to the perceived trustworthiness and competence of the organization or individuals responsible for implementing the intervention. [342]
Sustainability	Theme 8 (Monitoring and supervision)	Involves tracking and evaluating the implementation process and outcomes of the intervention. Monitoring and supervision play a crucial role in identifying issues promptly and taking measures to address them.	
		8a the role of existing community structures and personnel	Refers to the involvement and engagement of community-based organizations, local leaders, and existing personnel in the implementation of the intervention. [343]
		8b training and education of staff	Involves providing necessary training and education to the personnel responsible for monitoring and supervising the intervention. [344]
		8c empowering the state and non-state actors	Refers to strengthening the capacity of both governmental and non-governmental actors involved in monitoring and supervision. [345]
		8d routine system (feedback for continuous improvement of the quality of the	Involves establishing a regular feedback and review system to continuously improve the intervention's quality based on the monitoring and supervision findings.[346]

		project)	
		8e ongoing evaluation and reporting	Refers to continuous assessment and reporting of the intervention's progress and outcomes. [347]
		8f feedback mechanism	Involves establishing a system for receiving and providing feedback between different stakeholders involved in the intervention, enabling continuous improvement.[348]
		8g local supervisor support	Refers to the support and guidance provided by local supervisors to the those implementing interventions and monitoring teams. [349]
		8h the technical remote support from intervention developers	Involves providing technical assistance and support from the developers of the intervention to the implementing teams remotely.[350]
		8i actionable timelines	Refers to setting clear and achievable timelines for monitoring, supervision, and reporting activities, allowing for timely feedback and improvements.
		8j using frameworks	Involves utilizing established frameworks or models for monitoring and supervision to ensure a systematic and comprehensive approach to evaluation.[351]
	Theme 9 (Embedding in communities)	Involves integrating the intervention with existing resources and activities in the local community, making it sustainable and impactful.	
		9a community-based organizations	Refers to organizations that operate within the local community and play a

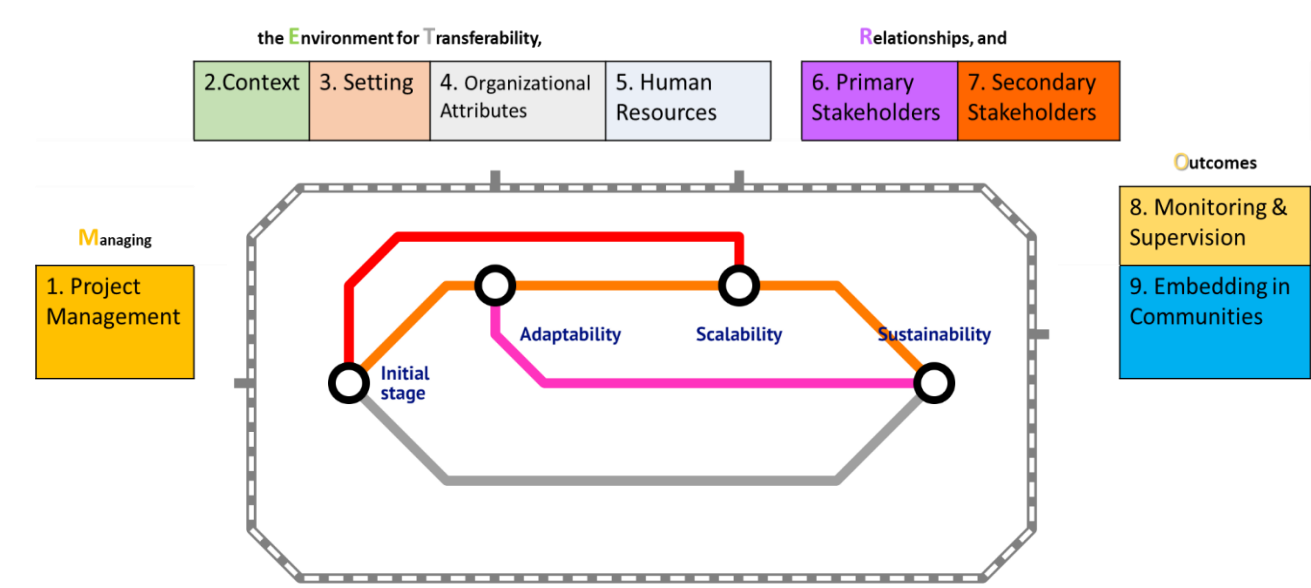
			role in delivering services, engaging community members, and addressing community needs. [352]
		9b community acceptance	Represents the level of approval and support the local community shows toward the intervention. [353]
		9c community ownership	Refers to the extent to which the local community takes responsibility for and has a sense of ownership over the intervention. [354]
		9d client advocacy	Involves empowering clients or beneficiaries to advocate for their own needs and rights within the community and with service providers. [355]
		9e training community volunteers	Involves providing training and support to community volunteers who actively participate in the intervention's implementation. [356]
		9f affordable and available in target community	Refers to ensuring that the intervention is affordable and easily accessible to the community members.
		9g community culture cooperation	Involves working in harmony with the community's culture, traditions, and social norms. [329]
		9h turnover of community key members	Refers to the changes in the composition of important community members or leaders who play a crucial role in the intervention. [357]
		9i regular feedback (feedback to the affected community)	Involves providing timely and regular feedback to the community about the intervention's progress, outcomes, and

			any necessary adjustments.

10.2 A guide to using the METRO Framework

This guide introduces the METRO Framework as a tool for researchers in the field of implementation science. The METRO Framework is built upon widely used TMFs in the field, such as the CFIR Framework[9], EPIS Framework[28], and MRC Framework[17]. It focuses on using the framework to navigate the adaptability, scalability, and sustainability phases of complex health interventions, providing a systematic approach to understanding and addressing influencing factors. Detailed descriptions of the METRO Framework's stages and instructions on its application are included to facilitate a comprehensive understanding of managing complex health interventions efficiently.

Figure 42: The METRO Framework



Managing the Environment for Transferability, Relationships and Outcomes (METRO)

The METRO Framework is a comprehensive guide for use in complex health intervention programs and is divided into four phases: Initial phase, Adaptability phase,

Scalability phase, and Sustainability phase (see Figure 42). Each phase covers key topics and factors, and the following topics and related recommendations should be considered during each phase:

Initial stage (Managing)

Initial stage requires major consideration of how the project should be managed.

Theme 1 (Project management)

In the early stages of an intervention, the project team needs to effectively manage and coordinate the various project management processes to maximize the success of a complex health intervention project. To accomplish this, here are some suggestions to help project teams better plan and execute project management processes:

(1a) Experience of implementing similar complex interventions by those implementing interventions: If you or your team have implemented similar complex intervention projects, consider whether you can capitalize on those experiences. By summarizing the success factors and challenges of previous projects, it can guide the planning and implementation of new projects. However, if you do not have relevant experience, then it is an option to consider whether to seek advice and experience sharing from other implementers.

(1b) leadership: Since the leader of the project team plays a key role in the success of the project, the leaders are required to have the skills needed to lead and coordinate the team. In this regard, it is important to consider whether the leader is able to communicate effectively, coordinate team members, develop plans, and solve problems. To empower leaders, you may also want to consider conducting regular leadership training and team building activities as needed.

(1c) local stakeholders involvement: It is recommended that the implementers of the intervention actively seek the participation and cooperation of local stakeholders. In this way, contacts can be established and dialogues with community leaders, government agencies, NGOs, etc. can be initiated to understand their needs and expectations. Doing so will enable them to have a place in the design and implementation of the intervention, thus enhancing the social acceptance and sustainability of the program.

(1d) integrating the intervention to existing system or projects: It is recommended that those implementing interventions should consider how to integrate your intervention into systems or programs already in place locally. This process may require collaboration with other programs or coordination with existing health delivery systems. The goal is to make the intervention compatible with the local environment and resources to reduce redundancy and increase efficiency.

(1e) support systems or tools: It is recommended that those implementing interventions explore whether support systems or tools exist for your intervention. These systems or tools may include data collection and management software, monitoring and evaluation tools, training materials, etc. Select and customize these tools to meet the specific needs of the program and ensure that the team is proficient in their use.

(1f) project champion: It is recommended that those implementing interventions consider assessing the competence and experience of the project champion. Project champions are individuals who passionately advocate for and support a project within an organization, often without formal authority over its execution. Unlike project leaders who directly manage the project's operational aspects, champions work behind the scenes to promote the project, secure buy-in from stakeholders, and

facilitate the necessary resources and support. They leverage their influence and enthusiasm to overcome resistance, motivate team members, and navigate political or organizational obstacles, playing a critical role in the project's success by ensuring it receives the attention and resources it needs.

(1g) time constraints: It is recommended that the time constraints of the project be clarified and that a reasonable timetable be established. Ensure that there are clear deadlines for all phases of the project and allow flexibility in the project plan to cater for unpredictable situations. Also, conduct regular time management evaluations to ensure that the project is completed on time.

(1h) resource allocation: It is recommended that a detailed resource management plan be developed, including human, financial and physical resources. This plan should ensure that resource allocation matches the different phases and needs of the project. At the same time, the use of resources should be tracked and timely adjustments should be made to ensure the effective utilization of resources.

Adaptability Phase (the Environment for Transferability) and Scalability Phase (Relationships)

Theme 2 (Context)

During the adaptability and scalability phase of a complex health intervention, program teams need to deeply understand and adapt to changing contextual factors. Below are some suggestions to help program teams better address contextual challenges and opportunities:

(2a) sociopolitical context: It is recommended that those implementing interventions begin their consideration of environmental adaptation with an understanding of the

social and political context of the area in which the intervention is to be implemented. This includes the ability to maintain close contact with local government and policy makers. It is recommended that those implementing interventions keep an eye on policy changes, regulations, and the political climate in order to make timely adjustments. Also, if possible, consider attending government and policy-related meetings and workshops on a regular basis, and building collaborative relationships with government departments to ensure policy coherence of the project. This set of initiatives can help ensure the legal and policy legitimacy of the project and increase the level of coordination with the government.

(2b) availability of resources: During the adaptation phase of the intervention, it is recommended to assess the status of available resources, including human, financial, and physical resources, and try to match the program's resource needs with available resources. In addition, those implementing interventions may consider developing resource planning strategies to maximize the efficiency of the use of available resources. Additional sources of resources, such as partnerships, sponsorships and funding opportunities, can also be sought.

(2c) primary stakeholders' accessibility to interventions: It is recommended that those implementing interventions consider making complex interventions as accessible as possible to primary stakeholders. Those implementing interventions may consider conducting community outreach activities to raise awareness among primary stakeholders and establishing accessible service points and channels so that primary stakeholders can participate in the intervention.

(2d) primary stakeholders' acceptability to interventions: It is recommended that those implementing interventions understand the attitudes and acceptance of primary stakeholders towards the intervention. In addition, interventionists can

conduct satisfaction surveys to understand the views of primary stakeholders and adjust intervention strategies as needed to maximize their acceptance of and participation in the intervention.

Theme 3 (Setting)

During the adaptability and scalability phase of a complex health intervention, local setting also influences the process of the intervention. The following are some recommendations.

(3a) geographical location of intervention implementation: It is recommended that complex those implementing interventions conduct a comprehensive geographic analysis, including cultural background, local resources, and community needs, when selecting a site for intervention implementation, which can help the intervention be better adapted to the local environment.

(3b) health system: It is recommended that the implementers of the intervention have an in-depth understanding and assessment of the state of the local health system. Understand the availability and quality of health facilities, health services and health professionals. At the same time, partnerships with local health departments and institutions can be considered in order to harmonize the project with the health system and provide the necessary support.

(3c) local legislation: Interventionists are advised to have a thorough understanding of local regulations and legal frameworks, especially those related to health interventions, to ensure that the program is legitimate and complies with legal requirements. If available, consider seeking advice from legal professionals to ensure the legitimacy of the program and its compliance with local regulations.

(3d) local social norms or regulations: It is recommended that those implementing interventions understand the norms of the local society to ensure that the project's intervention strategies and activities do not conflict with the local society. Also, if possible, is it possible to collaborate with local social workers, cultural experts or local leaders to minimize culturally relevant obstacles encountered by the project and avoid potential social conflicts.

(3e) local culture: It is recommended that those implementing interventions understand the local culture to ensure the project's strategies and activities do not conflict with it. Collaborating with local social workers, cultural experts, or leaders can help minimize cultural obstacles and avoid potential social conflicts. Additionally, actively interacting with community residents to learn about their culture and values can build relationships of mutual respect and understanding.

Theme 4 (Organizational attributes)

During the adaptability and scalability phase of a complex health intervention, project teams need to understand and adapt to a variety of organizational attribute factors. Here are some suggestions to help project teams better address organizational attribute challenges and opportunities.

(4a) organizational readiness: It is recommended that those implementing interventions assess the readiness of the organization implementing the intervention, including its resources. Also, use the results of the assessment to determine whether further training, resource allocation or management improvements are needed. Try to ensure that the organization is able to function effectively throughout the different phases of the project.

(4b) organizational culture: It is recommended that those implementing interventions

communicate with key contacts within the organization to understand its culture and values and to ensure that the design and implementation of the project is aligned with them.

(4c) organizational structure: Those implementing interventions should also consider how to assess the organization's structure and decision-making system, which helps the project to have a clear division of responsibilities and decision-making processes within the organization to avoid confusion and conflict.

(4d) interorganizational networks: It is recommended that implementers of the intervention may consider seeking effective partnerships with other relevant organizations and stakeholders to gain access to wider resources and support, all of which can help support the replication and success of the project. This emphasizes the interconnected nature of these factors, highlighting the importance of local stakeholder assistance and recognizing their inherent mutual influence.

(4e) local gatekeepers: It is recommended that the implementers of the intervention get to know and connect with the local gatekeepers to gain their support and participation, as these gatekeepers may be key players in influencing the success of the program. In other words, the role of local gatekeepers is primarily to emphasize their functional importance within communities and organizations.

(4f) government support: It is recommended that those implementing interventions assess whether the government provides support and resources to support program expansion and sustained implementation or whether there is a need to work with government departments for possible government support. In contrast to the health system, government support is more multifaceted. It can involve financial investments, the formulation of policies favorable to health service development, and the provision of essential public health infrastructure.

Theme 5 (Human resources)

Human resource management is critical in the adaptability and scalability phase of complex health interventions. The following are some recommendations.

(5a) capacity of staff: It is recommended that those implementing interventions conduct a staff skills and competency assessment to identify their strengths and weaknesses and to further determine if further support and training is needed.

(5b) training and education of staff: Assess the need for project implementers and staff to receive training relevant to the project objectives and tasks in order to improve their skill levels. If training is required, during the training period, it is recommended that a training plan be established that includes ongoing training to follow up on new knowledge and skills development.

(5c) staff turnover: It is recommended that those implementing interventions actively monitor staff turnover rates and understand the reasons for staff separations. This helps those implementing interventions to identify potential problems and take appropriate measures to improve employee satisfaction and increase employee retention. In addition, it is recommended to build up a talent pool to ensure that there are enough people who can successfully take over from departing employees when the need arises.

Theme 6 (Primary stakeholders' factors)

During the adaptability and scale-up phase of a complex health intervention, factors such as primary stakeholder understanding, awareness, training and education, and cultural differences play a key role in the success of the program. Below are some suggestions to help program teams better address primary stakeholder related factors.

(6a) Primary stakeholders' understanding and awareness: It is recommended that the intervention implementer and the primary stakeholders communicate on a regular basis to share the progress and results of the project, so that the primary stakeholders can fully understand the objectives, value and importance of the project, in order to enhance their understanding and awareness. This can be done in a variety of ways, such as seminars, presentations, etc.

(6b) training and education of primary stakeholders: Those implementing interventions need to conduct an assessment to determine whether, based on the needs and context of the primary stakeholders, they need to develop a training plan and provide them with customized training to ensure that they have the necessary knowledge and skills.

(6c) differences between individual culture: It is recommended that those implementing interventions be aware of the importance of recognizing and respecting cultural differences among key stakeholders. Consideration could be given to the need for cultural sensitivity training for staff to increase the program team's understanding of different cultural contexts.

Theme 7 (Secondary stakeholders' factors)

During the adaptability and scale-up phase of a complex health intervention, factors such as secondary stakeholder perceptions, the sharing of a common language, and the credibility of the provider or implementer are critical to the success of the intervention. Below are some suggestions to help program teams better address secondary stakeholder related factors.

(7a) local stakeholders perception of the need for change: It is recommended that those implementing interventions develop an understanding of the needs and

expectations of local stakeholders for the program. This can be gathered by conducting regular needs assessments and feedback, which can help the intervention to be tailored to local needs and also benefit the program's expansion in the local community.

(7b) implementer and local stakeholders sharing a common language: If possible, within the research team, it is recommended that someone in it can have a common language of communication with local stakeholders, which can help facilitate effective collaboration. If no suitable person is available, is there a need to consider the services of an interpreter or cultural intermediary to overcome language and cultural barriers.

(7c) credibility and reputation of the provider or implementer: It is recommended that those implementing interventions provide high-quality services and respond positively to the needs and feedback of local stakeholders in order to build and maintain the credibility and reputation of the program provider or implementer, which is beneficial for enhancing trusting relationships with the local community, as well as for enhancing the program's wider use in the local context.

Sustainability Phase (Outcomes)

Theme 8 (Monitoring and supervision)

Effective monitoring and supervision during the sustainability phase of a complex health intervention is critical to the continued success of the intervention. Below are some suggestions to help program teams better understand the factors correlated with monitoring and supervision.

(8a) the role of existing community structures and personnel: Those implementing interventions may consider utilizing existing community structures and personnel to collaborate on project monitoring and oversight. This will help them to understand

project objectives and needs in order to effectively assist in implementation.

(8b) training and education of staff: It is recommended that those implementing interventions assess the need for staff training and education to ensure that they have the necessary skills and knowledge for monitoring and supervision.

(8c) empowering the state and non-state actors: It is recommended that the implementers of the intervention consider the need to develop a monitoring and surveillance program with government departments and NGOs. Also, is there a need for training and technical support to strengthen their monitoring capacity.

(8d) routine system (feedback for continuous improvement of the quality of the project): It is recommended that those implementing interventions consider whether regular systems can be utilized to collect regular feedback, including input from stakeholders and practitioners. And these information can be used to further identify problems and develop plans for improvement.

(8e) ongoing evaluation and reporting: Set regular evaluation schedules to ensure timely data collection and analysis. Report on project progress and results in a timely manner. Provide transparent reporting to all stakeholders to enhance transparency and trust.

(8f) feedback mechanism: It is recommended that those implementing interventions establish feedback channels and effective feedback mechanisms to be used to receive feedback from implementers and stakeholders. This will help to ensure that stakeholders' comments and suggestions are responded to in a timely manner.

(8g) local supervisor support: It is recommended that those implementing interventions establish a partnership with local supervisors to collaborate on the

development of the monitoring plan and receive their support, which can enhance the effectiveness of monitoring during the sustainability phase of the intervention.

(8h) the technical remote support from intervention developers: It is recommended that those implementing interventions can establish communication channels to keep in touch with intervention developers. When the intervention encounters problems in the later sustainment phase, they can be approached for feedback on the problems and seek their advice and support to ensure a smooth and sustained implementation of the project.

(8i) actionable timelines: It is recommended that those implementing interventions develop a detailed timetable, including timelines for monitoring, reporting and improvement, to ensure that monitoring and supervision activities are carried out according to plan, and in turn, to keep the project on track.

(8j) using frameworks: It is recommended that those implementing interventions choose a framework that is appropriate to the needs of the program, such CCM model or EPIS framework, to ensure the effectiveness of monitoring and supervision.

Theme 9 (Embedding in communities)

Embedding in the communities is critical during the sustainability phase of a complex health intervention, which requires considering and managing multiple factors. Below are some suggestions to help program teams better manage the factors of community embedding.

(9a) community-based organizations: It is recommended that those implementing interventions can partner with community-based organizations to implement project activities to support project embedding and sustainability.

(9b) community acceptance: It is recommended that those implementing interventions understand community acceptance of the program by talking to residents and understanding their perceptions. And those implementing interventions can adjust program activities based on their feedback to improve community acceptance.

(9c) community ownership: It is recommended that those implementing interventions encourage community participation in the project and enable them to have some power in project decision-making. Consideration could be given to the establishment of community advisory committees or similar bodies that would allow community residents to participate in project decision-making and share ownership of the project.

(9d) client advocacy: It is recommended that those implementing interventions consider how to conduct client advocacy, for example by working with local client advocacy organizations to provide support and information to clients to enable them to take on the role of advocates.

(9e) training community volunteers: It is recommended that those implementing interventions provide training for community volunteers to equip them with the required skills and knowledge to be able to assist in program activities.

(9f) affordable and available in target community: It is recommended that the cost of program services be evaluated while looking for ways to reduce costs and increase availability to meet the needs of the community.

(9g) community culture cooperation: It is recommended that those implementing interventions may conduct cultural sensitivity training to ensure that program teams understand and respect the cultural values of the community.

(9h) turnover of community key members: It is recommended that those implementing interventions be aware of the need to consider the movement of key community members, understand their career dynamics, and develop coping plans to minimize the adverse effects of mobility in order to maintain program continuity.

(9i) regular feedback (feedback to the affected community): It is recommended that those implementing interventions provide regular feedback to the community to keep them informed of program progress. For example, community meetings can be organized or regular reports can be issued to provide information on the progress and outcomes of the project to community members and encourage them to participate in the feedback process.

Selection of the intervention route

When choosing an intervention route, the person or team implementing the intervention needs to determine the appropriate intervention route based on the purpose of the study, similar to choosing a subway route, so that the various influencing factors that may be encountered can be better taken into account.

Orange Line

First, the Orange Line is recommended for users who need to implement the entire intervention process in its entirety, i.e., from its inception, adaptation, extension, and continuation phases. In this case, all the topics mentioned in the METRO framework and the factors contained therein need to be taken into account.

Grey line

The grey line can be considered when you want to use a mature intervention and the staff has practical experience in similar areas.

In this case. First, the factors in Theme 1 need to be considered at the start of the intervention. Subsequently, focus on the factors in Theme 8 and Theme 9 in the Sustainability phase.

From the Orange Line to the Pink Line

This is mostly seen in the small-scale experimental phase to verify that the intervention can be adapted locally and sustained.

First, Theme 1 needs to be considered at the start of the intervention. Next, focus on the factors included in Themes 2, 3, 4, 5, 6, and 7 in the Adaptability Phase, and Themes 8 and 9 in the Sustainability phase.

Red to Orange Line

Interventionists may consider choosing the "Red to Orange Line" if they are planning to conduct a large-scale trial phase after having completed a small-scale feasibility study. In that case, the themes need to be considered in the following order:

First, focus on Theme 1 in the Initial stage.

Next, focus on Themes 2, 3, 4, 5, 6, and 7 in the Scalability phase.

Finally, focus on Theme 8 and Theme 9 in the Sustainability phase.

10.3 Summary

Chapter 10 presented the METRO framework, a comprehensive model developed through systematic reviews, Delphi surveys, and consensus meetings. This framework, designed for the implementation of complex health interventions in LMICs, integrates

factors influencing adaptability, scalability, and sustainability. By synthesizing expert consensus and empirical data, the METRO framework offers a practical tool for researchers and practitioners to navigate the multifaceted challenges of health interventions, ensuring more effective and sustainable outcomes.

Chapter 11 Discussion

This study embarked on an ambitious journey to elucidate the intricacies surrounding the adaptability, scalability, and sustainability (ASaS) of complex health interventions in low- and middle-income countries (LMICs). Through a comprehensive exploration that melded systematic reviews, Delphi surveys, consensus meetings, and the development of the METRO framework, we have ventured beyond the existing paradigms to offer a nuanced understanding of the factors influencing ASaS in LMICs.

Our initial phase involved conducting systematic reviews that illuminated the gaps within the current literature concerning ASaS. The Delphi method and consensus meetings emerged as critical tools in refining and validating the plethora of factors identified during the review phase. These methodologies facilitated a collaborative and iterative process, engaging a panel of experts to distill and prioritize the factors.

The culmination of our efforts was the development of the METRO framework. This framework is not just a theoretical contribution but a practical guide designed to navigate the multifaceted challenges of implementing complex health interventions in LMICs. The METRO framework, with its emphasis on the interplay between various factors, provides a comprehensive lens through which policymakers, practitioners, and researchers can view the ASaS of health interventions. Its development was a testament to the collaborative synthesis of theoretical and empirical findings, expert opinions, and practical considerations.

In responding to the objectives, our study not only identified and elaborated on the factors influencing ASaS but also elucidated the dynamic relationships between these factors. The METRO framework serves as a beacon, guiding the design, implementation, and evaluation of complex health interventions in LMICs. It embodies the principles of adaptability, scalability, and sustainability, ensuring that interventions are not only effective in the short term but also viable and relevant in the long term.

In conclusion, this study represents a significant stride toward understanding and enhancing the ASaS of complex health interventions in LMICs. The METRO framework stands as a testament to the potential of collaborative, interdisciplinary research in addressing global health challenges. As we move forward, it is imperative that this framework be tested, refined, and adapted, ensuring its relevance and utility in the ever-evolving landscape of public health in LMICs.

11.1 Summary of the framework

The METRO framework presents a novel and systematic approach to the analysis and implementation of complex interventions, with distinct advantages over existing frameworks such as the EPIS framework and the CFIR framework. To provide a comprehensive comparison, we'll examine the strengths of the METRO framework relative to these established frameworks based on its unique features:

11.1.1 Non-linear Approach to Intervention Implementation

Unlike traditional frameworks that may follow a linear progression through stages of implementation, the METRO framework adopts a non-linear approach, analogous to navigating through an underground metro system. This flexibility allows for interventions to be adapted, scaled, and sustained in a manner that is responsive to the unique challenges and opportunities presented at various stages of the intervention process. The ability to navigate through different routes—represented by the inner and outer rings—facilitates a more dynamic and adaptable intervention strategy.

11.1.2 Comprehensive Integration of Influencing Factors

The METRO framework's division into inner and outer rings with nine thematic areas enables a thorough examination of both the key concepts of adaptability, scalability, and sustainability (inner loop) and the external factors influencing these concepts

(outer loop). This structure ensures a comprehensive view of the intervention landscape, incorporating a wide range of factors from project management processes to community embedding. Such a detailed mapping allows for a more nuanced understanding and management of the elements that contribute to the success of complex interventions.

11.1.3 Emphasis on Stakeholder Relationships and Environment

While the EPIS framework and CFIR also consider the importance of external and internal contexts, the METRO framework places a significant emphasis on managing the environment for transferability and on the relationships among stakeholders. By explicitly integrating themes related to context, setting, organizational attributes, human resources, and stakeholder factors, the METRO framework highlights the critical role of environmental and relational factors in the success of interventions. This focus ensures that interventions are not only designed with adaptability, scalability, and sustainability in mind but also are deeply rooted in the context of their implementation, fostering stronger stakeholder engagement and support.

11.1.4 Visual and Conceptual Clarity

The visual representation of the METRO framework as an underground route map provides an intuitive and clear way to understand the complex relationships and pathways within an intervention. This metaphor not only aids in conceptual clarity but also facilitates communication among researchers, implementers, and stakeholders. By providing a visual language for discussing complex interventions, the METRO framework enhances collaborative planning and decision-making processes.

11.1.5 Flexibility in Application

The METRO framework's design allows for flexible application across different types of interventions and contexts. Its non-linear approach and consideration of various

influencing factors make it adaptable to a wide range of complex intervention environments. Whether dealing with initial implementation, scaling up, or sustaining interventions, the METRO framework provides a robust theoretical and practical guide that can be tailored to specific needs and circumstances.

In summary, the METRO framework advances the field of complex intervention implementation by offering a flexible, comprehensive, and visually intuitive model that emphasizes the importance of adaptability, stakeholder relationships, and environmental context. Its novel approach to integrating influencing factors and navigating through the intervention process provides a valuable tool for researchers and practitioners aiming to achieve effective and sustainable outcomes in complex intervention environments.

11.2 Comparison with other TMFs

Similarities

The METRO theoretical framework draws from several preceding theoretical models, such as the EPIS framework, CFIR framework, and MRC framework. Consequently, it undoubtedly encompasses certain shared components.

These frameworks all prioritize a practice-oriented approach, emphasizing the practical significance of addressing issues and enhancing intervention effectiveness in real-world applications. Similarly, the current theoretical framework aims to provide a set of influencing factors for users to reference in practical contexts.

Each of these frameworks considers multidimensional factors that influence intervention implementation, including intervention characteristics, external environment, internal context, individual attributes, and implementation processes. The present model also adopts a similar approach, albeit analyzing these factors from the perspectives of the nine identified themes and the ASaS framework's three

dimensions.

Moreover, these frameworks emphasize the close relationship between the implementation process and intervention delivery, from exploration and preparation to implementation and ongoing evaluation. While some frameworks are relevant to all phases of implementing interventions and some to specific phases, they all stress their close relationship to the process of intervention implementation.

Differences

The METRO theoretical framework exhibits several distinctions from previous theoretical models or frameworks.

Firstly, in terms of geographical application, many preceding models primarily target high-income countries (HICs) or provide generalized frameworks that often lack a dedicated focus on low- and middle-income countries (LMICs). For instance, the EPIS, CFIR, and MRC frameworks all offer generalized frameworks without specifically addressing the unique challenges faced in LMICs.

Furthermore, the depth and breadth of these frameworks vary due to differences in design objectives and application domains. Some frameworks provide detailed factor categorizations, while others focus more on macro-level factors. For example, the CFIR framework offers an extensive array of influencing factors with detailed classifications, making it suitable for diverse intervention domains. In contrast, the EPIS and MRC frameworks might concentrate on specific issues within complex or medical intervention contexts.

In summary, the METRO framework distinguishes itself by having a precise focus on LMICs and specifically targeting issues related to complex and medical interventions. It bridges gaps by addressing the unique contexts and intervention complexities of

LMICs, making it a valuable tool for understanding and enhancing implementation processes in these regions.

11.3 How this study will advance the implementation of complex health interventions in low- and middle-income countries

The METRO framework significantly advances our understanding of implementing complex health interventions in Low- and Middle-Income Countries (LMICs) by offering a nuanced, flexible, and context-sensitive approach that bridges gaps identified in existing literature. By integrating insights from systematic reviews, Delphi surveys, and consensus meetings, the framework builds upon and extends current knowledge in several important ways:

- **Comprehensive and Systematic Approach**

Existing literature has emphasized the importance of a comprehensive understanding of the factors influencing the implementation of health interventions in LMICs. The METRO framework's incorporation of nine themes, spanning from project management to community embedding, offers a more detailed and systematic approach than many models. This comprehensive view aligns with the call in the literature for more nuanced frameworks that consider a wide range of influencing factors, including those related to the environment, stakeholders, and outcomes[358].

- **Non-Linear Model for Complex Interventions**

The literature on health interventions in LMICs has highlighted the challenge of linear models failing to capture the complexity and dynamic nature of implementing changes in these settings[359]. The METRO framework's non-linear approach, analogous to navigating an underground metro system with multiple routes to a destination, addresses this challenge. It recognizes that interventions may need to move through phases of adaptability, scalability, and sustainability in a non-sequential manner,

offering a more realistic model for the unpredictable paths that interventions often take in LMICs.

- **Focus on Adaptability, Scalability, and Sustainability**

The need for adaptable, scalable, and sustainable health interventions in LMICs is a recurrent theme in existing literature. The METRO framework's emphasis on these three key concepts directly responds to this need, providing a structured yet flexible approach to planning and implementing interventions. This aspect of the METRO framework complements studies that have identified adaptability and scalability as critical for the success of health interventions in varied and changing LMIC contexts[360].

- **Enhanced Stakeholder Engagement**

A significant body of literature underscores the importance of engaging stakeholders at all levels of health intervention implementation in LMICs. The METRO framework's detailed attention to the roles of primary and secondary stakeholders and its emphasis on building and managing relationships offer practical strategies for enhancing stakeholder engagement. This approach is in line with recommendations for more participatory and stakeholder-informed intervention designs[361].

- **Resource Optimization in LMIC Settings**

The challenge of resource constraints in LMICs is well-documented, with many studies calling for more effective resource management strategies. The METRO framework addresses this by highlighting the importance of managing environments for transferability and outcomes, suggesting a strategic approach to resource allocation that considers the varying influence of different factors at different stages of the intervention process. This focus provides a concrete response to the literature's identification of resource optimization as a key factor in the success of interventions in LMICs [362].

By addressing these critical areas, the METRO framework enriches the existing literature on complex health interventions in LMICs, offering a robust, flexible, and comprehensive model that can guide the design, implementation, and evaluation of interventions. Its innovative approach not only addresses identified gaps in the literature but also provides a practical tool that can be adapted to the diverse and dynamic contexts of LMICs, thereby enhancing the potential for successful and sustainable health outcomes.

11.4 Who would use this framework?

Public health researchers and academics can leverage the METRO framework to incorporate non-linear models of intervention analysis, addressing gaps in existing literature on health interventions' adaptability and scalability. Additionally, the framework facilitates cross-disciplinary research by combining insights from public health, sociology, economics, and environmental studies to create more comprehensive intervention strategies.

Policy makers and health planners can apply the METRO framework to design integrated health systems that accommodate complex interventions, focusing on long-term sustainability and system-wide impact. The framework also supports evidence-based policy making by synthesizing evidence from diverse sources, guiding policy decisions through a comprehensive analysis of factors influencing health outcomes.

Health program implementers and NGOs can use the framework to develop community-based programs that align with local needs and capabilities, ensuring higher engagement and effectiveness. Furthermore, it allows NGOs to set up monitoring systems that feed into ongoing program adaptation, ensuring that interventions remain relevant and responsive over time.

Community leaders can use the framework to identify strategies for local empowerment, ensuring that health interventions are community-led and focused. Similarly, local health workers might employ the framework to tailor health education and communication strategies to the specific contexts and needs of their communities.

Funding organizations can use METRO to prioritize investments in interventions that demonstrate adaptability, scalability, and potential for sustainability, based on the framework's comprehensive analysis. International health agencies might apply the framework to ensure that global health initiatives align with local contexts, leveraging METRO's focus on adaptability and stakeholder engagement to tailor initiatives to specific regional needs.

Educators and trainers in public health and implementation science can develop case studies based on the METRO framework, helping students analyze complex health interventions through its lenses. Trainers could also design skill-building modules around the framework's themes, enhancing professionals' abilities in project management, stakeholder engagement, and resource optimization for health interventions.

11.5 What future research is needed?

The METRO framework, with its innovative approach to implementing complex health interventions, particularly in low- and middle-income countries (LMICs), opens several avenues for future research. These research directions aim not only to validate and refine the framework but also to explore its applications, impacts, and scalability across different settings.

One key area for future research is the evaluation of the framework's effectiveness and impact. Studies could assess the METRO framework's performance in achieving desired health outcomes across various contexts and health issues, comparing it

against traditional models of health intervention implementation. Longitudinal studies tracking interventions designed with the METRO framework would provide insights into its long-term impact on health outcomes, especially in terms of adaptability, scalability, and sustainability.

Another important research direction involves exploring the adaptability of the METRO framework to diverse contexts. This includes investigating how the framework can be modified to suit different cultural, socio-economic, and political environments, such as urban versus rural settings within LMICs. Additionally, research could examine the framework's applicability to a wide range of health issues, from infectious diseases to chronic conditions and mental health interventions.

Research into the integration of the METRO framework with local health systems in LMICs is also crucial. Studies could identify barriers to integration and develop strategies to overcome them, evaluating how the framework enhances the capacity of local health systems to manage and sustain complex health interventions. This includes examining the framework's role in improving local health systems' ability to handle complex health challenges.

Stakeholder engagement and community participation are vital components of the METRO framework. Qualitative research could focus on the experiences of various stakeholders, including policymakers, health workers, and community members, to identify factors influencing engagement and participation. Case studies could further illustrate the framework's effectiveness in building and maintaining strong relationships with primary and secondary stakeholders, and its impact on intervention outcomes.

Resource optimization and allocation are essential for successful health interventions, particularly in resource-constrained LMICs. Studies could analyze how the METRO

framework helps optimize resource allocation and utilization, identifying and leveraging untapped resources within communities and health systems. This research would provide valuable insights into how the framework can support efficient use of limited resources.

Training and capacity building are also critical areas for future research. Evaluating training programs and capacity-building initiatives based on the METRO framework could assess their effectiveness in enhancing the skills and competencies of health workers and implementers in LMICs. Additionally, research could explore the integration of the METRO framework into public health education and professional development programs, examining its impact on improving implementation science curricula.

Technological integration and digital health solutions present another promising research avenue. Exploring how digital health solutions and technological innovations can be integrated within the METRO framework could enhance health intervention implementation and monitoring. Studies could focus on the use of mobile health (mHealth) and information and communication technologies (ICTs) to support the framework's components, such as stakeholder engagement, resource allocation, and intervention adaptability.

Finally, ongoing refinement and development of the METRO framework based on empirical evidence and feedback from its application in various settings are essential. Research could focus on developing tools and methodologies for implementing the framework more effectively, including decision support systems, monitoring tools, and evaluation metrics.

By pursuing these research directions, the global health community can further understand the METRO framework's strengths, limitations, and potential for

broadening the impact of complex health interventions in LMICs and beyond. This research will also contribute to the evolution of implementation science, offering insights into designing, deploying, and sustaining health interventions in challenging environments.

11.6 Strengths and limitations

Strengths

The strengths of the Delphi method with respect to no geographical restrictions on recruiting experts, 'asynchronicity' (a capability that means that experts do not need to be working together at the same time) and anonymous have already been described in the methods (Chapter 4). These strengths were evident in this Delphi study. Specifically, experts from different countries and regions completed the Delphi questionnaire at their own convenience. Additionally, the anonymity of the process allowed for extensive and in-depth discussions on various factors, enabling experts to freely express their diverse views and opinions. By analyzing the results of the completed questionnaires, it is also possible to observe that the experts disagreed on certain factors, which indicates that the experts were able to think independently during the discussions without being influenced by other participating experts. This can be supported by the value of the Kendall coefficient, which does not converge to 1, which means that the experts' scores were not overly influenced by external factors, but rather reflect their personal views and judgments. This independence and diversity helps to ensure that the results of the study are comprehensive and accurate, as it takes into account the views and experiences of different experts.

Finally, in order to compensate for the possible shortcomings of Delphi survey due to the anonymity that prevents experts from communicating adequately. This study introduced a consensus meeting based on the Delphi questionnaire to give participants opportunities to express their views and opinions and to further explore the factors influencing ASaS of complex health interventions, which is another strength

of this study. Through consensus meeting, this study compensates to some extent for the lack of information communication between experts that may have existed in previous Delphi surveys.

Limitations

Although the Delphi method combined with consensus meeting has many advantages when applied to this study, it also has disadvantages.

Since the criteria for selecting experts are not currently standardised, this study has the potential bias when selecting experts: selection of experts may be influenced by biases, potentially leading to overrepresentation of specific fields or viewpoints, affecting representativeness and comprehensiveness[292]. While this study attempted to invite experts from different countries and regions, the lack of standardized criteria for experts' professionalism in this emerging field made expert selection subjective. Consequently, some biases may persist.

Furthermore, during the process of Delphi survey, as there were three rounds of Delphi questionnaire survey addition with a consensus meeting, some experts dropped out midway through the process because they found it too long or overwhelming, which may result in attrition bias and ultimately affected the results of the study.

Despite the measures taken to streamline the questionnaire and reduce the burden on experts, the attrition rate of experts in this study was relatively high. While 62 experts participated in this Delphi survey, only 21 experts completed the questionnaire in the third round. As for the consensus meeting, only 12 experts participated. Inevitably attrition rate may have impacted on the reliability of the questionnaire results.

As mentioned earlier, the Delphi study has the characteristic of flexibility, but flexibility and versatility are also considered to be one of Delphi's flaws[363]. Because Delphi researchers often modify the method to suit their needs, however, this may explain why the Delphi method has received criticism over the years[364]. Therefore, this study did not make too many adjustments to the original Delphi method, but only added a consensus meeting to increase the reliability and validity of the Delphi findings.

As for the experts participating in the Delphi survey, Anonymity may limit the willingness of some experts to participate, as some may wish to have their contributions recognised by other experts and to be able to communicate face-to-face and in depth with other experts. In addition, the experts may be reluctant to take responsibility for their opinions. Critics contend that the Delphi method is intrinsically flawed due to its absence of transparency, potentially leading to experts making rash or thoughtless assessments[365, 366]. This may result in some experts not being sufficiently accountable for their responses, thus affecting the reliability and validity of the findings. Also, for the experts participating the consensus meeting, anonymity cannot be achieved.

For the experts involved in this study, even for the same question, different conclusions may have been reached at different times. For this study, as the questionnaire was answered and concatenated by these experts at different points in time, the generalisation of the consensus reached in this case is limited and may be subject to challenge.

Moreover, experts in the Delphi process might be influenced by the results of the previous round,[367] causing them to adjust their opinions in subsequent rounds, potentially compromising independence. Also, experts' subjective opinions could be influenced by personal biases, experiences, and viewpoints, potentially deviating results from objective reality.

During the course of the Delphi, the moderator may not have been able to effectively poll the participating experts.

Subjectivity of Researchers: The Delphi method is not immune to drawbacks, such as researchers' subjectivity, the accuracy and reliability of the study rely on the subjective judgments of group members. For example, during the first round of the Delphi survey, since this is a PhD project, I took the role of coding by myself, which could result in omissions.

Expert Panel Composition: While the study divided experts into two groups, HICs and LMICs, the number of participants in the HICs group was approximately half that of the LMICs group. Therefore, it remains uncertain whether equalizing the number of experts in each specialty group would yield different results.

Although every effort was made to represent different fields and regions in the composition of the experts, academic researchers make up the majority, which may have led to the existence of a certain degree of bias. Furthermore, some studies have pointed out that although heterogeneity is beneficial for group decision-making, using a heterogeneous panel of experts does not necessarily guarantee the desired good results[368]. The depth of knowledge and experience of experts in a given field can lead to cognitive biases that make them produce different views and conclusions on certain issues[260].

Also, in the questionnaire, in order to help experts to better understand some of the questions, I have given some specific examples, for example, in Question 6,

Example: “When, in general, you design/pilot a complex health intervention, what factors do you consider in adapting an intervention to the local context?”

A study conducted within a decentralised public health care system describes the need to take into account the lack of electricity, water, functioning laboratories and adequate staffing in many centres when designing a complex intervention) Hernantes N (2022).”

While the example this study provided helps the expert to better understand the essence of the question, this example may somehow direct the expert's thinking such that their response is influenced by the example. When expert thinking is related to exposure to a specific example their responses may be influenced by that example and deviate to some extent from their original views. Therefore, this needs to be taken into account when analyzing and interpreting experts' responses to try to minimize the bias triggered by the examples provided.

Finally, the definition of consensus and the cut-off point set for reaching consensus is a controversial issue in this study. The first round of the Delphi survey set the consensus rate as 70% to be considered as reaching consensus, while in the follow-up survey, the consensus rate was set to 65% to be considered as reaching consensus.

This research design was chosen for this study for explicit reasons. In the second round of the Delphi survey, this study aimed to include factors that were explicit and non-controversial. And for those factors that presented a 65% to 70% consensus rate in the second round of the survey, this study hopes to obtain a detailed explanation in the third round to avoid possible errors, omissions, and misjudgments.

In terms of the results obtained from the Delphi survey and consensus meeting, many factors with a consensus rate of 65% to 70% are still controversial and needed to be explored in depth in the third round of Delphi survey or even consensus meeting. Doing so allowed for a comprehensive assessment of the importance of these factors and helped to better capture nuanced perspectives. The input provided by the experts

in the comment section helps to understand their reasons for agreeing or disagreeing with certain factors. This rich background information can guide subsequent analysis and help provide insights into the reasons behind different viewpoints.

However, although the issue of the definition and cut-off point of consensus is still much debated in the literature and lacks clear guidance, this study's setting of the consensus rate is potentially controversial. Keeney [292] suggests keeping the consensus rate consistent rather than using different rates between rounds, and his 75% consensus rate seems to be the minimum level.

Broomfield also supports that although the setting of cut-off points is arbitrary, the setting of precise cut-offs makes one speculate whether researchers sometimes succumb to the dubious practice of readjusting consensus cut-off points after data collection. (Broomfield & Humphris, 2001).

Chapter 12. Conclusion

This doctoral research harnessed the expertise of 62 global experts to dissect the multitude of factors affecting the Adaptability, Scalability, and Sustainability (AsaS) of complex health interventions, particularly within low- and middle-income countries (LMICs). Central to this exploration was the formulation of the METRO framework, a theoretical construct born from exhaustive Delphi surveys, consensus meetings, and systematic reviews. This concluding chapter endeavors not only to encapsulate the journey towards fulfilling the original objectives but also to critically examine the academic contributions, practical implications, and the framework's potential future pathways.

Enriching Knowledge

Through iterative Delphi surveys and consensus deliberations, this investigation ratified 51 critical factors pivotal for "sustainable support" across complex health interventions. While these factors were dissected across the dimensions of adaptability, scalability, and sustainability, an intriguing revelation was the intertwined nature of these dimensions, suggesting a more symbiotic relationship than previously acknowledged. The METRO framework stands as a testament to this intricate dance, offering a nuanced visualization that captures the dynamic interplay among these factors, thereby bridging previously identified gaps in the literature.

The METRO framework emerges not merely as a theoretical contribution but as a seminal tool poised to revolutionize how stakeholders—ranging from policymakers to grassroots implementers—conceptualize and navigate the complexities inherent in health interventions within LMICs. Its development represents a shift from linear methodologies to a more holistic and flexible approach that respects the unpredictability and diversity of real-world settings.

Practical Implications

At its inception, the METRO framework offers a blueprint for envisioning health interventions within LMICs through a more holistic lens. Despite its early stage, its foundations are robust, drawn from a wellspring of expert consensus and a comprehensive amalgamation of existing theoretical models. The framework's iterative development underscores a commitment to refinement and adaptability, qualities essential for any tool aspiring to influence real-world outcomes significantly. The METRO framework's practicality extends beyond academic circles, offering implementers a structured yet adaptable guide to navigating the multifaceted challenges of health interventions. Its emphasis on the interconnectedness of adaptability, scalability, and sustainability serves as a clarion call for interventions designed with the foresight of longevity and broad impact.

Future Directions

This research underscores the imperative of continuous engagement with the METRO framework—both in theoretical refinement and practical application. Future explorations should aim at validating and enriching the framework through diverse implementations, ensuring its evolution in tandem with emerging health challenges and innovations. The path forward calls for a collaborative ethos, inviting cross-disciplinary insights and integrating feedback loops from on-the-ground implementations to refine and enhance the METRO framework's utility.

The dissemination of this work assumes critical importance in magnifying its impact. Strategic publications, coupled with engagements through conferences, workshops, and digital platforms, will amplify the METRO framework's reach, inviting scrutiny, adoption, and adaptation across varied contexts.

In sum, this thesis not only contributes a pivotal framework to the academic and practical realms of public health but also opens avenues for future research and application that could shape the efficacy and impact of health interventions in LMICs. The METRO framework, in its essence, is a call to action—a tool for enabling more

resilient, adaptable, and sustainable health interventions that resonate with the needs and realities of diverse populations.

This study utilized 62 worldwide experts to identify the factors that influence AsaS of complex health interventions. Based on this, a theoretical (METRO) framework was developed to synthesize a description of these factors. This chapter will critically assess the extent to which the research has realized its initial objectives, while also scrutinizing its scholarly contributions, practical implications, and providing recommendations for prospective research endeavors.

The Contribution to Knowledge

After three rounds of Delphi survey iterations and subsequent consensus conferences, a total of 51 factors were agreed upon in this study that are relevant to influencing "sustainable support" for complex interventions. These factors were analyzed under one or more of the three concepts of adaptability, scalability, and sustainability, but there was no discussion of the factors common to all three concepts.

In order to better understand the relationship between these factors and the intricate intervention process, the researcher developed the METRO framework. The purpose of this graphic is to illustrate the connection between these factors and the complex intervention process in a more relatable way. This approach was not only helpful to the research team, but also potentially for various stakeholders, including other experts, implementers of complex interventions and relevant agencies. They can use the framework as a tool to assess the interventions they intend to undertake.

By applying the framework, stakeholders can take a holistic look at their intervention programs and determine if any key influencing factors may have been overlooked. This can help to improve the effectiveness and sustainability of interventions, thereby better meeting the needs of society and the health sector. This integrated approach is

expected to play an important role in future research and practice to better understand and address the challenges of complex interventions.

Implications for practice

At the current stage, the theoretical framework stands as a preliminary model. Despite its nascent state, it is firmly grounded in authoritative foundations. The comprehensive representation of expert perspectives from all three rounds of Delphi discussions and one consensus meeting lends it substantial credibility.

The establishment and refinement of the framework is a dynamic process that requires continuous validation and practice. Consequently, these factors are required to undergo validation and refinement through subsequent practical implementations of complex interventions to attain full consensus.

This may require interdisciplinary collaboration, including close cooperation between researchers, practitioners and government agencies. Consideration could be given to carrying out complex intervention projects in different countries and regions and observing their effectiveness in improving health and social well-being. These practical examples will help to further refine the framework so that it can be applied in different cultural and political contexts.

Consequently, an integral aspect of this study is the need for ongoing monitoring and follow-up. This involves not only the interventions conducted using this theoretical model by myself but also interventions carried out by other researchers employing this framework. If feasible, surveys or interviews could be administered to the utilized experts to gauge their experiential feedback.

The impact of this research on practice would be limited if its results are not disseminated. Publication serves as a conduit for reaching a broader audience, ensuring the broader dissemination of the developed framework. The choice of

publication outlet is a pivotal decision, as it can potentially influence practice in a significant manner.

Publication serves as an effective avenue for promotion and dissemination. Once referenced by others, it facilitates direct interaction with the users of the framework. Their feedback becomes invaluable for further refining and enhancing the model. Hence, I will encourage other researchers and practitioners to use our framework and network with them to get feedback on their experiences in practical applications. This collaboration and interaction will help us to continuously improve the framework and make it valuable for practical applications. In addition to academic journals and government reports, we will also consider disseminating our results by presenting at academic conferences, organizing workshops and seminars, preparing policy briefs, and using social media.

The extent to which these findings can be widely adopted or disseminated remains uncertain at this juncture. Yet, this uncertainty underscores the importance of ongoing refinement and updates to the theoretical framework in future research endeavours.

References

1. Venkatesh, V., Brown, S.A., and Sullivan, Y.W., *Guidelines for Conducting Mixed-methods Research: An Extension and Illustration*, Journal of the AIS, 2016. **17**(7): p. 435-495. <https://doi.org/10.17705/1jais.00433>.
2. Brugha, R. and A. Zwi, *Improving the quality of private sector delivery of public health services: challenges and strategies*. Health policy and planning, 1998. **13**(2): p. 107-120.
3. Prabhakaran, D., et al., *Cardiovascular, respiratory, and related disorders: key messages and essential interventions to address their burden in low-and middle-income countries*. Cardiovascular, Respiratory, and Related Disorders. 3rd edition. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017. Chapter 1. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK525173/> doi: 10.1596/978-1-4648-0518-9_ch1.
4. Olayemi, E., E.V. Asare, and A.A. Benneh-Akwasi Kuma, *Guidelines in lower-middle income countries*. British journal of haematology, 2017. **177**(6): p. 846-854.
5. Logan, P.A., et al., *A multidomain decision support tool to prevent falls in older people: the FinCH cluster RCT*. Health Technology Assessment (Winchester, England), 2022. **26**(9): p. 1.
6. CHU Hongling., *Introduction and interpretation of process evaluation of complex interventions: medical research council guidance*. Chinese Journal of Evidence-Based Medicine, 2020. **20**(11).
7. Moullin, J.C., et al., *Exploration, preparation, implementation, sustainment (EPIS) framework*. Handbook on implementation science, 2020: p. 32-61.
8. Damschroder, L.J., et al., *Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science*. Implementation science, 2009. **4**(1): p. 1-15.
9. Damschroder, L.J., et al., *Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science*. Implementation science, 2009. **4**: p. 1-15.
10. Gaglio, B., J.A. Shoup, and R.E. Glasgow, *The RE-AIM framework: a systematic review of use over time*. American journal of public health, 2013. **103**(6): p. e38-e46.
11. Bartels, S.M., et al., *Diversifying implementation science: a global perspective*. Global Health: Science and Practice, 2022. **10**(4).
12. Bergeron, K., et al., *Theories, models and frameworks used in capacity building interventions relevant to public health: a systematic review*. BMC public health, 2017. **17**: p. 1-12.
13. Kemp, C.G., et al., *Implementation science and stigma reduction interventions in low-and middle-income countries: a systematic review*. BMC medicine, 2019. **17**: p. 1-18.
14. Hodge, L.M. and K.M. Turner, *Sustained implementation of evidence-based programs in disadvantaged communities: A conceptual framework of supporting factors*. American Journal of Community Psychology, 2016. **58**(1-2): p. 192-210.
15. Frech, S., et al., *C/Can city Engagement process: an implementation framework*

for strengthening cancer care in cities in low-and middle-income countries. JCO Glob Oncol. 2021; **7**: p. 901–916.

16. Movsisyan, A., et al., *Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance.* Implementation Science, 2019. **14**: p. 1-20.

17. Skivington, K., et al., *A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance.* bmj, 2021. **374**.

18. Means, A.R., et al., *Evaluating and optimizing the consolidated framework for implementation research (CFIR) for use in low-and middle-income countries: a systematic review.* Implementation Science, 2020. **15**: p. 1-19.

19. Barker, P.M., A. Reid, and M.W. Schall, *A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa.* Implementation Science, 2015. **11**(1): p. 1-11.

20. Iwelunmor, J., et al., *Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and conceptual framework.* Implementation Science, 2015. **11**(1): p. 1-27.

21. Anderson, R., *New MRC guidance on evaluating complex interventions.* British Medical Journal Publishing Group, 2008. 337 :a1937 doi:10.1136/bmj.a1937.

22. Craig, P., et al., *Developing and evaluating complex interventions: the new Medical Research Council guidance.* Bmj, 2008. **337**.

23. Reed, M.S., et al., *Five principles for the practice of knowledge exchange in environmental management.* Journal of environmental management, 2014. **146**: p. 337-345.

24. Klerkx, L., A. Hall, and C. Leeuwis, *Strengthening agricultural innovation capacity: are innovation brokers the answer?* International Journal of Agricultural Resources, Governance and Ecology, 2009. **8**(5-6): p. 409-438.

25. Murray, E., et al., *Evaluating digital health interventions: key questions and approaches.* 2016, Elsevier. p. 843-851.

26. McCann, E. and K. Ward, *Assembling urbanism: Following policies and ‘studying through’ the sites and situations of policy making.* Environment and Planning A, 2012. **44**(1): p. 42-51.

27. Craig, P. and M. Petticrew, *Developing and evaluating complex interventions: reflections on the 2008 MRC guidance.* International journal of nursing studies, 2013. **50**(5): p. 585-587.

28. Moullin, J.C., et al., *Systematic review of the exploration, preparation, implementation, sustainment (EPIS) framework.* Implementation Science, 2019. **14**(1): p. 1-16.

29. Sarma, H., et al., *Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting.* Public health nutrition, 2021. **24**(S1): p. s7-s22.

30. Teal, C.R. and R.L. Street, *Critical elements of culturally competent communication in the medical encounter: a review and model.* Social science & medicine, 2009. **68**(3): p. 533-543.

31. Weller, J.M., M. Barrow, and S. Gasquoine, *Interprofessional collaboration among junior doctors and nurses in the hospital setting*. Medical education, 2011. **45**(5): p. 478-487.
32. Hamel, C., Michaud, A., Thuku, M., Skidmore, B., Stevens, A., Nussbaumer-Streit, B. and Garritty, C., *Defining rapid reviews: a systematic scoping review and thematic analysis of definitions and defining characteristics of rapid reviews*. Journal of Clinical Epidemiology, 2021. **129**, p.74-85.
33. WHO., *Practical guidance for scaling up health service innovations*. 2009: World Health Organization.
34. Waddington, C., *Scaling up health services: Challenges and choices*. HLSP Institute. <http://www.hlsp.org/LinkClick.aspx>, 2012.
35. Milat, A.J., et al., *The concept of scalability: increasing the scale and potential adoption of health promotion interventions into policy and practice*. Health promotion international, 2013. **28**(3): p. 285-298.
36. Scheirer, M.A. and J.W. Dearing, *An agenda for research on the sustainability of public health programs*. American journal of public health, 2011. **101**(11): p. 2059-2067.
37. LaPelle, N.R., J. Zapka, and J.K. Ockene, *Sustainability of public health programs: the example of tobacco treatment services in Massachusetts*. American Journal of Public Health, 2006. **96**(8): p. 1363-1369.
38. Shediach-Rizkallah, M.C. and L.R. Bone, *Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy*. Health education research, 1998. **13**(1): p. 87-108.
39. Mundial B., *World Bank Country and Lending Groups*. 2021: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.
40. May, C.R., et al., *Using normalization process theory in feasibility studies and process evaluations of complex healthcare interventions: a systematic review*. Implementation science, 2018. **13**: p. 1-27.
41. Sepasgozar, S.M., M. Loosemore, and S.R. Davis, *Conceptualising information and equipment technology adoption in construction: A critical review of existing research*. Engineering, Construction and Architectural Management, 2016. **23**(2): p. 158-176.
42. Lau, W.K.R., *Implementation of Complex Interventions in UK General Practice*. 2018, UCL (University College London).
43. Pfadenhauer, L.M., et al., *Context and implementation: a concept analysis towards conceptual maturity*. Zeitschrift für Evidenz, Fortbildung und Qualität im Gesundheitswesen, 2015. **109**(2): p. 103-114.
44. Yan, L.L., et al., *Prevention, management, and rehabilitation of stroke in low-and middle-income countries*. Eneurologicalsci, 2016. **2**: p. 21-30.
45. Maselko, J., *Social epidemiology and global mental health: expanding the evidence from high-income to low-and middle-income countries*. Current Epidemiology Reports, 2017. **4**: p. 166-173.
46. Robinson, H.M. and K. Hort, *Non-communicable diseases and health systems reform in low-and-middle-income countries*. Pac Health Dialog, 2012. **18**(1): p. 179-90.

47. Booth, A. and C. Carroll, *Systematic searching for theory to inform systematic reviews: is it feasible? Is it desirable?* Health Information & Libraries Journal, 2015. **32**(3): p. 220-235.
48. Noyes, J., et al., *Current use was established and Cochrane guidance on selection of social theories for systematic reviews of complex interventions was developed.* Journal of clinical epidemiology, 2016. **75**: p. 78-92.
49. Oliver, S.R., et al., *A multidimensional conceptual framework for analysing public involvement in health services research.* Health expectations, 2008. **11**(1): p. 72-84.
50. Milat, A.J. and B. Li, *Narrative review of frameworks for translating research evidence into policy and practice.* Public Health Res Pract, 2017. **27**(1): p. e2711704.
51. Rimer, B.K. and K. Glanz, *Theory at a glance: a guide for health promotion practice.* 2005: US Department of Health and Human Services, National Institutes of Health
52. Nilsen, P., *Making sense of implementation theories, models, and frameworks*, in *Implementation Science 3.0*. 2020, Springer. p. 53-79.
53. Ridde, V., D. Pérez, and E. Robert, *Using implementation science theories and frameworks in global health.* BMJ global health, 2020. **5**(4): p. e002269.
54. Sabatier, P.A. and C.M. Weible, *Theories of the policy process.* 2014: Westview Press.
55. Caldwell, K., L. Henshaw, and G. Taylor, *Developing a framework for critiquing health research: an early evaluation.* Nurse education today, 2011. **31**(8): p. e1-e7.
56. Creswell, J.W. and J.D. Creswell, *Research design: Qualitative, quantitative, and mixed methods approaches.* 2017: Sage, Newbury Park.
57. Bergeron, K., et al., *Theories, models and frameworks used in capacity building interventions relevant to public health: a systematic review.* BMC public health, 2017. **17**(1): p. 1-12.
58. Lucas, P.J., et al., *Worked examples of alternative methods for the synthesis of qualitative and quantitative research in systematic reviews.* BMC medical research methodology, 2007. **7**(1): p. 1-7.
59. Barnett-Page, E. and J. Thomas, *Methods for the synthesis of qualitative research: a critical review.* BMC medical research methodology, 2009. **9**(1): p. 1-11.
60. Wong, G., et al., *RAMESES publication standards: realist syntheses.* BMC medicine, 2013. **11**(1): p. 1-14.
61. Stetler, C.B., *Stetler model.* Models and frameworks for implementing evidence-based practice: Linking evidence to action, 2010: p. 51-81.
62. Titler, M.G., et al., *The Iowa model of evidence-based practice to promote quality care.* Critical care nursing clinics of North America, 2001. **13**(4): p. 497-509.
63. Graham, I.D. and J.M. Tetroe, *The knowledge to action framework.* Models and frameworks for implementing evidence-based practice: Linking evidence to action, 2010. **207**: p. 222.
64. Meyers, D.C., J.A. Durlak, and A. Wandersman, *The quality implementation framework: a synthesis of critical steps in the implementation process.* American journal of community psychology, 2012. **50**(3-4): p. 462-480.
65. Jacobson, N., D. Butterill, and P. Goering, *Development of a framework for knowledge translation: understanding user context.* Journal of health services research

- & policy, 2003. **8**(2): p. 94-99.
66. Atkins, L., et al., *A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems*. Implementation Science, 2017. **12**(1): p. 1-18.
 67. Cochrane, L.J., et al., *Gaps between knowing and doing: understanding and assessing the barriers to optimal health care*. Journal of continuing education in the health professions, 2007. **27**(2): p. 94-102.
 68. Birken, S.A., et al., *Organizational theory for dissemination and implementation research*. Implementation Science, 2017. **12**(1): p. 1-15.
 69. Glanz, K., *Theory at a glance: A guide for health promotion practice*. 1997: US Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute.
 70. Rogers, Everett M., Arvind Singhal, and Margaret M. Quinlan. *Diffusion of innovations*. In *An integrated approach to communication theory and research*, Routledge. 2014. p: 432-448.
 71. Michie, S., M.M. Van Stralen, and R. West, *The behaviour change wheel: a new method for characterising and designing behaviour change interventions*. Implementation science, 2011. **6**(1): p. 1-12.
 72. May, C.R., et al., *Development of a theory of implementation and integration: Normalization Process Theory*. Implementation Science, 2009. **4**(1): p. 1-9.
 73. Glasgow, R.E., T.M. Vogt, and S.M. Boles, *Evaluating the public health impact of health promotion interventions: the RE-AIM framework*. American journal of public health, 1999. **89**(9): p. 1322-1327.
 74. Green, L. and M. Kreuter, *The precede-proceed model*. Health promotion planning: an educational approach. 3rd ed. Mountain View (CA): Mayfield Publishing Company, 1999: p. 32-43.
 75. Movsisyan, A., et al., *Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance*. Implementation Science, 2019. **14**(1): p. 1-20.
 76. Chambers, D.A., R.E. Glasgow, and K.C. Stange, *The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change*. Implementation Science, 2013. **8**(1): p. 1-11.
 77. Davy, C., et al., *Factors influencing the implementation of chronic care models: a systematic literature review*. BMC family practice, 2015. **16**(1): p. 1-12.
 78. Stirman, S.W., A.A. Baumann, and C.J. Miller, *The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions*. Implementation Science, 2019. **14**(1): p. 1-10.
 79. Simpson, D.D., *A framework for implementing sustainable oral health promotion interventions*. Journal of public health dentistry, 2011. **71**: p. S84-S94.
 80. Khalil, H. and K. Kynoch, *Implementation of sustainable complex interventions in health care services: the triple C model*. BMC Health Services Research, 2021. **21**(1): p. 1-10.
 81. Mendel, P., et al., *Interventions in organizational and community context: a framework for building evidence on dissemination and implementation in health*

- services research. *Administration and Policy in Mental Health and Mental Health Services Research*, 2008. **35**(1-2): p. 21-37.
82. Pfadenhauer, L.M., et al., *Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework*. *Implementation science*, 2017. **12**(1): p. 1-17.
83. Scott, K.A. and J. Pringle, *The Power of the Frame: Systems Transformation Framework for Health Care Leaders*. *Nurs Adm Q*, 2018. **42**(1): p. 4-14.
84. Feldstein, A.C. and R.E. Glasgow, *A practical, robust implementation and sustainability model (PRISM) for integrating research findings into practice*. *The Joint Commission Journal on Quality and Patient Safety*, 2008. **34**(4): p. 228-243.
85. Yamey, G., *Scaling up global health interventions: a proposed framework for success*. *PLoS medicine*, 2011. **8**(6): p. e1001049.
86. Cooley, L., R. Kohl, and R. Ved, *Scaling up—from vision to large-scale change: a management framework for practitioners*. Washington, DC: Management Systems International, 2006.
87. Shelton, R.C., B.R. Cooper, and S.W. Stirman, *The sustainability of evidence-based interventions and practices in public health and health care*. *Annual review of public health*, 2018. **39**: p. 55-76.
88. De Silva, M.J., et al., *Theory of change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions*. *Trials*, 2014. **15**(1): p. 1-13.
89. Stratil, J.M., M. Voss, and L. Arnold, *WICID framework version 1.0: criteria and considerations to guide evidence-informed decision-making on non-pharmacological interventions targeting COVID-19*. *BMJ global health*, 2020. **5**(11): p. e003699.
90. Murray, E., et al., *Normalisation process theory: a framework for developing, evaluating and implementing complex interventions*. *BMC medicine*, 2010. **8**(1): p. 1-11.
91. Aarons, G.A., M. Hurlburt, and S.M. Horwitz, *Advancing a conceptual model of evidence-based practice implementation in public service sectors*. *Administration and policy in mental health and mental health services research*, 2011. **38**(1): p. 4-23.
92. McMullen, H., et al., *Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory*. *Trials*, 2015. **16**(1): p. 1-16.
93. Hockley, J., et al., *A framework for cross-cultural development and implementation of complex interventions to improve palliative care in nursing homes: the PACE steps to success programme*. *BMC health services research*, 2019. **19**(1): p. 1-11.
94. Artieta-Pinedo, I., et al., *Framework for the establishment of a feasible, tailored and effective perinatal education programme*. *BMC pregnancy and childbirth*, 2017. **17**(1): p. 1-10.
95. Apostolopoulos, Y., et al., *Moving alcohol prevention research forward—Part I: Introducing a complex systems paradigm*. *Addiction*, 2018. **113**(2): p. 353-362.
96. Greene, R.A., et al., *A person-focused model of care for the twenty-first century: A system-of-systems perspective*. *Population Health Management*, 2014. **17**(3): p. 166-171.

97. Beets, M.W., et al., *Translating policies into practice: A framework to prevent childhood obesity in afterschool programs*. Health Promotion Practice, 2013. **14**(2): p. 228-237.
98. Bradley, E.H., et al., *A model for scale up of family health innovations in low-income and middle-income settings: a mixed methods study*. BMJ open, 2012. **2**(4): p. e000987.
99. Hirschhorn, L.R., et al., *Development and application of a hybrid implementation research framework to understand success in reducing under-5 mortality in Rwanda*. Gates Open Research, 2021. **5**.
100. Singh, N.S., et al., *A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India*. BMJ Global Health, 2021. **6**(Suppl 5): p. e005041.
101. Aarons, G.A., M. Hurlburt, and S.M. Horwitz, *Advancing a conceptual model of evidence-based practice implementation in public service sectors*. Administration and policy in mental health and mental health services research, 2011. **38**: p. 4-23.
102. Mendel, P., et al., *Interventions in organizational and community context: a framework for building evidence on dissemination and implementation in health services research*. Administration and Policy in Mental Health and Mental Health Services Research, 2008. **35**: p. 21-37.
103. Albers, B., A. Shlonsky, and R. Mildon, *Implementation Science 3.0*. 2020: Springer.
104. Greenhalgh, T., et al., *Diffusion of innovations in service organizations: systematic review and recommendations*. The milbank quarterly, 2004. **82**(4): p. 581-629.
105. Heiman, H.J. and S. Artiga, *Beyond health care: the role of social determinants in promoting health and health equity*. Vol. 4. 2015: November.
106. Simpson, D.D., *A conceptual framework for transferring research to practice*. Journal of substance abuse treatment, 2002. **22**(4): p. 171-182.
107. Torry, M., *Ethical religion in primary care*. London journal of primary care, 2017. **9**(4): p. 49-53.
108. James, H.M., et al., *Spread, scale-up, and sustainability of video consulting in health care: systematic review and synthesis guided by the NASSS framework*. Journal of medical Internet research, 2021. **23**(1): p. e23775.
109. Raab, J., *Interorganizational Networks*, in *Encyclopedia of Social Network Analysis and Mining*, R. Alhajj and J. Rokne, Editors. 2018, Springer New York: New York, NY. p. 1136-1146.
110. Provan, K.G., A. Fish, and J. Sydow, *Interorganizational networks at the network level: A review of the empirical literature on whole networks*. Journal of management, 2007. **33**(3): p. 479-516.
111. Simpson, D.D. and D.F. Dansereau, *Assessing organizational functioning as a step toward innovation*. Science & Practice Perspectives, 2007. **3**(2): p. 20.
112. Chamberlain, P., et al., *Engaging and recruiting counties in an experiment on implementing evidence-based practice in California*. Administration and Policy in Mental Health and Mental Health Services Research, 2008. **35**(4): p. 250-260.
113. Glisson, C. and S.K. Schoenwald, *The ARC organizational and community*

intervention strategy for implementing evidence-based children's mental health treatments. Mental health services research, 2005. **7**(4): p. 243-259.

114. Mohiddin, A., et al., *Sharing specialist skills for diabetes in an inner city: A comparison of two primary care organisations over 4 years.* Journal of evaluation in clinical practice, 2006. **12**(5): p. 583-590.

115. Wang, A., et al., *The North Carolina experience with the diabetes health disparities collaboratives.* The Joint Commission Journal on Quality and Safety, 2004. **30**(7): p. 396-404.

116. Sunaert, P., et al., *Implementation of a program for type 2 diabetes based on the Chronic Care Model in a hospital-centered health care system:" the Belgian experience".* BMC Health Services Research, 2009. **9**(1): p. 1-14.

117. Wellingham, J., et al., *The development and implementation of the chronic care management programme in counties Manukau.* The New Zealand Medical Journal (Online), 2003. **116**(1169).

118. Lemay, C.A., et al., *Peer reviewed: lessons learned from a collaborative to improve care for patients with diabetes in 17 community health centers, Massachusetts, 2006.* Preventing chronic disease, 2010. **7**(4).

119. Bodenheimer, T., E.H. Wagner, and K. Grumbach, *Improving primary care for patients with chronic illness.* Jama, 2002. **288**(14): p. 1775-1779.

120. Nasmith, L., et al., *The challenge of promoting integration: conceptualization, implementation, and assessment of a pilot care delivery model for patients with type 2 diabetes.* Family Medicine, 2004. **36**(1): p. 40-45.

121. Carson Weinstein, L., et al., *Transforming assertive community treatment into an integrated care system: The role of nursing and primary care partnerships.* Journal of the American Psychiatric Nurses Association, 2011. **17**(1): p. 64-71.

122. Donovan, R.J., *Understanding the social determinants of health.* Social Marketing Quarterly, 2000. **6**(3): p. 55-57.

123. Biswas, R.K., et al., *A systematic assessment on COVID-19 preparedness and transition strategy in Bangladesh.* Journal of Evaluation in Clinical Practice, 2020. **26**(6): p. 1599-1611.

124. University, T. *Why Healthcare Advocacy Is Important.* 2021 [cited 2021 9th August].

125. Damanpour, F., *Organizational innovation: A meta-analysis of effects of determinants and moderators.* Academy of management journal, 1991. **34**(3): p. 555-590.

126. Ferlie, E.B. and S.M. Shortell, *Improving the quality of health care in the United Kingdom and the United States: a framework for change.* The Milbank Quarterly, 2001. **79**(2): p. 281-315.

127. Glisson, C. and L.R. James, *The cross-level effects of culture and climate in human service teams.* Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior, 2002. **23**(6): p. 767-794.

128. Aarons, G.A., *Transformational and transactional leadership: Association with attitudes toward evidence-based practice.* Psychiatric services, 2006. **57**(8): p. 1162-

- 1169.
129. Yano, E.M., *The role of organizational research in implementing evidence-based practice: QUERI Series*. Implementation Science, 2008. **3**(1): p. 1-15.
130. Aarons, G.A., et al., *Expanding the domains of attitudes towards evidence-based practice: the evidence based practice attitude scale-50*. Administration and policy in mental health and mental health services research, 2012. **39**(5): p. 331-340.
131. Armenakis, A.A., et al., *Organizational change recipients' beliefs scale: Development of an assessment instrument*. The Journal of applied behavioral science, 2007. **43**(4): p. 481-505.
132. Glisson, C., et al., *Assessing the organizational social context (OSC) of mental health services: Implications for research and practice*. Administration and Policy in Mental Health and Mental Health Services Research, 2008. **35**(1-2): p. 98.
133. Review, T.O. *Absorptive capacity: Definition and explanation*. 2021 [cited 2021 02/10].
134. Patterson, F., E. Ferguson, and S. Thomas, *Using job analysis to identify core and specific competencies: implications for selection and recruitment*. Medical Education, 2008. **42**(12): p. 1195-1204.
135. Katz, I., et al., *Managing type 2 diabetes in Soweto—the South African chronic disease outreach program experience*. Primary care diabetes, 2009. **3**(3): p. 157-164.
136. Si, D., et al., *Describing and analysing primary health care system support for chronic illness care in Indigenous communities in Australia's Northern Territory—use of the Chronic Care Model*. BMC Health Services Research, 2008. **8**(1): p. 1-14.
137. Prennushi, Giovanna, Gloria Rubio, and Kalanidhi Subbarao. *Monitoring and evaluation. A sourcebook for poverty reduction strategies*, 2002. p. 107-30.
138. Maidique, M.A., *Entrepreneurs, champions, and technological innovation*. Sloan management review, 1980. **21**(2): p. 59-76.
139. Hroschowski, M.C., et al., *Challenges of change: a qualitative study of chronic care model implementation*. The Annals of Family Medicine, 2006. **4**(4): p. 317-326.
140. Rashed, S., et al., *Sustaining malaria prevention in Benin: local production of bednets*. Health Policy and Planning, 1997. **12**(1): p. 67-76.
141. Osawa, E., T. Kodama, and E. Kundishora, *Motivation and sustainability of care facilitators engaged in a community home-based HIV/AIDS program in Masvingo Province, Zimbabwe*. AIDS care, 2010. **22**(7): p. 895-902.
142. Humphries, D., L. Gomez, and K. Hartwig, *Sustainability of NGO capacity building in southern Africa: successes and opportunities*. The International journal of health planning and management, 2011. **26**(2): p. e85-e101.
143. Proctor, E., et al., *Intermediary/purveyor organizations for evidence-based interventions in the US child mental health: characteristics and implementation strategies*. Implementation Science, 2019. **14**(1): p. 1-14.
144. Hean, S., et al., *The contribution of theory to the design, delivery, and evaluation of interprofessional curricula: BEME Guide No. 49*. Medical teacher, 2018. **40**(6): p. 542-558.
145. Greenhalgh, T., et al., *Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and*

- sustainability of health and care technologies*. Journal of medical Internet research, 2017. **19**(11): p. e367.
146. Ye, F., *A study on the descriptive definition and evaluation criterion of subhealth using modified Delphi method*. Peking Union Medical College, 2000.
 147. Eldredge, L.K.B., et al., *Planning health promotion programs: an intervention mapping approach*. 2016: John Wiley & Sons.
 148. Swindle, T., et al., *Implementation fidelity, attitudes, and influence: a novel approach to classifying implementer behavior*. Implementation Science Communications, 2022. **3**(1): p. 60.
 149. Mariani, G., et al., *Improving women's health in low-income and middle-income countries. Part I: challenges and priorities*. Nuclear medicine communications, 2017. **38**(12): p. 1019.
 150. Bhanbhro, S., et al., *Factors affecting maternal nutrition and health: A qualitative study in a matrilineal community in Indonesia*. Plos one, 2020. **15**(6): p. e0234545.
 151. Sheeran, P. and C. Abraham, *The health belief model*. Predicting health behaviour, 1996. **2**: p. 29-80.
 152. Ajzen, I., *From intentions to actions: A theory of planned behavior*, in *Action control*. 1985, Springer. p. 11-39.
 153. Weiner, B.J., et al., *The meaning and measurement of implementation climate*. Implementation Science, 2011. **6**(1): p. 1-12.
 154. Klaic, M., et al., *Implementability of healthcare interventions: an overview of reviews and development of a conceptual framework*. Implementation Science, 2022. **17**(1): p. 1-20.
 155. Craig, P., et al., *Developing and evaluating complex interventions an introduction to the new Medical Research Council guidance*. Evidence-Based Public Health: Effectiveness and Efficiency, 2010. **1**: p. 185-203.
 156. Wade, D.M., et al., *Detecting acute distress and risk of future psychological morbidity in critically ill patients: validation of the intensive care psychological assessment tool*. Critical Care, 2014. **18**(5): p. 1-9.
 157. Minary, L., et al., *Which design to evaluate complex interventions? Toward a methodological framework through a systematic review*. BMC Medical Research Methodology, 2019. **19**(1): p. 1-9.
 158. Ghiron, L., et al., *Promoting Scale-Up Across a Global Project Platform: Lessons from the Evidence to Action Project*. Global Implementation Research and Applications, 2021. **1**(2): p. 69-76.
 159. World Bank. *World Bank Global Index LMIC List 2020* 2020 [cited 2021 29 September].
 160. U.S. Department of Labor. *Implementation Guidelines, Version 1.0 | CLEAR*. 2014 [cited 2021 13th Sep.].
 161. Heller, R.F., et al., *Critical appraisal for public health: a new checklist*. Public health, 2008. **122**(1): p. 92-98.
 162. Bulthuis, S.E., et al., *Factors influencing the scale-up of public health interventions in low-and middle-income countries: a qualitative systematic literature*

review. *Health policy and planning*, 2020. **35**(2): p. 219-234.

163. Berta, W.B., et al., *Sustainment, Sustainability, and Spread Study (SSaSSy): protocol for a study of factors that contribute to the sustainment, sustainability, and spread of practice changes introduced through an evidence-based quality-improvement intervention in Canadian nursing homes*. *Implementation Science*, 2019. **14**(1): p. 1-10.

164. Abbey, M., et al., *Factors related to retention of community health workers in a trial on community-based management of fever in children under 5 years in the Dangme West District of Ghana*. *International Health*, 2014. **6**(2): p. 99-105.

165. Ahluwalia, I.B., et al., *Sustainability of community-capacity to promote safer motherhood in northwestern Tanzania: what remains?* *Global health promotion*, 2010. **17**(1): p. 39-49.

166. Ajayi, I.O., S.A. Jegede, and C.O. Falade. *Sustainability of intervention for home management of malaria: the Nigerian experience*. in *American Journal of Tropical Medicine and Hygiene*. 2010. AMER SOC TROP MED & HYGIENE 8000 WESTPARK DR, STE 130, MCLEAN, VA 22101 USA.

167. Amo-Adjei, J., *Perspectives of stakeholders on the sustainability of tuberculosis control programme in Ghana*. *Tuberculosis research and treatment*, 2013. **2013**.

168. Chibanda, D., et al., *Using a theory driven approach to develop and evaluate a complex mental health intervention: the friendship bench project in Zimbabwe*. *International journal of mental health systems*, 2016. **10**(1): p. 1-9.

169. Cleary, S., et al., *The everyday practice of supporting health system development: learning from how an externally-led intervention was implemented in Mozambique*. *Health policy and planning*, 2018. **33**(7): p. 801-810.

170. Dolan, S.B., et al., *Perceptions of factors influencing the introduction and adoption of electronic immunization registries in Tanzania and Zambia: a mixed methods study*. *Implementation Science Communications*, 2020. **1**(1): p. 1-15.

171. Fried, J., B. Harris, and J. Eyles, *Hopes interrupted: accessing and experiences of antiretroviral therapy in South Africa*. *Sexually transmitted infections*, 2012. **88**(2): p. 147-151.

172. Ghiron, L., et al., *Beginning with sustainable scale up in mind: initial results from a population, health and environment project in East Africa*. *Reproductive health matters*, 2014. **22**(43): p. 84-92.

173. Hutchinson, C., et al., *Exploring the sustainability of obstetric near-miss case reviews: a qualitative study in the South of Benin*. *Midwifery*, 2010. **26**(5): p. 537-543.

174. Igwesi-Chidobe, C.N., et al., *Evidence, theory and context: using intervention mapping in the development of a community-based self-management program for chronic low back pain in a rural African primary care setting-the good back program*. *BMC public health*, 2020. **20**(1): p. 1-21.

175. Katz, I., et al., *Lessons learned from stakeholder-driven sustainability analysis of six national HIV programmes*. *Health policy and planning*, 2014. **29**(3): p. 379-387.

176. Le Gargasson, J.-B., et al., *Sustainability of National Immunization Programme (NIP) performance and financing following Global Alliance for Vaccines and*

- Immunization (GAVI) support to the Democratic Republic of the Congo (DRC)*. Vaccine, 2013. **31**(15): p. 1886-1891.
177. Leon, N., S. Lewin, and C. Mathews, *Implementing a provider-initiated testing and counselling (PITC) intervention in Cape town, South Africa: a process evaluation using the normalisation process model*. Implementation Science, 2013. **8**(1): p. 1-17.
 178. Maticka-Tyndale, E., *Sustainability of gains made in a primary school HIV prevention programme in Kenya into the secondary school years*. Journal of Adolescence, 2010. **33**(4): p. 563-573.
 179. Mutabazi, J.C., et al., *Integrating the prevention of mother-to-child transmission of HIV into primary healthcare services after AIDS denialism in South Africa: perspectives of experts and health care workers-a qualitative study*. BMC Health Services Research, 2020. **20**(1): p. 1-18.
 180. Mutale, W., et al., *Application of systems thinking: 12-month postintervention evaluation of a complex health system intervention in Zambia: the case of the BHOMA*. Journal of evaluation in clinical practice, 2017. **23**(2): p. 439-452.
 181. Rasschaert, F., et al., *Sustainability of a community-based anti-retroviral care delivery model—a qualitative research study in Tete, Mozambique*. Journal of the International AIDS Society, 2014. **17**(1): p. 18910.
 182. Roura, M., et al., *Barriers to sustaining antiretroviral treatment in Kisesa, Tanzania: a follow-up study to understand attrition from the antiretroviral program*. AIDS patient care and STDs, 2009. **23**(3): p. 203-210.
 183. Sako, B., et al., *Exploring barriers and enablers for scaling up a community-based grain bank intervention for improved infant and young child feeding in Ethiopia: a qualitative process evaluation*. Maternal & child nutrition, 2018. **14**(2): p. e12551.
 184. Sebotsa, M.L.D., et al., *Assessment of the sustainability of the iodine-deficiency disorders control program in Lesotho*. Food and nutrition bulletin, 2007. **28**(3): p. 337-347.
 185. Somassè, Y.E., et al., *Sustainability and scaling-up analysis of community-based management of acute malnutrition: lessons learned from Burkina Faso*. Food and nutrition bulletin, 2013. **34**(3): p. 338-348.
 186. Teguete, I., et al., *Can visual cervical screening be sustained in routine health services? Experience from Mali, Africa*. BJOG: An International Journal of Obstetrics & Gynaecology, 2012. **119**(2): p. 220-226.
 187. Torpey, K., et al., *Increasing the uptake of prevention of mother-to-child transmission of HIV services in a resource-limited setting*. BMC health services research, 2010. **10**(1): p. 1-8.
 188. Vamos, S., et al., *Translation and sustainability of an HIV prevention intervention in Lusaka, Zambia*. Translational behavioral medicine, 2014. **4**(2): p. 141-148.
 189. Walsh, A., et al., *“The problem is ours, it is not CRAIDS”. Evaluating sustainability of Community Based Organisations for HIV/AIDS in a rural district in Zambia*. Globalization and health, 2012. **8**(1): p. 1-16.
 190. Wandeler, G., et al., *Outcomes of antiretroviral treatment programs in rural Southern Africa*. Journal of acquired immune deficiency syndromes (1999), 2012. **59**(2):

p. e9.

191. Zakumumpa, H., S. Bennett, and F. Ssengooba, *Accounting for variations in ART program sustainability outcomes in health facilities in Uganda: a comparative case study analysis*. BMC health services research, 2016. **16**(1): p. 1-13.
192. Zullig, L.L., et al., *Sustainability of cancer registration in the Kilimanjaro Region of Tanzania—a qualitative assessment*. World health & population, 2014. **15**(1): p. 21.
193. Arthur, K., N. Christofides, and G. Nelson, *Process evaluation of a pre-adolescent transdisciplinary health intervention for inter-generational outcomes*. Plos one, 2021. **16**(12): p. e0261632.
194. Bright, S., et al., *Scale-up of a novel vital signs alert device to improve maternity care in Sierra Leone: a mixed methods evaluation of adoption*. Reproductive Health, 2023. **20**(1): p. 6.
195. Ezezika, O., et al., *The implementation of a maternal mHealth project in South Africa: Lessons for taking mHealth innovations to scale*. African Journal of Science, Technology, Innovation and Development, 2022. **14**(7): p. 1798-1812.
196. Grant, J., et al., *Challenges and lessons learned during the planning and early implementation of the RTS, S/AS01E malaria vaccine in three regions of Ghana: a qualitative study*. Malaria journal, 2022. **21**(1): p. 1-12.
197. Ishola, O.D., et al., *What underlies state government performance in scaling family planning programming? A study of the challenge initiative state partnerships in Nigeria*. Global Health: Science and Practice, 2022.
198. Iwelunmor, J., et al., *Factors influencing the integration of evidence-based task-strengthening strategies for hypertension control within HIV clinics in Nigeria*. Implementation Science Communications, 2022. **3**(1): p. 1-12.
199. Kiracho, E.E., et al., *Designing for Scale and taking scale to account: lessons from a community score card project in Uganda*. International journal for equity in health, 2021. **20**: p. 1-11.
200. Niang, M., M.-P. Gagnon, and S. Dupéré, *Using systems thinking to understand scale-up and sustainability of health innovation: a case study of Seasonal malaria chemoprevention processes in Burkina Faso*. 2023.
201. O'Malley, G., et al., *Health care providers as agents of change: integrating PrEP with other sexual and reproductive health services for adolescent girls and young women*. Frontiers in Reproductive Health, 2021. **3**: p. 668672.
202. Renzaho, A.M., et al., *Pathways and approaches for scaling-up of community-based management of acute malnutrition programs through the lens of complex adaptive systems in South Sudan*. Archives of Public Health, 2022. **80**(1): p. 203.
203. Wexler, C., et al., *Implementing at-birth, point-of-care HIV testing in Kenya: a qualitative study using the Consolidated Framework for Implementation Research*. Implementation Science Communications, 2021. **2**(1): p. 1-13.
204. Ansbro, É., et al., *MSF experiences of providing multidisciplinary primary level NCD care for Syrian refugees and the host population in Jordan: an implementation study guided by the RE-AIM framework*. BMC health services research, 2021. **21**(1): p. 1-19.
205. Biswas, R.K., et al., *A systematic assessment on COVID-19 preparedness and*

transition strategy in Bangladesh. Journal of Evaluation in Clinical Practice, 2020. **26**(6): p. 1599-1611.

206. Bogren, M.U., et al., *Towards a midwifery profession in Bangladesh—a systems approach for a complex world*. BMC pregnancy and childbirth, 2015. **15**(1): p. 1-11.

207. Chu, H., et al., *A mixed methods process evaluation of a clustered-randomized controlled trial to determine the effects of community-based dietary sodium reduction in rural China*. Frontiers in medicine, 2021. **8**.

208. Echaubard, P., et al., *Fostering social innovation and building adaptive capacity for dengue control in Cambodia: a case study*. Infectious Diseases of Poverty, 2020. **9**(1): p. 1-12.

209. Morrison, J., et al., *Implementation and fidelity of a participatory learning and action cycle intervention to prevent and control type 2 diabetes in rural Bangladesh*. Global health research and policy, 2019. **4**(1): p. 1-15.

210. VanDevanter, N., et al., *Application of the Consolidated Framework for Implementation Research to assess factors that may influence implementation of tobacco use treatment guidelines in the Viet Nam public health care delivery system*. Implementation Science, 2017. **12**(1): p. 1-8.

211. Varghese, J., et al., *Advancing the application of systems thinking in health: understanding the growing complexity governing immunization services in Kerala, India*. Health Research Policy and Systems, 2014. **12**(1): p. 1-12.

212. Huda, F.A., et al., *Examining the implementation of Facility-Based Integrated Management of Childhood Illness and Insecticide Treated Nets in Bangladesh: lessons learned through implementation research*. medRxiv, 2023: p. 2023.05. 30.23290710.

213. Lu, S., et al., *Using Stakeholder Perceptions to Inform Future Efforts to Implement Mental Health First Aid Training in China: A Qualitative Study*. Frontiers in Psychiatry, 2021. **12**: p. 557282.

214. Zhou, S., et al., *Barriers and enablers in the implementation of a quality improvement program for acute coronary syndromes in hospitals: a qualitative analysis using the consolidated framework for implementation research*. Implementation Science, 2022. **17**(1): p. 36.

215. Arredondo, A., A. Azar, and A.L. Recaman, *Challenges and dilemmas on universal coverage for non-communicable diseases in middle-income countries: evidence and lessons from Mexico*. Globalization and health, 2018. **14**(1): p. 1-10.

216. Cardenas, M., J. Miranda, and D. Beran, *Delivery of Type 2 diabetes care in low-and middle-income countries: lessons from Lima, Peru*. Diabetic Medicine, 2016. **33**(6): p. 752-760.

217. Diaz, L.J.R. and D.d.A.L.M.d. Cruz, *Designing a telephone intervention program for family caregivers*. Revista da Escola de Enfermagem da USP, 2018. **51**.

218. Ledogar, R.J., et al., *Mobilising communities for Aedes aegypti control: the SEPA approach*. BMC Public Health, 2017. **17**(1): p. 103-114.

219. Rivière-Cinamond, A., et al., *Identifying the social and environmental determinants of plague endemicity in Peru: insights from a case study in Ascope, La Libertad*. BMC public health, 2018. **18**(1): p. 1-11.

220. Buccini, G., S.I. Venancio, and R. Pérez-Escamilla, *Scaling up of Brazil's Criança*

Feliz early childhood development program: an implementation science analysis. Annals of the New York Academy of Sciences, 2021. **1497**(1): p. 57-73.

221. Harker Roa, A., et al., *Implementing psychosocial support models in contexts of extreme adversity: lessons from a process evaluation in Colombia.* Frontiers in psychology, 2023. **14**: p. 1134094.

222. Straw, C., et al., *Implementation and scaling-up of an effective mHealth intervention to increase adherence to triage of HPV-positive women (ATICA study): perceptions of health decision-makers and health-care providers.* BMC Health Services Research, 2023. **23**(1): p. 1-13.

223. Atun, R.A., et al., *Diffusion of complex health innovations—implementation of primary health care reforms in Bosnia and Herzegovina.* Health policy and planning, 2007. **22**(1): p. 28-39.

224. Beardmore-Gray, A., et al., *Planned early delivery for late preterm pre-eclampsia in a low-and middle-income setting: a feasibility study.* Reproductive health, 2021. **18**(1): p. 1-17.

225. Blanchet, K., et al., *Advancing the application of systems thinking in health: analysing the contextual and social network factors influencing the use of sustainability indicators in a health system—a comparative study in Nepal and Somaliland.* Health research policy and systems, 2014. **12**(1): p. 1-11.

226. Adam, T., et al., *Evaluating health systems strengthening interventions in low-income and middle-income countries: are we asking the right questions?* Health policy and planning, 2012. **27**(suppl_4): p. iv9-iv19.

227. Correia, J.C., et al., *Interventions targeting hypertension and diabetes mellitus at community and primary healthcare level in low-and middle-income countries: a scoping review.* BMC Public Health, 2019. **19**(1): p. 1-20.

228. Gruen, R.L., et al., *Sustainability science: an integrated approach for health-programme planning.* The Lancet, 2008. **372**(9649): p. 1579-1589.

229. Pérez-Escamilla, R., et al., *Becoming Breastfeeding Friendly Index: Development and application for scaling-up breastfeeding programmes globally.* Maternal & Child Nutrition, 2018. **14**(3): p. e12596.

230. Schruijer, S., *The dynamics of interorganizational collaborative relationships: Introduction.* 2020, MDPI. p. 53.

231. Aunger, J.A., et al., *Why do some inter-organisational collaborations in healthcare work when others do not? A realist review.* Systematic reviews, 2021. **10**: p. 1-22.

232. Eaton, J., et al., *A structured approach to integrating mental health services into primary care: development of the Mental Health Scale Up Nigeria intervention (mhSUN).* International journal of mental health systems, 2018. **12**(1): p. 1-12.

233. Edwards, N. and P.M. Barker, *The importance of context in implementation research.* JAIDS Journal of Acquired Immune Deficiency Syndromes, 2014. **67**: p. S157-S162.

234. Walugembe, D.R., et al., *Sustainability of public health interventions: where are the gaps?* Health research policy and systems, 2019. **17**(1): p. 1-7.

235. Means, A.R., et al., *Evaluating and optimizing the consolidated framework for*

implementation research (CFIR) for use in low-and middle-income countries: a systematic review. Implementation Science, 2020. **15**(1): p. 1-19.

236. Hall, R., *Mixed methods: In search of a paradigm.* Conducting research in a changing and challenging world, 2013: p. 71-78.

237. Creswell, J.W., *Qualitative, quantitative and mixed methods approaches.* 2014, Sage.

238. Kukla, A., *Social constructivism and the philosophy of science.* 2013: Routledge.

239. Legg, C. and C. Hookway, *Pragmatism.* 2008.

240. Creswell, J.W., *The selection of a research approach.* Research design: Qualitative, quantitative, and mixed methods approaches, 2014. **2014**: p. 3-24.

241. Johnson, R.B. and A.J. Onwuegbuzie, *Mixed methods research: A research paradigm whose time has come.* Educational researcher, 2004. **33**(7): p. 14-26.

242. Kaushik, V. and C.A. Walsh, *Pragmatism as a research paradigm and its implications for social work research.* Social sciences, 2019. **8**(9): p. 255.

243. Watkins, D. and D. Gioia, *Mixed methods research.* 2015: Pocket Guide to Social Work Re.

244. Shorten, A. and J. Smith, *Mixed methods research: expanding the evidence base.* 2017, Royal College of Nursing. p. 74-75.

245. Fabregues, S., et al., *Use of mixed methods research in intervention studies to increase young people's interest in STEM: A systematic methodological review.* Frontiers in Psychology, 2023. **13**: p. 956300.

246. Regnault, A., et al., *Towards the use of mixed methods inquiry as best practice in health outcomes research.* Journal of patient-reported outcomes, 2018. **2**(1): p. 19.

247. Ivankova, N.V., J.W. Creswell, and S.L. Stick, *Using mixed-methods sequential explanatory design: From theory to practice.* Field methods, 2006. **18**(1): p. 3-20.

248. Hasson, F., S. Keeney, and H. McKenna, *Research guidelines for the Delphi survey technique.* Journal of advanced nursing, 2000. **32**(4): p. 1008-1015.

249. Harvey, N. and C.A. Holmes, *Nominal group technique: an effective method for obtaining group consensus.* International journal of nursing practice, 2012. **18**(2): p. 188-194.

250. Venkatesh, V., S.A. Brown, and Y. Sullivan, *Guidelines for conducting mixed-methods research: An extension and illustration.* Venkatesh, V., Brown, SA, and Sullivan, YW'Guidelines for Conducting Mixed-methods Research: An Extension and Illustration,'Journal of the AIS (17: 7), 2016: p. 435-495.

251. Flyvbjerg, B., *Case study.* The Sage handbook of qualitative research, 2011. **4**: p. 301-316.

252. Murry Jr, J.W. and J.O. Hammons, *Delphi: A versatile methodology for conducting qualitative research.* The review of higher education, 1995. **18**(4): p. 423-436.

253. Waggoner, J., J.D. Carline, and S.J. Durning, *Is there a consensus on consensus methodology? Descriptions and recommendations for future consensus research.* Academic Medicine, 2016. **91**(5): p. 663-668.

254. Suckley, J., *Core clinical competencies for extended-scope physiotherapists working in musculoskeletal (MSK) interface clinics based in primary care: a Delphi*

- consensus study*. 2012: University of Salford (United Kingdom).
255. de Meyrick, J., *The Delphi method and health research*. Health education, 2003.
 256. Schneider, P., et al., *Moving forward through consensus: protocol for a modified Delphi approach to determine the top research priorities in the field of orthopaedic oncology*. BMJ open, 2016. **6**(5): p. e011780.
 257. Hsu, C.-C. and B.A. Sandford, *The Delphi technique: making sense of consensus*. Practical assessment, research, and evaluation, 2007. **12**(1).
 258. Skulmoski, G.J., F.T. Hartman, and J. Krahn, *The Delphi method for graduate research*. Journal of Information Technology Education: Research, 2007. **6**(1): p. 1-21.
 259. Okoli, C. and S.D. Pawlowski, *The Delphi method as a research tool: an example, design considerations and applications*. Information & management, 2004. **42**(1): p. 15-29.
 260. Turoff, M. and H.A. Linstone, *The Delphi method-techniques and applications*. 2002.
 261. Rowe, G. and G. Wright, *Expert opinions in forecasting: the role of the Delphi technique*. Principles of forecasting: A handbook for researchers and practitioners, 2001: p. 125-144.
 262. Cook, C., F. Heath, and R.L. Thompson, *A meta-analysis of response rates in web-or internet-based surveys*. Educational and psychological measurement, 2000. **60**(6): p. 821-836.
 263. Manfreda, K.L., et al., *Web surveys versus other survey modes: A meta-analysis comparing response rates*. International journal of market research, 2008. **50**(1): p. 79-104.
 264. Sheehan, K.B., *E-mail survey response rates: A review*. Journal of computer-mediated communication, 2001. **6**(2): p. JCMC621.
 265. Kaplowitz, M.D., T.D. Hadlock, and R. Levine, *A comparison of web and mail survey response rates*. Public opinion quarterly, 2004. **68**(1): p. 94-101.
 266. Sills, S.J. and C. Song, *Innovations in survey research: An application of web-based surveys*. Social science computer review, 2002. **20**(1): p. 22-30.
 267. Gordon, T.J., *The delphi method*. Futures research methodology, 1994. **2**(3): p. 1-30.
 268. Whitaker, J., et al., *Assessing barriers to quality trauma care in low and middle-income countries: a Delphi study*. Injury, 2020. **51**(2): p. 278-285.
 269. Adler, M. and E. Ziglio, *Gazing into the oracle: The Delphi method and its application to social policy and public health*. 1996: Jessica Kingsley Publishers.
 270. Linstone, H.A. and M. Turoff, *The delphi method*. 1975: Addison-Wesley Reading, MA.
 271. Yousuf, M.I., *The delphi technique*. Essays in Education, 2007. **20**(1): p. 8.
 272. Hasson, F. and S. Keeney, *Enhancing rigour in the Delphi technique research*. Technological Forecasting and Social Change, 2011. **78**(9): p. 1695-1704.
 273. Beretta, R., *A critical review of the Delphi technique*. Nurse researcher, 1996. **3**(4): p. 79-89.
 274. Rowe, G. and G. Wright, *The Delphi technique as a forecasting tool: issues and*

- analysis. International journal of forecasting, 1999. **15**(4): p. 353-375.
275. Wright, A., *Predictions on the future of clinical psychology in Wales: A modified Delphi Study*. 2012, Cardiff University.
276. Diamond, I.R., et al., *Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies*. Journal of clinical epidemiology, 2014. **67**(4): p. 401-409.
277. Stone, F.L. and D. Busby, *The Delphi Method*. Research methods in family therapy, 2005: p. 238-253.
278. Downing, J., et al., *Priorities for global research into children's palliative care: results of an International Delphi Study*. BMC Palliative Care, 2015. **14**(1): p. 1-10.
279. Ntoburi, S., et al., *Development of paediatric quality of inpatient care indicators for low-income countries-A Delphi study*. BMC pediatrics, 2010. **10**(1): p. 1-11.
280. Chalmers, Jane & Armour, Mike. The Delphi Technique. In *Pranee Liamputtong (ed.), Handbook of Research Methods in Health Social Sciences*. Springer Singapore. 2019. p. 715-735.
281. Crane, D., E.J. Henderson, and D.R. Chadwick, *Exploring the acceptability of a 'limited patient consent procedure' for a proposed blood-borne virus screening programme: a Delphi consensus building technique*. BMJ Open, 2017. **7**(5): p. e015373.
282. Cook, S., et al., *Development of the diabetes problem-solving measure for adolescents*. The Diabetes Educator, 2001. **27**(6): p. 865-874.
283. Wainwright, P., et al., *The use of vignettes within a Delphi exercise: a useful approach in empirical ethics?* Journal of Medical Ethics, 2010. **36**(11): p. 656-660.
284. Boel, A., et al., *Two different invitation approaches for consecutive rounds of a Delphi survey led to comparable final outcome*. Journal of Clinical Epidemiology, 2021. **129**: p. 31-39.
285. Clibbens, N., S. Walters, and W. Baird, *Delphi research: issues raised by a pilot study*. Nurse researcher, 2012. **19**(2).
286. Sharma, H., *How short or long should be a questionnaire for any research? Researchers dilemma in deciding the appropriate questionnaire length*. Saudi journal of anaesthesia, 2022. **16**(1): p. 65.
287. Chyung, S.Y., et al., *Evidence-based survey design: The use of a midpoint on the Likert scale*. Performance Improvement, 2017. **56**(10): p. 15-23.
288. Krippendorff, K., *Content analysis: An introduction to its methodology*. 2018: Sage publications.
289. Braun, V. and V. Clarke, *Using thematic analysis in psychology*. Qualitative research in psychology, 2006. **3**(2): p. 77-101.
290. Braun, V. and V. Clarke, *Thematic analysis*. 2012: American Psychological Association.
291. Fink, A., et al., *Consensus methods: characteristics and guidelines for use*. American journal of public health, 1984. **74**(9): p. 979-983.
292. Keeney, S., F. Hasson, and H. McKenna, *Consulting the oracle: ten lessons from using the Delphi technique in nursing research*. Journal of advanced nursing, 2006. **53**(2): p. 205-212.

293. Organization, W.H., *Decision-making for guideline development at WHO*. WHO handbook for guideline development, 2014: p. 201-14.
294. Black, N., et al., *Consensus development methods: a review of best practice in creating clinical guidelines*. Journal of health services research & policy, 1999. **4**(4): p. 236-248.
295. Murphy, M., et al., *Consensus development methods, and their use in clinical guideline development*. Health Technology Assessment (Winchester, England), 1998. **2**(3): p. i-88.
296. Durão, S., et al., *Infrastructure, policy and regulatory interventions to increase physical activity to prevent cardiovascular diseases and diabetes: a systematic review*. BMC public health, 2023. **23**(1): p. 1-37.
297. Darzi, A., et al., *A methodological survey identified eight proposed frameworks for the adaptation of health related guidelines*. Journal of clinical epidemiology, 2017. **86**: p. 3-10.
298. Gearing, R.E., et al., *Adaptation and translation of mental health interventions in Middle Eastern Arab countries: A systematic review of barriers to and strategies for effective treatment implementation*. International journal of social psychiatry, 2013. **59**(7): p. 671-681.
299. BAILEY, S., et al., *Involving disabled children and young people as partners in research: a systematic review*. Child: care, health and development, 2015. **41**(4): p. 505-514.
300. Chola, L., et al., *Reducing diarrhoea deaths in South Africa: costs and effects of scaling up essential interventions to prevent and treat diarrhoea in under-five children*. BMC Public Health, 2015. **15**(1): p. 1-10.
301. Cabassa, L.J., et al., *Using the collaborative intervention planning framework to adapt a health-care manager intervention to a new population and provider group to improve the health of people with serious mental illness*. Implementation Science, 2014. **9**(1): p. 1-11.
302. Weiser, S.D., et al., *Food insecurity as a barrier to sustained antiretroviral therapy adherence in Uganda*. PloS one, 2010. **5**(4): p. e10340.
303. Group, W.H.O.M.P.S.C., *An assessment of interactions between global health initiatives and country health systems*. The Lancet, 2009. **373**(9681): p. 2137-2169.
304. Shariff, N., *Utilizing the Delphi survey approach: A review*. J Nurs Care, 2015. **4**(3): p. 246.
305. Von Der Gracht, H.A., *Consensus measurement in Delphi studies: review and implications for future quality assurance*. Technological forecasting and social change, 2012. **79**(8): p. 1525-1536.
306. Kviz, F.J., *Toward a standard definition of response rate*. The Public Opinion Quarterly, 1977. **41**(2): p. 265-267.
307. Hsu, C.-C. and B.A. Sandford, *The Delphi technique: making sense of consensus*. Practical assessment, research, and evaluation, 2019. **12**(1): p. 10.
308. Jacob, N., *Cross-cultural investigations: emerging concepts*. Journal of Organizational Change Management, 2005. **18**(5): p. 514-528.
309. Ladhari, R., et al., *Culture and personal values: How they influence perceived*

- service quality*. Journal of Business Research, 2011. **64**(9): p. 951-957.
310. Greenhalgh, T. and C. Papoutsis, *Spreading and scaling up innovation and improvement*. Bmj, 2019. **365**.
 311. Siminerio, L.M., G. Piatt, and J.C. Zgibor, *Implementing the chronic care model for improvements in diabetes care and education in a rural primary care practice*. The Diabetes Educator, 2005. **31**(2): p. 225-234.
 312. Barker, P.M., A. Reid, and M.W. Schall, *A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa*. Implementation Science, 2015. **11**: p. 1-11.
 313. Aarons, G.A., et al., *Validation of the implementation leadership scale (ILS) in substance use disorder treatment organizations*. Journal of Substance Abuse Treatment, 2016. **68**: p. 31-35.
 314. Avolio, B.J. and F.J. Yammarino, *Transformational and Charismatic Leadership: The Road Ahead 10th Anniversary Edition* (Monographs in Leadership and Management, Vol. 5), Emerald Group Publishing Limited, Leeds, 2013. p. iii. <https://doi.org/10.1108/S1479-357120130000005037>
 315. Brinkerhoff, J.M., *Partnership for international development: rhetoric or results?* 2002: Lynne Rienner Publishers. 10.1515/9781685855154.
 316. Pluye, P., L. Potvin, and J.-L. Denis, *Making public health programs last: conceptualizing sustainability*. Evaluation and program planning, 2004. **27**(2): p. 121-133.
 317. Klein, K.J. and J.S. Sorra, *The challenge of innovation implementation*. Academy of management review, 1996. **21**(4): p. 1055-1080.
 318. Milliken, F.J., E.W. Morrison, and P.F. Hewlin, *An exploratory study of employee silence: Issues that employees don't communicate upward and why*. Journal of management studies, 2003. **40**(6): p. 1453-1476.
 319. Meredith, J.R. and S.J. Mantel Jr, *Project management: A managerial approach: A managerial approach*. 2011: Wiley Global Education.
 320. Kerzner, H., *Project management metrics, KPIs, and dashboards: a guide to measuring and monitoring project performance*. 2022: John Wiley & Sons.
 321. Gilson, L. and N. Raphaely, *The terrain of health policy analysis in low and middle income countries: a review of published literature 1994–2007*. Health policy and planning, 2008. **23**(5): p. 294-307.
 322. Soucat, A., et al., *Pay-for-performance debate: not seeing the forest for the trees*. Health Systems & Reform, 2017. **3**(2): p. 74-79.
 323. Levesque, J.-F., M.F. Harris, and G. Russell, *Patient-centred access to health care: conceptualising access at the interface of health systems and populations*. International journal for equity in health, 2013. **12**: p. 1-9.
 324. Sekhon, M., M. Cartwright, and J.J. Francis, *Acceptability of healthcare interventions: an overview of reviews and development of a theoretical framework*. BMC health services research, 2017. **17**(1): p. 1-13.
 325. Galea, S. and D. Vlahov, *Urban health: evidence, challenges, and directions*. Annu. Rev. Public Health, 2005. **26**: p. 341-365.
 326. Reinhardt U, Cheng T. *The world health report 2000 – Health systems:*

- improving performance*. Bull World Health Organ. 2000;**78**(8): p. 1064. PMCID: PMC2560832.
327. Pillay, Y., N. Marawa, and P. Proudlock, *Health legislation: framework for transformation*. South African health review, 2002. **2002**(1): p. 3-12.
328. Cislighi, B. and L. Heise, *Theory and practice of social norms interventions: eight common pitfalls*. Globalization and health, 2018. **14**(1): p. 1-10.
329. Kleinman, A. and P. Benson, *Anthropology in the clinic: the problem of cultural competency and how to fix it*. PLoS medicine, 2006. **3**(10): p. e294.
330. Weiner, B.J., *A theory of organizational readiness for change*. Implementation science, 2009. **4**(1): p. 1-9.
331. Scott, T., et al., *The quantitative measurement of organizational culture in health care: a review of the available instruments*. Health services research, 2003. **38**(3): p. 923-945.
332. Hage, J. (1980). *Review of The Structuring of Organizations: A Synthesis of Research., by H. Mintzberg*. Administrative Science Quarterly, 1980. **25**(3): p. 547-552. <https://doi.org/10.2307/2392276>
333. Provan, K.G. and P. Kenis, *Modes of network governance: Structure, management, and effectiveness*. Journal of public administration research and theory, 2008. **18**(2): p. 229-252.
334. Graham, I.D., et al., *Lost in knowledge translation: time for a map?* Journal of continuing education in the health professions, 2006. **26**(1): p. 13-24.
335. Björkman, M. and J. Svensson, *Power to the people: evidence from a randomized field experiment on community-based monitoring in Uganda*. The Quarterly Journal of Economics, 2009. **124**(2): p. 735-769.
336. Mitchell, L. and G. Boak, *Developing competence frameworks in UK healthcare: lessons from practice*. Journal of European industrial training, 2009. **33**(8/9): p. 701-717.
337. Morris, J.A. and G.W. Stuart, *Training and education needs of consumers, families, and front-line staff in behavioral health practice*. Administration and Policy in Mental Health and Mental Health Services Research, 2002. **29**: p. 377-402.
338. Holtom, B.C., et al., *5 turnover and retention research: a glance at the past, a closer review of the present, and a venture into the future*. The Academy of Management Annals, 2008. **2**(1): p. 231-274.
339. Fleuren, M., K. Wiefferink, and T. Paulussen, *Determinants of innovation within health care organizations: literature review and Delphi study*. International journal for quality in health care, 2004. **16**(2): p. 107-123.
340. Zhang, Z., et al., *Web-based training for primary healthcare workers in rural China: a qualitative exploration of stakeholders' perceptions*. PLoS One, 2015. **10**(5): p. e0125975.
341. Nancarrow, S.A., et al., *Ten principles of good interdisciplinary team work*. Human resources for Health, 2013. **11**(1): p. 1-11.
342. Gall, T., J.P. Ioannidis, and Z. Maniadis, *The credibility crisis in research: Can economics tools help?* PLoS biology, 2017. **15**(4): p. e2001846.
343. Green, L.W. and M.W. Kreuter, *Health program planning: An educational and*

ecological approach, 2005. p. B1-B91

344. Schleiff, M.J., et al., *Community health workers at the dawn of a new era: 6. Recruitment, training, and continuing education*. Health Research Policy and Systems, 2021. **19**: p. 1-28.
345. Ayinkamiye, R., *The Strategies Used by State and Non State Actors in Empowering the Refugees in Kenya: A Case Study of Tushirikiane Afrika (TUSA)*. 2015, University of Nairobi.
346. Leon, N., et al., *Routine Health Information System (RHIS) improvements for strengthened health system management*. Cochrane Database of Systematic Reviews, 2020(8).
347. Scriven, M., R. Tyler, and R. Gagne, *Perspectives of curriculum evaluation*. The methodology of evaluation, 1967. **1**: p. 39-83.
348. Scott, J., et al., *Healthcare professional and patient codesign and validation of a mechanism for service users to feedback patient safety experiences following a care transfer: a qualitative study*. BMJ open, 2016. **6**(7): p. e011222.
349. Proctor, E., et al., *Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda*. Administration and policy in mental health and mental health services research, 2011. **38**: p. 65-76.
350. Higgs, J., et al., *Clinical reasoning in the health professions E-book*. 2008: Elsevier Health Sciences.
351. Campbell, D.T. and J.C. Stanley, *Experimental and quasi-experimental designs for research*. 2015: Ravenio books.
352. Butterfoss, F.D., R.M. Goodman, and A. Wandersman, *Community coalitions for prevention and health promotion*. Health education research, 1993. **8**(3): p. 315-330.
353. Vassli, L.T. and B.A. Farshchian, *Acceptance of health-related ICT among elderly people living in the community: A systematic review of qualitative evidence*. International Journal of Human-Computer Interaction, 2018. **34**(2): p. 99-116.
354. Campbell, Catherine, Wood, Rachel and Kelly, Moira *Social capital and health*. Health Education Authority, London, UK, 1999.
355. London, L., *What is a human-rights based approach to health and does it matter?* Health and human rights, 2008: p. 65-80.
356. Greene, J.C., V.J. Caracelli, and W.F. Graham, *Toward a conceptual framework for mixed-method evaluation designs*. Educational evaluation and policy analysis, 1989. **11**(3): p. 255-274.
357. Raja, S., et al., *Trauma informed care in medicine*. Family & community health, 2015. **38**(3): p. 216-226.
358. Peters, D.H., et al., *Implementation research: what it is and how to do it*. Bmj, 2013. **347**.
359. Atun, R., et al., *Integration of targeted health interventions into health systems: a conceptual framework for analysis*. Health policy and planning, 2010. **25**(2): p. 104-111.
360. Fixsen, D.L., *Implementation Research: A Synthesis of the Literature*. Tamps, FL: University of South Florida, Louis de la Parte Florida Mental Health Institute, National

Implementation Research Network, 2005.

361. Gilson, L., U. Lehmann, and H. Schneider, *Practicing governance towards equity in health systems: LMIC perspectives and experience*. 2017, Springer. p. 1-5.

362. Bhattacharyya, O., et al., *Innovative health service delivery models in low and middle income countries-what can we learn from the private sector?* Health Research Policy and Systems, 2010. **8**: p. 1-11.

363. Gupta, U.G. and R.E. Clarke, *Theory and applications of the Delphi technique: A bibliography (1975–1994)*. Technological forecasting and social change, 1996. **53**(2): p. 185-211.

364. Mullen, P.M., *Delphi: myths and reality*. Journal of health organization and management, 2003. **17**(1): p. 37-52.

365. Goodman, C.M., *The Delphi technique: a critique*. Journal of advanced nursing, 1987. **12**(6): p. 729-734.

366. Sackman, H., *Delphi critique: Expert opinion, forecasting, and group process*. (No Title), 1975. p. 77-137,

367. McPherson, S., C. Reese, and M.C. Wendler, *Methodology update: Delphi studies*. Nursing research, 2018. **67**(5): p. 404-410.

368. Bantel, K.A., *Comprehensiveness of strategic planning: the importance of heterogeneity of a top team*. Psychological Reports, 1993. **73**(1): p. 35-49.

Appendix

Appendix 1: The BeHEMoTh search process

Elements						
Procedure						
Question Preparation						
Formulating BeHEMoTh Question	a	Review Team formulates question in terms of Behaviour of Interest/Health Context.	Be AND H	NOT E		Models, Theories, Concepts or Frameworks
Identifying incidental occurrences of Theory						
Step 1a Incidental occurrences of theory	–	Mine internal Reference Management database: Review of titles, abstracts and selective full text of items retrieved from Topic search conducted for the evidence synthesis (either via sift or through internal searches using theor*, model*, concept* or framework*) to compile list (Step 1a) of incidental occurrences of theories/models relating to Behaviour of Interest/Health Context (informs Step 2 below)	Be AND H			Models, Theories, Concepts or Frameworks
BeHEMoTh searches						
Step 1b Searches specified by formulated BeHEMoTh	–	BeHEMoTh search of external databases combining Behaviour of Interest and Health Context with generic theory-related terms	Be AND H	NOT E		AND Models, Theories, Concepts or Frameworks

Elements	
Procedure	
question	(model*, theor*, concept*, framework*) e.g. Smoking Cessation AND Workplace AND (model* OR theor* OR concept* OR framework*)
Step 1c – Drop a concept from BeHEMoTh search	BeHEMoTh search of external databases dropping either Behaviour of Interest or Health Context combined with generic theory-related terms (model*, theor*, concept*, framework*) e.g. (Smoking Cessation AND (model* OR theor* OR concept* OR framework*) OR (Workplace AND (model* OR theor* OR concept* OR framework*))
Specific Theory searches	
Step 2 – Compile list of named theories	Merge list of theories identified in Step 1a with pre-specified list of most common theories
Step 3 – Named item searching	Combine list of pre-specified common and identified theories with either Behaviour of Interest/Health Context. Common theories may be compared with less common theories e.g. Whitely and Seyd's General incentives
	(Be NOT E AND Models, OR Theories, H) Concepts or Frameworks
	Be AND combined list of theories identified from Step 2.

Procedure	Elements
Steps 4a and 4b - Citation searching for pre-specified or identified theories combined with topic-specific strategies	model. A phrase search using name of theory, 'General incentives model', combined with Behaviour of Interest or Health Context identifies further explicit mentions of this theory. Identify key citations for named theories/models identified in Step 2 (i.e. from merging list from Step 1a and Pre-identified list). Combining articles citing a key source citation with Behaviour of Interest or Health Context retrieves instances of theory otherwise 'hidden' in the references of an article but where the theory is not named in title or abstract. Be AND key OR original H model citation(s)

Key: Be, Behaviour; H, Health Context; E, Exclusions.

This table extracted from [47]

Appendix 2: The specific search terms and strategy of systematic review of TMFs

- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion)
- (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption)
- (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)
- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion) AND (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption)
- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion) AND (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)
- (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption) AND (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)
- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion) AND (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption) AND (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)

All previous mentioned search terms were combined with the following two sets of terms using the Boolean operator “AND”.

AND (complex NEAR3 intervention* OR complex NEAR3 treatment* OR complex NEAR3 training OR complex NEAR3 system* OR adaptive system*)

AND (Theor* OR models* OR Framework* OR Heuristic* OR Lens OR Paradigm*)

Appendix 3: The quality assessment of the included studies in the systematic review of TMFs

N	Author (year)	Name of the study	1) Is the methodology identified and justified?	2) Was a theoretical lens or perspective used to guide the study, with a reference provided?	3) Is the theoretical framework described?	4) Is the theoretical framework easily linked with the problem?	5) If a conceptual framework is used, are the concepts adequately defined?	6) Are the relationships among concepts clearly identified?	7) Are the influencing factors of concepts clearly identified?	8) Are the relationships among influencing factors clearly described?
1	AC Feldstein, 2008	A Practical, Robust Implementation and Sustainability Model (PRISM) for Integrating Research Findings into Practice	√	√	√	√	√	√	√	×
2	A Movsisyan, 2019	Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance	√	√	√	√	√	√	√	√

3	C Davy, 2015	Factors influencing the implementation of chronic care models: A systematic literature review	√	√	√	√	√	√	√	√
4	DA Chambers, 2013	The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change	√	√	√	√	√	√	√	√
5	DD Simpson, 2011	A framework for implementing sustainable oral health promotion interventions	√	√	√	√	√	√	√	×
6	EH Bradley, 2012	A model for scale up of family health innovations in low-income and middle-income settings: A mixed methods study	√	√	√	√	√	√	√	√

7	Murray., 2010	Normalisation process theory: a framework for developing, evaluating and implementing complex interventions	√	√	√	√	√	√	√	√
8	GA Aarons,, 2010	Advancing a Conceptual Model of Evidence-Based Practice Implementation in Public Service Sectors	√	√	√	√	√	√	√	√
9	G Yamey, 2012	Scaling Up Global Health Interventions: A Proposed Framework for Success	√	√	√	√	√	√	√	√
10	H Khalil, 2021	Implementation of sustainable complex interventions in health care	√	√	√	√	√	√	√	×

		services: the triple C model								
11	Greenhalgh, Trisha., 2017	Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies	√	√	√	√	√	√	√	√

12	H Sarma, 2021	Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting	√	√	√	√	√	√	√	×
13	J Iwelunmor, 2015	Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and conceptual framework	√	√	√	√	√	√	√	√
14	JC Moullin, 2019	Systematic review of the Exploration, Preparation, Implementation, Sustainment (EPIS) framework	√	√	√	√	√	√	√	√

15	Kathy A Scott, 2018	The Power of the Frame : Systems Transformation Framework for Health Care Leaders	√	√	√	√	√	√	√	√
16	L Cooley, 2006	Scaling up—from vision to large-scale change: a management framework for practitioners	√	√	√	√	√	√	√	√
17	LJ Damschroder, 2009	Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science (CFIR)	√	√	√	√	√	√	√	√

18	Lisa M. Pfadenhauer, 2017	Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework	√	√	√	√	√	√	√	√
19	MA Scheirer, 2011	An Agenda for Research on the Sustainability of Public Health Programs	√	√	√	√	√	√	√	√
20	MJ De Silva, 2014	Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions	√	√	√	√	√	√	×	×

21	PM Barker, 2016	A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa	√	√	√	√	√	√	√	√
22	P Mendel, 2008	Interventions in Organizational and Community Context: A Framework for Building Evidence on Dissemination and Implementation in Health Services Research	√	√	√	√	√	√	√	√
23	RA Greene, 2014	A Person-Focused Model of Care for the Twenty-First Century: A System-of-Systems Perspective	√	√	√	√	√	√	×	×

24	RC Shelton, 2018	The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care	√	√	√	√	√	√	√	√
25	RE Glasgow, 1999	Evaluating the public health impact of health promotion interventions: the RE-AIM framework	√	√	√	√	√	√	×	×
26	B Gaglio, 2013	The RE-AIM framework: a systematic review of use over time	√	√	√	√	√	√	×	×
27	SW Stirman, 2019	The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions	√	√	√	√	√	√	√	√

28	WHO, 2009	Practical guidance for scaling up health service innovations. Geneva: World Health Organization	√	√	√	√	√	√	√	√
29	I Artieta-Pinedo, 2017	Framework for the establishment of a feasible, tailored and effective perinatal education programme	√	√	√	√	√	√	√	√
30	J Hockley, 2019	A framework for cross-cultural development and implementation of complex interventions to improve palliative care in nursing homes: the PACE steps to success programme	√	√	√	√	√	√	×	×

31	H McMullen, 2015	Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory	√	√	√	√	√	√	√	√
32	JM Stratil, 2020	WICID framework version 1.0: criteria and considerations to guide evidence-informed decision-making on non-pharmacological interventions targeting COVID-19	√	√	√	√	√	√	×	×

33	MW Beets,2013	Translating Policies Into Practice: A Framework to Prevent Childhood Obesity in Afterschool Programs	√	√	√	√	√	√	√	√
34	Y Apostolopoulos, 2018	Moving alcohol prevention research forward—Part I: introducing a complex systems paradigm	√	√	√	√	√	√	√	√
35	Birken, 2017	Organizational theory for dissemination and implementation research	√	√	√	√	√	√	√	√
Studies obtained from the citation searching										

36	A. Milat, K, 2020	Development and application of a hybrid implementation research framework to understand success in reducing under-5 mortality in Rwandamakers and implementers	√	√	√	√	√	√	√	√
37	N. S. Singh, 2021	A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India	√	√	√	√	√	√	√	√

Appendix 4

Table 1: the basic information of included studies in theoretical systematic review

N	Author (year)	Name of the study	Name of the framework	Country	Method	Reference models	Purpose of the framework	Key concepts within the TMFs
1	AC Feldstein, 2008	A Practical, Robust Implementation and Sustainability Model (PRISM) for Integrating Research Findings into Practice	PRISM—the Practical, Robust Implementation and Sustainability Model.	worldwide	Descriptive	CCM (chronic care model, Model for Improvement; RE-AIM	To provide a new tool for researchers and health care decision makers that integrates existing concepts relevant to translating research into practice.	(PARIHS) framework, which focuses on three elements: evidence, context, and facilitation

2	Movsisyan, 2019	Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance	Overview of phases and steps in the process of adaptation	worldwide	Systematic review	n/a	To provide information of the establishment of general guidelines on the adaptation of health interventions for complex populations	Adaptability Drift Fidelity Replicability Scalability Social validity

3	C Davy, 2015	Factors influencing the implementation of chronic care models: A systematic literature review	chronic care models	worldwide	systematic review	n/a	To explore the influencing factors of the implementation of CCMs in primary care settings	1.acceptability of CCM 2. CCM funding, mental health, teamwork support the healthcare workers 3.supporting patients Encouraging patients, self-management, timely reporting, etc. 4. Prepared resources for interventions to sustain

4	DA Chambers,2013	The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change	The dynamic sustainability framework (DSF)	worldwide	literature review	multiple models	To develop an iterative, dynamic framework named 'Dynamic Sustainability Framework' (DSF) to explore the sustainability related concepts in complex interventions	1. intervention/context 2. practice setting (e.g. clinical or community setting) 3. ecological system (external facilitator for sustainability)

5	DD Simpson, 2011	A framework for implementing sustainable oral health promotion interventions	Stages of innovation implementation and factors affecting sustainability	worldwide	Descriptive	PRECEDE- PROCEED planning model, DSF model	To explore fundamental procedural and assessment concepts relevant to the implementation of sustainable behavioral and social interventions in oral health	1.training 2.adoption, 3.implementation 4.practice

6	EH Bradley, 2012	A model for scale up of family health innovations in low-income and middle-income settings: A mixed methods study	the AIDED model	LMICs	A mixed methods study	multiple models	To build an integrated and practical model of scale up that synthesises experiences of family health programmes in low-income and middle-income countries (LMICs).	The AIDED model comprised 5 different but intercorrelated parts: 1. assess the landscape, 2. innovate to fit user receptivity, 3. develop support, 4. engage with user groups 5. devolve efforts for spreading the innovation.

7	Murray., 2010	Normalisation process theory: a framework for developing, evaluating and implementing complex interventions	NPT theory	worldwide	descriptive	MRC framework	The develop a theory indicating the factors are required for successful implementation and integration of interventions into routine work (normalisation)	1.Coherence 2.Cognitive participation 3.Collective action 4.Reflexive monitoring

8	GA Aarons,, 2010	Advancing a Conceptual Model of Evidence-Based Practice Implementation in Public Service Sectors	EPIS model	used in US previously and now used worldwide	literature review	multiple models	Proposes a multi-level, four phase model of the implementation process (i.e., Exploration, Adoption/Preparation, Implementation, Sustainment), derived from extant literature, and applies it to public sector services.	1. Exploration Phase 2. Adoption Decision/Preparation Phase 3. Active Implementation Phase 4. Sustainment Phase

9	G Yamey, 2011	Scaling Up Global Health Interventions: A Proposed Framework for Success	A Proposed Framework for Success	worldwide	literature review	n/a	This framework is aimed at planners of scale-up processes to use in thinking about strategies for implementing a new program, policy, or intervention to scale. • attributes of the specific tool or service being scaled up • attributes of the implementers • the chosen delivery strategy • attributes of the “adopting” community • the socio-political context, and Political will and national policies • the research context

10	H Khalil, 2021	Implementation of sustainable complex interventions in health care services: the triple C model	triple C model	worldwide	literature review	ACE (Academic Center for Evidence Based Practice) Star Model of Knowledge Transformation, the Knowledge to Action Framework, the Iowa Model, the Ottawa Model for Research Use and the Joanna Briggs Institute (JBI) model, CFIR, RE-AIM	The framework was used to devise the components of the model that explains the successful implementation of complex interventions in healthcare	The consultation stage The collaboration stage The consolidation stage

11	Greenhalgh, Trisha., 2017	Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies	NASSS Framework	worldwide	systematic review	28 previous technology implementation frameworks, of which 14 had taken a dynamic systems approach	to produce an evidence-based, theory-informed, and pragmatic framework to help predict and evaluate the success of a technology-supported health or social care program	Domain 1: The Condition Domain 2: The Technology Domain 3: The Value Proposition Domain 4: The Adopter System Domain 5: The Organization Domain 6: The Wider Context Domain 7: Interactions Between Domains and Adaptation Over Time

12	H Sarma, 2021	Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting	A comprehensive conceptual framework for implementation science	n/a	narrative review	n/a	The aim of this paper is to identify and develop a comprehensive conceptual framework using implementation science that can be applied to assess a nutrition intervention in a real-world setting.	The framework consisted of three domains: Domain i – efficacy to effectiveness trials, Domain ii – scaling-up and Domain iii – sustainability. These three domains encompass five components: 1. identifying an ‘effective’ intervention; 2. scaling-up and implementation fidelity; 3. course corrections during implementation; 4. promoting sustainability of interventions and consideration of a comprehensive methodological paradigm to identify ‘effective’ interventions and to 5. assess the process and outcome indicators of implementation.

13	J Iwelunmor, 2015	Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and conceptual framework	Conceptual framework of sustainability of interventions implemented in SSA	sub-Saharan Africa	Systematic review	multiple models such as PEN-3 model	The purpose of this study was to conduct a systematic review of empirical literature to explore how health interventions implemented in SSA are sustained.	Intervention Socio-culture and community context Organizational settings

14	JC Moullin, 2019	Systematic review of the Exploration, Preparation, Implementation, Sustainment (EPIS) framework	Exploration, Preparation, Implementation, Sustainment (EPIS) framework	Sweden [19], South Africa [20], and Mexico [21]. EPIS has also been used in other settings including public health [22], schools [23], and community health centers	systematic review	n/a	To examine and describe the research application of a widely used implementation framework, the Exploration, Preparation, Implementation, Sustainment (EPIS) framework.	Exploration-Preparation- Implementation- Sustainment

15	2018	Kathy A Scott,	The Power of the Frame : Systems Transformation Framework for Health Care Leaders	The systems transformation framework	n/a	Descriptive	n/a	to create environments that are readiness for change to plan, design, implement, and evaluate change within complex adaptive systems	8 major domains: 1. vision, 2. leadership, 3. organizational culture, 4. organizational behavior, 5. organizational structure, 6. performance measurements, 7. internal learning, 8. external learning.

16	L Cooley, 2006	Scaling up— from vision to large-scale change: a management framework for practitioners	Scaling up— from vision to large-scale change	worldwide	Descriptive	n/a	• To provide an easily understood and straightforward way for donors and investors to assess the scalability of proposed interventions; • To provide guidelines for designing pilot projects and other innovations “with scale in mind”; • To provide tools and approaches to help practitioners manage the scaling up process	STEP 1: Develop a Scaling Up Plan Task 1: Create a Vision Task 2: Assess Scalability Task 3: Fill Information Gaps Task 4: Prepare a Scaling Up Plan STEP 2: Establish the Preconditions for Scaling Up Task 5: Legitimize Change Task 6: Build a Constituency Task 7: Realign and Mobilize Resources STEP 3: Implement the Scaling up Process Task 8: Modify and Strengthen Organizations Task 9: Coordinate Action Task 10: Adapt Strategy and Maintain Momentum

17	LJ Damschroder, 2009	Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science (CFIR)	a consolidated framework for advancing implementation science (CFIR)	worldwide	a snowball sampling approach	n/a	To offer an overarching typology to promote implementation theory development and verification about what works where and why across multiple contexts.	intervention characteristics, outer setting, inner setting, characteristics of the individuals involved, and the process of implementation

18	2017	Lisa M. Pfadenhauer,	Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework	the Context and Implementation of Complex Interventions (CICI) framework	n/a	The Context and Implementation of Complex Interventions (CICI) framework was developed in an iterative manner and underwent extensive application	n/a	To develop a framework to facilitate the structured and comprehensive conceptualisation and assessment of context and implementation of complex interventions.	1. context 2. implementation 3. setting

19	MA Scheirer, 2011	An Agenda for Research on the Sustainability of Public Health Programs	Conceptual framework for sustainability of public health programs.	worldwide	Descriptive	n/a	To develop a theoretical model to guide health-related researchers and funders in making clear and transparent decisions about research methods to promote the sustainability of interventions.	Inputs Factors Affecting Sustainability Obtaining financial resources Outcomes (programs sustained)

20	MJ De Silva, 2014	Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions	Theory of Change (ToC)	worldwide	a theory-driven approach to the design and evaluation of complex interventions by adapting and integrating a programmatic design and evaluation tool,	n/a	to develop complex medical interventions that are more likely to be effective, sustainable and scalable.	Development of complex interventions using Theory of Change Feasibility and piloting complex interventions using Theory of Change Evaluating complex interventions using Theory of Change Implementing complex interventions using Theory of Change

21	PM Barker, 2016	A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa	IHI Framework for Going to Full Scale.	LMICs	literature review	multiple models	To describe a framework for taking health interventions to full scale	4 phases (1) Set-up(2) Develop the Scalable Unit(3) Test of Scale-up (4) Go to Full Scale 3 core components (1) a sequence of activities (2) underlying influencing factors (3) support system

22	P Mendel, 2008	Interventions in Organizational and Community Context: A Framework for Building Evidence on Dissemination and Implementation in Health Services Research	Framework of Dissemination in Health Services Intervention Research	n/a	Descriptive	n/a	to address this research-to-practice gap	Context of diffusion Stages of Diffusion Intervention Outcomes
								(a) the patient's health (spiritual-social-physical) in relation to the patient, the payer, the caregiver and the clinician; (b) the person in relation to other entities (i.e. the patient); (c) the caregiver in relation to other entities; (d) the clinician in relation to other entities
23	RA Greene, 2014	A Person-Focused Model of Care for the Twenty-First Century: A System-of-Systems Perspective	A Person-Focused Model of Care	America	Descriptive	prior models of chronic care with new empiric findings and complex adaptive system (CAS) theory	to offer a unifying focus for all participants in the health care delivery process	

- (d) clinicians who have relationships with other entities; and
- (e) payers who have relationships with other entities.

24	RC Shelton, 2018	The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care	Integrated sustainability framework.	worldwide	literature review	n/a	to address the gap between research and practice in public health	Influencing factors: Inner contextual factors; Processes; Characteristics of the intervention; Program sustainability; Outer contextual factors Intervention process: development, adoption, implementation (with potential adaptations), and sustainability

25	RE Glasgow, 1999	Evaluating the public health impact of health promotion interventions: the RE-AIM framework	RE-AIM	worldwide	Descriptive	n/a	To develop a comprehensive evaluation framework to facilitate progress in public health and community-based interventions to (1) describe criteria for reporting on diverse dimensions of the RE-AIM framework, (2) review the empirical studies using RE-AIM framework, (3) emphasis experience learned from using RE-AIM, and (4) provide recommendations for future studies.	Five main components: reach, effectiveness, adoption, implementation, maintenance
26	B Gaglio, 2013	The RE-AIM framework: a systematic review of use over time	RE-AIM	worldwide	systematic review	n/a		Five main components: reach, effectiveness, adoption, implementation, maintenance

27	SW Stirman, 2019	The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions	The FRAME	n/a	Descriptive	n/a	1.to improve feasibility or acceptability, 2.to increase reach or engagement, to improve fit (note that cultural modifications intended to improve fit are assigned a subcategory under this goal), 3.to reduce costs, to improve clinical outcomes, 4.to align the intervention with cultural values, norms, or priorities.	(1) when and how in the implementation process the modification was made, (2) whether the modification was planned/proactive (i.e., an adaptation) or unplanned/reactive, (3) who determined that the modification should be made, (4) what is modified, (5) at what level of delivery the modification is made, (6) type or nature of context or content-level modifications, (7) the extent to which the modification is fidelity-consistent, and (8) the reasons for the modification, including (a) the intent or goal of the modification (e.g., cultural adaptations, to reduce costs, etc.) and (b) contextual factors that influenced the decision.

28	WHO, 2009	Practical guidance for scaling up health service innovations. Geneva: World Health Organization	ExpandNet framework	n/a	Descriptive	n/a	To provide a way of thinking about scaling up; To identify conditions that lead to success; To articulate strategic choices that have to be made; To highlight actions that enhance the potential for success and sustainability	The innovation, The user organization, The environment, The resource team or organization, Strategic choice areas The type of scaling up to be pursued. Methods of dissemination and advocacy. Organisation of the scaling-up process. The cost of scaling up and mobilising resources to support it. Monitoring and evaluation.



								• Individual characteristics Demographic Personality External characteristics
		Framework for the establishment of a feasible, tailored and effective perinatal education programme					to assess women needs, identify factors that influence the desired outcomes, and propose a framework for developing new perinatal education	• Normative beliefs Behavioural beliefs Efficacy beliefs
29	I Artieta-Pinedo, 2017		multiple models	Spain	literature review and qualitative research with focus groups	diverse models		• Constraints Skills Intention • behaviour

30	J Hockley, 2019	A framework for cross-cultural development and implementation of complex interventions to improve palliative care in nursing homes: the PACE steps to success programme	A cross-cultural adaptation framework	seven European countries	part of the PACE cluster randomised control trial	PARiHS framework	To offer a framework for the cross-cultural development and support necessary to implement a complex palliative care intervention in nursing homes.	Phase 1: adaptation and preparation of resources Phase 2: training and implementation of the programme using the train-the-trainer model Phase 3: supporting the implementation

31	H McMullen, 2015	Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory	diffusion of innovation model	UK	ethnographic observation, 21 semi-structured interviews and analysis of routine documents	Greenhalgh et al.'s model	to a retrospective process evaluation of a complex intervention to introduce rapid HIV testing in a general practice setting	THE INNOVATION 1. SYSTEM ANTECEDENTS FOR INNOVATIONS 2. Absorptive capacity for new knowledge 3. Receptive context for change 4. SYSTEM READINESS FOR INNOVATION 5. COMMUNICATION AND INFLUENCE DIFFUSION 6. The Outer context 7. LINKAGE 8. THE IMPLEMENTATION PROCESS 9. The adopter 10. Assimilation

32	JM Stratil, 2020	WICID framework version 1.0: criteria and considerations to guide evidence- informed decision-making on non- pharmacological interventions targeting COVID-19	WICID framework	worldwide	case study systematic review qualitative analysis conceptual analysis	WHO- INTEGRATE framework 'best fit' framework	To develop a decision- making framework adapted to the challenges of decision- making on non- pharmacological interventions to contain the global SARS-CoV-2 pandemic.	1. implications for the course of the pandemic and its impact on health 2. implications for quality of life social well-being and mental health 3. implications for physical health beyond COVID-19 4. proportionality and implications for individual autonomy and fundamental rights 5. acceptability of and willingness to implement the measures 6. equity, equality, and fair distribution of benefits and burdens 7. societal and environmental implications 8 considerations 8. economic implications & considerations 9. resource implications & considerations 10. feasibility implications & considerations 11. interaction with and

implications for the health
system
quality of evidence

33	Beets,2013	Translating Policies Into Practice: A Framework to Prevent Childhood Obesity in Afterschool Programs	Conceptual Framework to Prevent Childhood Obesity Through Policy-Level Initiatives in Afterschool Programs	the United States	Descriptive	Afterschool programs	to discuss obesity prevention policies in ASPs and outline a conceptual framework for future research related to the successful adoption and implementation of such policies within the ASP setting	1. Outside organizational partners (university, community, school) 2. National, state, local organization 3. Site 4. Asp leader 5. Frontline staffers 6. Child 7. Physical activity/diet

34	Apostolopoulos, 2018	Moving alcohol prevention research forward—Part I: introducing a complex systems paradigm	complex adaptive system	the United States	A complex systems paradigm, grounded in socio-ecological and complex systems theories and computational modeling and simulation	n/a	(1) outlines the limitations inherent in current approaches to alcohol prevention research and explore how complex systems approaches can cope with these flaws; (2) offers the reader a fundamental comprehension of computational simulation modelling methods and an overview of heuristic conceptual models	government and business forces college environment student microsocial factors alcohol misuse consequences

35	Birken, 2017	Organizational theory for dissemination and implementation research	Organizational theory	the United States	Descriptive	transaction cost economics theory, institutional theory, contingency theories, and resource dependency theory	To demonstrate the utility of organizational theories for implementation research	Adoption Implementation Sustainment

Studies obtained from the citation searching after the confirmation review

N	Author (year)	Name of the study	Name of the framework	Country	Method	Reference models	Purpose of the framework	Key concepts within the TMFs
36	A. Milat, K, 2020	Development and application of a hybrid implementation research framework to understand	Hybrid Framework for Understanding Interventions to Reduce Under-5 Mortality	LMICs	Descriptive	existing IR frameworks	to better understand U5M reduction in LMICs from identification of leading causes of amenable U5M, to EBI choice, identification,	Ministry Leadership Data availability and use Donor coordination culture org structure mission and values

		success in reducing under-5 mortality in Rwandamakers and implementers					and testing of strategies, work to achieve sustainability at scale, and key contextual factors	Decision making process Capacity development Interaction with other ministries Community and other stakeholder engagement National context Leadership Budget Support from other org Legislation and policies Economic development Community advocacy and civil society Accountability Data availability and use stability
37	N. S. Singh, 2021	A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India	Conceptual framework for evaluating the scale-up and sustainability of digital solutions for front-line health workers.	Inida	Descriptive	n/a	to answer 'Why have some digital health programmes scaled, and others not, and what are the implications for sustainability in India?'. To understand the factors that	Perceived value Adaptability Data storage and governance Government champions Stakeholders networks Frontline health worker engagement

							underpin the scale-up and sustainability of different typologies of digital health solutions in India	Investing in evidence Operationalization Evolving stakeholder roles and relationships National-state dynamics Interoperability

Table 2: The factors influencing the adaptability, scalability and sustainability of complex interventions in the included studies of theoretical systematic review

	Influencing factors		Referred studies
	Main themes	sub-components	
outer context	Sociopolitical context		6,7,8,9,10,11,18,24,26,27,28,29,30,31,33,35, 36,37
		ethical	18,32
		legislation	6,11,18,24,26,33,35, 36
		norms or regulations	4,6,7,13,22,26,32,33
		policies	4,8,10,13,17,18,19,21,22,24,26,30,32,33, 36
		religion	6
	leadership		5,6,8,9,13,14,15,16,17,21,24,26,30,32,35, 36
	funding		3,4,5,6,8,11,13,14,17,18,19,22,23,24,26,27,33,35, 36
	Client Advocacy		8,14,19
	Interorganizational Networks		3,8,9,10,11,14,15,17,19,22,23,24,29,30,32,35, 36,37
inner context			
	Organizational characteristics		1,4,7,8,11,15,19,27,29,30,33,35
		Absorptive capacity	5,8,10,11,13,15,17,19,21,24,27,29,30,32, 36
		Organization readiness	8,27,29,30,35

		structure	4,7,11,15,17,22,24,26,29,30,36
		values or visions	10,15,16,24,26,30,35,36
		working environment	1,4,8,14,17,19,27,30,32,33
		tension for change	7,17,28,30
		Organization culture	6,8,15,16,17,26,35
		Credibility and reputation	16
	leadership		5,6,8,9,13,14,15,16,17,21,24,26,30,32,35,36
	Individual adopter or provider characteristics		1,3,4,5,6,14,17,26,27,28,30,31,32,33
		ability or capacity	11,17,21,24,26,28,30,32
		race	26
		spoken language	26,29
		training or education	4,5,15,26,27,29,30,32,35
		views	8,11,17,26,28,30,32,37
		tension for change	17,28,30
		individual culture	26,28,32,36
	monitoring and evaluation		6,8,11,13,15,16,24,30
	staffing		3,4,5,8,10,11,14,16,24,26,29,30,32,35
intervention characteristics			5,17,25,27,28,30,31
		communication	7,10,14,24,27,30

		Quality and fidelity monitoring/support	2,5,14,24,35
		geographical	5,18,32,33,35
		project champion	3,5,7,8,10,13,15,24,27,32,37
		resources	3,13,17,22,29,30,32,35,36
		stakeholders involvement	2,6,8,9,13,14,23,30,32,36,37
		supervision	4,13,16,24,29,32
		support system or tool	4,5,8,10,14,21,27,33,35
		technology advance or environment	6,11,24,26,27,30,32,35
		Time	3,7,26,35
Bridging factors	community engagement		3,6,9,13,14,19,22,24,27,32,33,35,36
	Purveyors/intermediaries		14

The study name of the referred study number

1. A Practical, Robust Implementation and Sustainability Model (PRISM) for Integrating Research Findings into Practice
2. Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance
3. Factors influencing the implementation of chronic care models: A systematic literature review
4. The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change
5. A framework for implementing sustainable oral health promotion interventions
6. A model for scale up of family health innovations in low-income and middle-income settings: A mixed methods study

7. Normalisation process theory: a framework for developing, evaluating and implementing complex interventions
8. Advancing a Conceptual Model of Evidence-Based Practice Implementation in Public Service Sectors
9. Scaling Up Global Health Interventions: A Proposed Framework for Success
10. Implementation of sustainable complex interventions in health care services: the triple C model
11. Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies
12. Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting
13. Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and conceptual framework
14. Systematic review of the Exploration, Preparation, Implementation, Sustainment (EPIS) framework
15. The Power of the Frame : Systems Transformation Framework for Health Care Leaders
16. Scaling up—from vision to large-scale change: a management framework for practitioners
17. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science (CFIR)
18. Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework
19. An Agenda for Research on the Sustainability of Public Health Programs
20. Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions
21. A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa

22. Interventions in Organizational and Community Context: A Framework for Building Evidence on Dissemination and Implementation in Health Services Research
23. A Person-Focused Model of Care for the Twenty-First Century: A System-of-Systems Perspective
24. The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care
25. Evaluating the public health impact of health promotion interventions: the RE-AIM framework
26. The RE-AIM framework: a systematic review of use over time
27. The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions
28. Practical guidance for scaling up health service innovations. Geneva: World Health Organization
29. Framework for the establishment of a feasible, tailored and effective perinatal education programme
30. A framework for cross-cultural development and implementation of complex interventions to improve palliative care in nursing homes: the PACE steps to success programme
31. Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory
32. WICID framework version 1.0: criteria and considerations to guide evidence-informed decision-making on non-pharmacological interventions targeting COVID-19
33. Translating Policies Into Practice: A Framework to Prevent Childhood Obesity in Afterschool Programs
34. Moving alcohol prevention research forward—Part I: introducing a complex systems paradigm
35. Organizational theory for dissemination and implementation research

Studies obtained from the citation searching after the confirmation review

36. Development and application of a hybrid implementation research framework to understand success in reducing under-5 mortality in Rwanda
37. A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India

Table 3: the correlation between influencing factor mentioned in each included study and the three concepts of adaptability, scalability and sustainability

General frameworks	Name of study	Directly concerned with the core concepts of Sustainability	Concerned with non-core concepts of Sustainability	Directly concerned with the core concepts of Adaptability	Concerned with non-core concepts of Adaptability	Directly concerned with the core concepts of Scalability	Concerned with non-core concepts of Scalability
1	A Practical, Robust Implementation and Sustainability Model (PRISM) for Integrating Research Findings into Practice	sustaining					diffusion
2	Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance	sustainable		Adaptability		scalable	
3	Factors influencing the implementation of chronic care models: A systematic literature review	sustainability					

4	The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change	sustainability		adaptation	adaptation phase		
5	A framework for implementing sustainable oral health promotion interventions	sustainable					Diffusion of innovation theory
6	A model for scale up of family health innovations in low-income and middle-income settings: A mixed methods study	sustainability				scale up	dissemination, diffusion
7	Normalisation process theory: a framework for developing, evaluating and implementing complex interventions		Normalisation				wide scale

8	Advancing a Conceptual Model of Evidence-Based Practice Implementation in Public Service Sectors	Sustainment Sustainability			Fidelity Monitoring and Support		Dissemination
9	Scaling up global health interventions: a proposed framework for success					Scaling up	
10	Implementation of sustainable complex interventions in health care services: the triple C model	sustainability		adaptability			

11	NASSS Framework Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies	sustainability				scale-up	Spread
12	Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting	sustainability				Scaling-up	
13	Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and	sustainability		local adaptation			

	conceptual framework						
14	Systematic review of the Exploration, Preparation, Implementation, Sustainment (EPIS) framework	Sustainment		adaptation			diffusion
15	The Power of the Frame : Systems Transformation Framework for Health Care Leaders	sustainable			complex adaptive system		

16	Cooley L, Kohl R. Scaling up—from vision to large-scale change: a management framework for practitioners. Washington D.C: Management Systems International; 2006.	sustaining		adapting		Scaling up	expanding
17	Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science	sustainability		adaptation		Scaling up	dissemination

18	Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework	sustainability		adaption			
19	An Agenda for Research on the Sustainability of Public Health Programs	sustainable		adaptation			diffusion
20	Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions	sustainable				scalable	
21	A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa					Scaling up	spread

22	Interventions in Organizational and Community Context: A Framework for Building Evidence on Dissemination and Implementation in Health Services Research	sustainability		adapting			disseminating
23	A Person-Focused Model of Care for the Twenty-First Century: A System-of-Systems Perspective	sustainable			complex adaptive systems		
24	The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care	sustainable		adaptability			
25	Evaluating the public health impact of health promotion interventions: the RE-AIM framework.			adaptation	fidelity, cost		

26	The RE-AIM framework: a systematic review of use over time	maintenance or sustainability		adaptation			
27	The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions			adaptation	fidelity		
28	ExpandNet WHO. Practical guidance for scaling up health service innovations. Geneva: World Health Organization; 2009.	sustainable		Adapting health service innovations, adaptation		Scaling up	
Specific frameworks							
29	Framework for the establishment of a feasible, tailored and effective perinatal education programme	sustainability		adaptation	feasibility		

30	A framework for cross-cultural development and implementation of complex interventions to improve palliative care in nursing homes: the PACE steps to success programme	sustainability		cross-cultural adaptation			
31	Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory	sustainably		adaptation			diffusion, spread
32	WICID framework version 1.0: criteria and considerations to guide evidence-informed decision-making on non-pharmacological interventions targeting COVID-19			adaption			expanded

33	Translating Policies Into Practice: A Framework to Prevent Childhood Obesity in Afterschool Programs				adapted from other settings		
34	Moving alcohol prevention research forward—Part I: introducing a complex systems paradigm			adaptation	complex adaptive system		
35	Organizational theory for dissemination and implementation research	sustainment		adaptation			dissemination

Studies obtained from the citation searching after the confirmation review

36	Development and application of a hybrid implementation research framework to understand success in reducing	Sustainment		adaptation			diffusion

	under-5 mortality in Rwanda						
37	A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India	sustainability		Adaptability		scalable	

Appendix 5: Overview of frameworks and models used in the complex health interventions

Category of the framework	Name of the framework (underlying theory if any)	Name of the study	The correlation with three key concepts (adaptability, scalability and sustainability)
Process models	EPIS Model	Advancing a Conceptual Model of Evidence-Based Practice Implementation in Public Service Sectors	Sustainability Fidelity Monitoring and Support Dissemination
		Systematic review of the Exploration, Preparation, Implementation, Sustainment (EPIS) framework	Sustainment adaptation diffusion
	The dynamic sustainability framework (DSF)	The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change	sustainability adaptation/adaptation phase
	Overview of phases and steps in the process of adaptation	Adapting evidence-informed complex population health interventions for new contexts: a systematic review of guidance	sustainable Adaptability scalable
	Stages of innovation implementation and factors	A framework for implementing sustainable oral health promotion interventions	sustainable Diffusion of innovation theory

	affecting sustainability		
	the AIDED model	A model for scale up of family health innovations in low-income and middle-income settings: A mixed methods study	sustainability scaling up dissemination, diffusion
	triple C model	Implementation of sustainable complex interventions in health care services: the triple C model	sustainability adaptability
	The Scaling Up Management (SUM) Framework	Scaling up—from vision to large-scale change: a management framework for practitioners	sustaining adapting Scaling up/expanding
	PRISM	A Practical, Robust Implementation and Sustainability Model (PRISM) for Integrating Research Findings into Practice	Sustaining diffusion
	IHI Framework for Going to Full Scale	A framework for scaling up health interventions: lessons from large-scale improvement initiatives in Africa	Scaling up/spread
	A cross-cultural adaptation framework	A framework for cross-cultural development and implementation of	sustainability cross-cultural adaptation

		complex interventions to improve palliative care in nursing homes: the PACE steps to success programme	
	WICID framework	WICID framework version 1.0: criteria and considerations to guide evidence-informed decision-making on non-pharmacological interventions targeting COVID-19	adaption expanded
	Greenhalgh et al.'s diffusion of innovation model	Explaining high and low performers in complex intervention trials: a new model based on diffusion of innovations theory	sustainably adaptation diffusion, spread
	Hybrid Framework	Development and application of a hybrid implementation research framework to understand success in reducing under-5 mortality in Rwanda	Sustainment adaptation diffusion
Determinant frameworks	CFIR	Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science (CFIR)	sustainability adaptation Scaling up, dissemination

	chronic care models (CCM)	Factors influencing the implementation of chronic care models: A systematic literature review	sustainability
	A Proposed Framework for Success	Scaling Up Global Health Interventions: A Proposed Framework for Success	
	Conceptual framework of sustainability of interventions implemented in SSA	Toward the sustainability of health interventions implemented in sub-Saharan Africa: a systematic review and conceptual framework	sustainability local adaptation
	Conceptual framework for sustainability of public health programs	An Agenda for Research on the Sustainability of Public Health Programs	sustainable adaptation diffusion
	Framework of Dissemination in Health Services Intervention Research	Interventions in Organizational and Community Context: A Framework for Building Evidence on Dissemination and Implementation in Health Services Research	sustainability adapting disseminating
	A Person-Focused Model of Care	A Person-Focused Model of Care for the Twenty-First Century: A System-of-Systems	sustainable complex adaptive systems

		Perspective	
	Integrated sustainability framework	The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care	sustainable adaptability
	FRAME	The FRAME: an expanded framework for reporting adaptations and modifications to evidence-based interventions	Adaptation/fidelity
	ExpandNet framework	Practical guidance for scaling up health service innovations. Geneva: World Health Organization	sustainable adaptation Scaling up
	multiple models	Framework for the establishment of a feasible, tailored and effective perinatal education programme	sustainability adaptation feasibility
	Conceptual Framework to Prevent Childhood Obesity Through Policy-Level Initiatives in Afterschool Programs	Translating Policies Into Practice: A Framework to Prevent Childhood Obesity in Afterschool Programs	adapted from other settings
	complex adaptive system	Moving alcohol prevention research	Adaptation, complex adaptive system

		forward—Part I: introducing a complex systems paradigm	
Classic theories	Organizational theory	Organizational theory for dissemination and implementation research	Adaptation, dissemination, sustainment
Implementation theories	NPT theory	Normalisation process theory: a framework for developing, evaluating and implementing complex interventions	Normalisation Wide scale
Evaluation frameworks	RE-AIM	Evaluating the public health impact of health promotion interventions: the RE-AIM framework	adaptation fidelity, cost
	Theory of Change (ToC)	Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions	sustainable scalable
	NASSS Framework	Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies	sustainability scale-up/spread

	A comprehensive conceptual framework for implementation science	Developing a conceptual framework for implementation science to evaluate a nutrition intervention scaled-up in a real-world setting	sustainability Scaling-up
	The systems transformation framework (STF)	The Power of the Frame: Systems Transformation Framework for Health Care Leaders	sustainable complex adaptive system
	the Context and Implementation of Complex Interventions (CICI) framework	Making sense of complexity in context and implementation: the Context and Implementation of Complex Interventions (CICI) framework	sustainability adaption
	Conceptual framework for evaluating the scale-up and sustainability of digital solutions for front-line health workers	A tale of 'politics and stars aligning': analysing the sustainability of scaled up digital tools for front-line health workers in India	sustainability Adaptability scalable

Note: n/a means not available

Appendix 6: The search strategy of empirical systematic review

- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion)
- (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption)
- (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)
- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion) AND (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption)
- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion) AND (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)
- (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption) AND (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)
- (Sustainable OR Sustainability OR Capacity* building OR Spread OR diffusion) AND (Adaptable OR Adaptability OR Replicabilit* OR Fidelit* OR Adoption) AND (Scalability OR Scalable OR Scaling up OR Scale out OR expansion)

All previous mentioned search terms were combined with the following terms using the Boolean operator “AND”.

AND (complex interventions OR complex health interventions OR Health interventions OR intervention studies OR evidence-based practice OR evidence-based medicine)

AND (“Low-and-middle-income countries” OR “developing countries” OR “LMICs” OR Afghanistan OR Albania OR Algeria OR American Samoa OR American Samoa OR Angola OR Argentina OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Belize OR Benin OR Bhutan OR Bolivia OR "Bosnia and Herzegovina" OR "Bosnia and Herzegovina" OR Botswana OR Brazil OR Bulgaria OR Burkina Faso OR Burundi OR Cabo Verde OR Cambodia OR Cameroon OR Central African Republic OR Central African Republic OR Chad OR China OR Colombia OR Comoros OR Congo OR Costa Rica OR Cote d'Ivoire OR Cote d'Ivoire OR ivory coast OR Cuba OR Djibouti OR Dominica OR Dominican Republic OR Dominican Republic OR Ecuador OR Egypt OR El Salvador OR

Guinea OR Eritrea OR Ethiopia OR Fiji OR Gabon OR Gambia OR Georgia OR Ghana OR Grenada OR Guatemala OR Guinea OR Guinea-Bissau OR Guyana OR Haiti OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Korea OR Kosovo OR Kyrgyzstan OR Kyrgyz Republic OR Kyrgyzstan OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia OR Madagascar OR Malawi OR Malaysia OR Maldives OR Mali OR Micronesia OR Marshall Islands OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Pakistan OR Palau OR Panama OR Papua New Guinea OR Papua New Guinea OR Paraguay OR Peru OR Philippines OR Romania OR Russia OR Russian Federation OR Rwanda OR Samoa OR Sao Tome and Principe OR Senegal OR Serbia OR Sierra Leone OR Melanesia OR Solomon Islands OR Somalia OR South Africa OR South Africa OR South Sudan OR South Sudan OR Sri Lanka OR Saint Lucia OR Saint Lucia OR St. Lucia OR "Saint Vincent and the Grenadines" OR "Saint Vincent and the Grenadines" OR "St. Vincent and the Grenadines" OR Sudan OR Suriname OR Swaziland OR Syria OR Syria OR Syrian Arab Republic OR Tajikistan OR Tanzania OR Thailand OR Timor-Leste OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbekistan OR Vanuatu OR Venezuela OR Vietnam OR Palestine OR "West Bank and Gaza" OR Yemen OR Zambia OR Zimbabwe)

Note: The name of these countries are obtained from the World Bank Data[39]

Appendix 7: Quality assessment form

Appendix 7a: CLEAR assessment form

1. Study Design	
Criterion 1.1: Is the overall study design appropriate for addressing the research questions?	
1a	Is the proposed research strategy appropriate for meeting the aims of study?
1b	Does the study present a convincing argument for different features of its design?
1c	Does it discuss limitations of the design and appropriate implications for interpreting findings? For which topics does it note limitations?
1d	Does the study include a logic model? Does it use the logic model to illuminate research questions and guide the study?
Criterion 1.2: Are the data sources clearly identified and appropriate for addressing the research questions?	
1e	Does the study clearly identify and describe all data sources and methods?
1f	Does the study document the sample sizes/coverage of each data source?
1g	Does the study indicate the strengths and weaknesses of each data source?
1h	Does the study provide evidence of triangulation of data sources across respondents and/or with administrative or observational data?
1i	Does the study describe the domains and data sources used to construct measures of implementation inputs (for example, organizational characteristics, staffing structures, and service delivery supports); contextual factors; and implementation outputs (such as content, quantity, quality, and delivery mode of the intervention)?
1j	Does the study discuss the range of values of the implementation fidelity measures that can be computed with these data and methods, and the thresholds that are used to make an assessment of implementation fidelity (by program component)?
1k	Does the study discuss measure validity, particularly those assessing the quality of service delivery?
2. Study Sample	
Criterion 2.1: Is the design and method for selecting sites clearly explained and appropriate for the purposes of the study?	
2a	Does the study describe the breadth of the study in terms of the population of interest and how sample selection relates to it (for example, purposive or representative sample)?
2b	Does the study specify clearly the criteria and rationale used in site selection?
2c	Does the study describe a systematic process to obtain eventual sites (including methods of site replacement, if appropriate)?

2d	Does the study explain how site selection is aligned with the purpose of the study?
2e	Does the study consider the factor site selection criteria into the interpretation of the findings?
2f	Does the study discuss what findings on sites can be generalized to the wider population from which it is drawn, as well as limitations to drawing wider inferences?
Criterion 2.2: Are the methods for drawing samples from data sources and identifying and sampling respondents clearly defined and defensible?	
2g	Does the study explain the method/criteria for selecting a sample of respondents?
2h	Does the study explain how the most appropriate respondents who held the type of knowledge sought by the study were identified and selected for qualitative interviews?
2i	Does the study discuss missing observations or information and implications for study findings?
2j	Does the study discuss representativeness, response/participation rates, and potential reasons for nonresponse/nonparticipation?
2k	Does the study discuss reasons for and methods of drawing samples?
2l	Does the study describe reasons for and methods of selecting examples of program activities for observation? (The importance of randomness and representativeness in this process will depend on the prominence of the activity for the study purpose; representativeness is important in assessing implementation quality and fidelity.)
3. Data Collection	
Criterion 3.1: Does data collection reflect sound and systematic methods to produce reliable data?	
3a	Does the study discuss who conducted data collection and training provided for data collectors?
3b	Does the study describe interview methods (such as semistructured interviews, use of topic guides) and conventions for taking notes?
3c	Does the study describe quality assurance procedures in data collection and verification of qualitative data?
3d	Does the study describe quality assurance procedures in data collection and verification of quantitative data, such as training and quality checks for conducting surveys, methods of training on observational measures, and achieving and ensuring reliability based on developer standards?
3e	Does the study discuss how on-site data collection settings or methods might have influenced data collected?
3f	Does the study identify limitations in data collection methods and steps taken to address them?
Criterion 3.2: Does the study include any information that raises the risk that results are biased or that there might be other ethical issues?	
3g	Evidence that the research team is not fully independent or objective
3h	Consent was not obtained from respondents or the study was misrepresented to them
3i	Data confidentiality procedures and procedures for maintaining respondents' anonymity were compromised

3j	Necessary approval from an institutional review board was not obtained
4. Data Analysis and Findings	
Criterion 4.1: Are the analysis methods clearly described and sufficiently rigorous?	
4a	Does the study describe the analysis methods, such as the use of specific qualitative analysis tools or software, or statistical tests to test hypotheses using quantitative data?
4b	Does the study present evidence of evenness in use of all data in the analysis to include multiple perspectives and alternative positions (or contradictory data)?
4c	Does the study describe a consistent and systematic coding process implemented across data sources?
4d	Does the study describe the original form of data and how the initial descriptive analytic categories/variables were generated and used (for example, use of a protocol to construct descriptive categories a priori, variables derived directly from survey questions)?
4e	Does the study present evidence of how categories or themes were derived from the data (for thematic analysis of qualitative data or to construct analytic variables from quantitative data)?
4f	Does the study explain how the data presented were selected from the original sample to demonstrate the analysis process? For example, does the study avoid generalizations and provide information about the extent of an activity or theme? Does it explain the selection of textual abstracts such as quotes or vignettes?
Criterion 4.2: Are the links among data, interpretation, and findings clear? Can the route to the findings be explicitly followed?	
4g	Are findings and conclusions aligned with the study's research questions?
4h	Are findings clearly supported by the data presented? Does the study present findings accurately and objectively and not introduce speculative hypotheses that are not supported by the data?
4i	Does the study describe how or why particular interpretation or significance is assigned to aspects of the analysis and findings?
4j	Do the findings make sense as a whole? Are seemingly odd or inconsistent findings acknowledged and addressed appropriately?
4k	Does the study demonstrate credibility of the findings? For example, triangulation of data, respondent validation, and more than one researcher involved in analysis?
4l	Are findings placed in the appropriate context with regard to generalizability given limitations in design, data sources, and methods of the study?
4m	Does the study discuss considerations relevant to replicability of findings in different contexts or circumstances?

Appendix 7b: Details of Quality Appraisal

Sheet 1

Author	Abbey M et al., 2014	Adam, T. , 2012	Ahluwalia et al. (2010)	Ajayi et al. (2014)	Amo-Adjei (2013)	Ansbro, É., 2021	Arredondo, A., 2018	Atun, R. A., 2007	Beardmore-Gray, A., 2021
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1j	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	No	Yes
1k	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear

2l	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes
3f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4f	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Author	Bhanbhro, S., 2020	Biswas, R. K., 2020	Blanchet et al. (2014)	Bogren, M. U., 2015	Cardenas, M. K., 2016	Chibanda, D., 2016	Chu, H., 2021	Cleary, S., 2018	Correia, J. C., 2019
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
1k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2l	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes
Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes
3f	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4d	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
4m	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Sheet 3

Author	Diaz, L. J. R., 2017	Dolan, S. B., 2020	Echaubard, P., 2020	Fried, J., 2012	Ghiron et al. (2014)	Gruen, R. L., 2008	Hutchinson, C., 2010	Humphries et al. (2011)	Igwesi- Chidobe, C. N., 2020
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1i	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
2f	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2l	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes

Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3f	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4d	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes
4f	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4m	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes

Sheet 4

Author	Katz et al. (2014)	Ledogar, R. J., 2017	Leon, N., 2013	Le Gargasson et al. (2013)	Maticka- Tyndale et al. (2010) Kenya	Morrison, J., 2019	Mutabazi, J. C., 2020	Mutale et al. (2015)	Perez- Escamilla, R., 2018
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

1j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1k	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes
Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2f	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes
2l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3f	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	No	Yes
4f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4m	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes

Sheet 5

Author	Rassachaert et al. (2014) Mozambique	Rivière- Cinnamond, A., 2018	Roura et al. (2009) Tanzania	Sako, B., 2018	Sebotsa et al. (2007) Lesotho	Somasse (2013) Burkina Faso	Teguete et al. (2012) Mali	Torpey et al. (2011) Zambia	VanDevanter, N., 2017
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1k	No	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes
Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2f	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes
2l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3f	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
4f	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4m	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

Sheet 6

Author	Varghese, J., 2014	Vamos et al. (2014) Zambia	Walsh et al. (2012) Zambia	Wandeler et al. (2012) Zimbabwe, Mozambique, and Lesotho	Zakumumpa, H., 2016	Zullig et al. (2014) Tanzania			
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1j	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes
1k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2f	No	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
2l	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes

Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3f	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4f	Yes	Not clear	Yes	Not clear	Yes	Yes	Yes	Yes	Yes
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4m	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes

Studies obtained from the citation searching (continuation sheet)

Sheet 7

Author	K. Arthur, (2021)	G. Buccini, (2021)	O. Ezezika, (2021)	E. E. Kiracho, (2021)	S. Lu, Y. (2021)	G. O'Malley, (2021)	C. Wexler, (2021)	J. Grant, (2022)	O. D. Ishola, (2022)
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1j	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1k	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
2f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes
3f	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear	Yes
4e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes
4l	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Sheet 8

Author	J. Iwelunmor (2022)	A. M. N. Renzaho (2022)	S. Zhou, (2022)	S. Bright, (2023)	A. Harker Roa, (2023)	F. A. Huda, (2023)	M. Niang, (2023)	C. Straw, (2023)	
Criterion 1.1									
1a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Criterion 1.2									
1e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1j	Yes	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes
1k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.1									
2a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
2f	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 2.2									
2g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2l	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 3.1									
3a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3f	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Criterion 3.2									
3g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.1									
4a	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4b	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4c	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4d	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4e	Yes	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	Yes
4f	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Criterion 4.2									
4g	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4h	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4j	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4k	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4l	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not clear
4m	Yes	Not clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix 8

Table 1: the basic information of included studies in systematic review of empirical studies

N	Author/ year	Name of the study	Objective	Country	Setting	Participants	Duration	Region	Study design	Study methodo logy	Implementation Outcomes
1	Abbey M et al., 2014	Factors related to retention of community health workers in a trial on community- based management of fever in children under 5 years in the Dangme West District of Ghana	To examine factors influencing retention of volunteer CHWs in a cluster randomised trial on community management of under-5 fever in a rural Ghanaian district	Ghana	community- based management in the Dangme West District, a rural district in the Greater Accra Region	structured interviews (n=520) and focus group discussions (n=5)	2006– 2009 Between January 2006 and December 2009	Africa	structured interviews and focus group discussion s with CHWs	Mixed methods	Attrition was comparatively higher in younger age groups (25.9% in 15–25 years group, 18.2% in 26–45 years group and 16.5% in ≥46 years group)

Evaluating health systems strengthening interventions in low-income and middle-income countries: are we asking the right questions?

to assess the scope and research questions explored in recent HSS evaluations

n/a

n/a

NA

NA

n/a

systematic review

qualitative study

Of the 106 evaluations, 43% of the studies asked broad research questions.

Only half of the assessments considered referring to a conceptual framework to guide the evaluation of complex interventions.

Overall, 24% of process evaluations were conducted, and 9% of background evaluations

3	Ahluwalia et al. (2010)	Sustainability of community-capacity to promote safer motherhood in northwestern Tanzania: what remains?	To examine the remains of the Community-Based Reproductive Health Project (CBRHP) implemented by CARE-Tanzania to address high maternal mortality in two rural districts.	Tanzania	two rural health districts including 29 villages	This group included male (n = 34) and female (n = 28) community leaders, sub-village leaders from different parts of the village (n = 30), women (n = 60) and men (n = 63), and government extension workers (n = 34)	2001–2006	Africa	Document review, community assessment survey, volunteer health workers survey	qualitative study	From 2001 to 2006, with the help of women's health workers trained in chemical, biological and health programmes and free or low-cost transport services in six villages with emergency transport systems, maternal and child health indicators such as early prenatal care and identification of pregnancy-related risk signs have improved in both target areas

											Utilisation of the CMDs was high at the start of the project, but declined after the researchers left the community.
4	Ajayi et al. (2014)	Sustainability of intervention for home management of malaria: the Nigerian experience	To improve Home Management of Malaria (HMM) in Ona-Ara Local Government Area of Oyo State, Nigeria two years after end of intervention. to explore the views of some key actors who are engaged in TB control in Ghana on the sustainability of TB control programme within the context of	Nigeria	two rural health districtsp of Ona-Ara Local Government area (LGA)	n/a	2005–2007	Africa	Focus group and key informant interviews	qualitative study	All CMDs mentioned that they did not receive any support from the community, and none of the CMDs observed had an AL inventory or sponsorship record in the past year. Optimists argue that in health systems, using funds at the disposal of the health system to co-ordinate the treatment of patients with tuberculosis and AIDS can improve the disease situation
5	Amo-Adjei (2013)	Perspectives of stakeholders on the sustainability of tuberculosis control programme in Ghana		Ghana	four out of the 10 administrative regions	In-depth qualitative interviews with 19 stakeholders	2012	Africa	In-depth qualitative interviews	qualitative study	

					international or local (country) level health policy and planning discourses							in general and can provide a positive way to achieve sustainability. Pessimists, on the other hand, point out that existing programmes are unlikely to be sustainable as long as the majority of operational funding comes from external sources.
6	Ansbro, É., 2021	MSF experiences of providing multidisciplinary primary level NCD care for Syrian refugees and the host population in Jordan: an implementation study guided	To conclude the integrity evaluation, which employs the RE-AIM framework to assess coverage; effectiveness; programme adoption and acceptance; fidelity, adaptability and cost of	Jordan	Irbid, the second largest city	Syrian refugee (either registered or unregistered with UNHCR), refugee of other origin or a vulnerable member of the Jordanian host population	Retrospective cohort study: 3 years; December 2014 to December 2017	Costing study: 3 years;	Western Asia	retrospective evaluation	mixed method	As the program matured, blood pressure and blood glucose control levels improved, by 6.6 mmHg and 1.12 mmol/l respectively within 6 months of admission. 23% increase in annual cost per patient
												Per patient per year cost increased 23%

		by the RE-AIM framework	implementation ; and maintenance of the programme over time.			with “target NCDs”	Clinical audit:12 months				from INT\$ 1424 (2015) to 1751 (2016), and by 9% to 1904 (2017). Cost per consultation increased from INT\$ 209 to 253 (2015–2017).
							Medication adherence survey: 2 weeks;				
							Qualitative study: in August 2017.				
7	Arredondo, A., 2018	Challenges and dilemmas on universal coverage for non-communicable diseases in middle-income countries: evidence and lessons from Mexico	to highlight what has been achieved in universal coverage for the management of hypertension and diabetes.	Mexico	n/a	NA	NA	North America	narrative review	mixed method	Standard/crude coverage for hypertension observed in the 96 selected countries ranged from 7-61% and effective coverage from 11-31%; Peru, Qatar, Egypt, Kyrgyzstan and Cambodia were the countries with the highest effective coverage.

8	Atun, R. A., 2007	Diffusion of complex health innovations - implementation of primary health care reforms in Bosnia and Herzegovina	To examine PHC reforms in a transition country from an innovation lens	Bosnia and Herzegovina	n/a	six policy makers, nine clinicians, 11 family physicians, five nurses, 18 managers and nine patients	18 months	southeastern Europe	semi-structured interview	mixed method (both qualitative and quantitative methods)	While diabetes coverage ranged from 3 to 70% for normative/crude coverage and 4 to 60% for effective coverage
											Complex systems face epidemiological, cultural, organisational and economic challenges and barriers The Republic of BiH has managed to expand its multifaceted reforms to cover more than 25% of the country. Our analysis reveals complex contextual and bi-directional interactions between innovation,

adopters and the environment, which together influence the diffusion process.

The complex contexts and bidirectional interactions between innovation, adopters and environment combine to influence the diffusion process.

9	Beardmore-Gray, A., 2021	Planned early delivery for late preterm pre-eclampsia in a low- and middle-income setting: a feasibility study	to explore the feasibility of planned early delivery in women with pre-eclampsia between 34+0- and 36+6-weeks' gestation in order to inform the design of the intervention and the main trial protocol	India and Zambia	tertiary level hospitals (providing Comprehensive Emergency Obstetric and Newborn Care) situated in urban environments	326 women with pre-eclampsia (and 342 infants) 59 key stakeholder	3 months	India (South Asia) Zambia (southern Africa)	Case notes review Focus group discussions Key stakeholder interviews	mixed methods	Case record data (n = 326) showed that 19.5% (n = 44) of women with pre-eclampsia who delivered at more than 34 weeks experienced poor outcomes in our setting. Among women delivering at 34 + 0 to 36 + 6 weeks, the number of antenatal stillbirths [n = 3 (3.3%)] and neonatal deaths [n = 3 (3.4%)] were similar, with median birth weights of 2.2 kg and 1.9 kg in Zambia and India, respectively. The lived experience of women and health care providers is an

important contributor to the proposed intervention. Preference for natural births and limited neonatal resources were identified as potential barriers.

10	Bhanbhro, S., 2020	Factors affecting maternal nutrition and health: A qualitative study in a matrilineal community in Indonesia	To explore the feasibility of establishing culturally appropriate interventions to promote maternal health and nutrition in a widely recognised matrilineal	Indonesia	a suburban area of Padang district in West Sumatra province	pregnant women and/or women who had been pregnant in the last twelve months (n = 7), their husbands (n = 3), mothers	Not mentioned	Southeast Asia and Oceania	Qualitative semi-structured individual interviews	qualitative study	The main challenges faced by the mothers and families participating in the study included the healthy dietary patterns of the participants, such as eating vegetables and fruit regularly. However, poverty, access to food,

			community in Indonesia			and mothers-in-law (n = 4), health-care professionals (n = 3) and Kaders—volunteer community workers (n = 2)					dietary contraindications and inadequate nutritional information
11	Biswas, R. K., 2020	A systematic assessment on COVID-19 preparedness and transition strategy in Bangladesh	to assist the evaluation of health system of Bangladesh	Bangladesh	the whole country	NA	up to June 15, 2020	South Asian	secondary data analysis	mixed method (both qualitative and quantitative methods)	The findings indicate that Bangladesh is seriously unprepared to deal with the spread of COVID-19, which has short and long-term implications for health, the economy and good governance. Lack of planning and coordination, uneven distribution of resources, infrastructure challenges, bureaucratic delays,

											unsynchronised risk communication, poor leadership of relevant authorities and inconsistent decision-making have led to a dangerous situation that will create much uncertainty in the coming days.
12	Blanchet et al. (2014)	Advancing the application of systems thinking in health: analysing the contextual and social network factors influencing the use of sustainability indicators in a health system – a comparative	To compare the definition and use of sustainability indicators developed via the sustainability analysis process in the rehabilitation sectors of Nepal and Somaliland, and further to analyse the contextual	Nepal and Somaliland	n/a	n/a	2010	Nepal (South Asia) Somaliland (Africa)	In-depth interviews and observations	qualitative study	There are differences in the governance and structure of current recovery systems. In Somali Land, priorities competed and a network of small, centralized stakeholders between the system's two major information brokers experienced a serious disruption

		study in Nepal and Somaliland	factors influencing sustainability.								due to the withdrawal of either international assistance. Progress towards self-defined sustainability was limited.
13	Bogren, M. U., 2015	Towards a midwifery profession in Bangladesh--a systems approach for a complex world	to explore how different stakeholders connect to promote the Bangladesh's midwifery profession	Bangladesh	n/a	16 key persons representing nine different organisations	2 months	South Asian	semi-structured interviews	Qualitative study	Saving lives by educating and deploying 3,000 midwives. Each participant contributed to the strength and performance of his or her knowledge system. Collaboration is projected to achieve more than individual

											organizations. An important achievement in this regard was the development of the two midwives curriculum and the nurturing of the teachers.
14	Cardenas, M. K., 2016	Delivery of Type 2 diabetes care in low- and middle-income countries: Lessons from Lima, Peru	to assess the facilitators and barriers that help or hinder access to care for people with diabetes in Peru	Peru	Lima, the capital city of Peru	111 interviews in Lima, the capital city of Peru, with patients with diabetes, healthcare providers and healthcare officials.	12 months (in 2013)	South America	literature review in-depth interview	mixed method	The study identified three major system-level barriers: (1) the availability of information at the level of different health systems affecting several processes of health care delivery; (2) insufficient financial resources; and (3) insufficient human resources trained in diabetes management.

15	Chibanda, D., 2016	Using a theory driven approach to develop and evaluate a complex mental health intervention: the friendship bench project in Zimbabwe	to develop a common vision that describes the causal pathway leading to the program/initiative/intervention goal	Zimbabwe	three large primary care clinics in Harare Zimbabwe	The first formative ToC workshop: Director of City Health Services, the Minister of Health and several stakeholders; 54 participants recorded by DC The second workshop: a smaller group (n = 28); The third workshop: senior clinic managers of the City Health Department,	6 months	southern Africa	ToC workshops	qualitative study	Key influencing factors include political buy-in from stakeholders together with key resources, which included human, facility/infrastructure, communication and supervision were identified as critical needs using the ToC approach

						their supervisors, and the Director of City Health services (n = 28)					
16	Chu, H., 2021	A Mixed Methods Process Evaluation of a Clustered-Randomized Controlled Trial to Determine the Effects of Community-Based Dietary Sodium Reduction in Rural China	To provide us a comprehensive view of implementation and effectiveness and promoted evidence-based practice for village doctors who provide the basic medical service as a family doctor to prevent and control chronic disease in local village in rural China.	China	five Northern Provinces of China, including Hebei, Liaoning, Ningxia, Shanxi, and Shaanxi	In RCT, n=1,903 people Quantitative data were collected from activity logs and routine study records. Qualitative data were collected from 53 project stakeholders and 45 villagers from 10	In RCT study, 18 months 16 months	Asia	A clustered-randomized controlled trial a semi-structured , face-to-face depth interview	mixed-methods	A total of 5,450 posters, 31,400 calendars and 78,000 stickers were distributed and 11 awareness-raising events were held in each village. Environmental factors that influenced the effectiveness of the intervention included preference for salty taste, high cost of low sodium salt and low education level of villagers. Other environmental

						intervention villages					factors, active policy support, administrative support and staff motivation were facilitators of implementation.

17	Cleary, S., 2018	The everyday practice of supporting health system development: learning from how an externally-led intervention was implemented in Mozambique	To explore the key features of the implementation approach; the reasons for the approach; the factors that influence the intervention; and how the intervention is influenced	Mozambique	Sofala	Participants included members of the Health Alliance International (HAI) intervention team (e.g. the Mozambique-based Country Director, Coordinators, Advisors and Assistants); provincial- and district-level health officials (Programme/ Department Managers, Programme Supervisors, District Health Directors,	4 years	southern Africa	23 in-depth interviews , a focus group discussion, observation of intervention activities and primary project documentation	Qualitative study	In Mozambique, the Population Health Implementation and Training Partnership focused on strengthening integrated health system management at the local and national level, developing appropriate tools to improve the quality of routine data and facilitating decision-making by national and regional managers. Build the ability to design and implement innovative operational studies to guide integration and system improvement efforts.

						Chief Medical Officers, District Health Statisticians); health workers in facilities; and other partners (e.g. staff from the Beira Operations Research Centre, CIOB).					

18	Correia, J. C., 2019	Interventions targeting hypertension and diabetes mellitus at community and primary healthcare level in low- and middle-income countries:a scoping review	to describe the key characteristics of HTN and DM focused primary care and community level interventions in LMICs	LMICs	n/a	NA	NA	n/a	a scoping review	mixed method	Complex interventions are mainly related to the description or testing of interventions, evaluation of programs, quality improvement measures, screening and prevention efforts, hypertension or diabetes management, integrated health services, knowledge and attitude surveys, cost-effective laboratory testing) and policy development

19	Diaz, L. J. R., 2017	Designing a telephone intervention program for family caregivers	To describe the development process of a nursing intervention program to promote the adaptation of family caregivers for people with chronic diseases in Colombia and Brazil.	Colombia and Brazil	city of São Paulo, and the city of Bucaramanga	a group of seven nurses (three Colombians and four Brazilians) who fulfilled the following criteria were selected: having the title of nurse and having a minimum clinical practice of 1 year in areas related to care of people with chronic diseases or family caregivers.	2 months	South America	literature review in-depth interview	qualitative study	An intervention programme to facilitate the adaptation of family caregivers of chronically ill patients was formulated and tested in a clinical trial

20	Dolan, S. B., 2020	Perceptions of factors influencing the introduction and adoption of electronic immunization registries in Tanzania and Zambia: a mixed methods study	to describe perceptions of factors that influenced scale-up of the EIR in Tanzania and Zambia To provide resource and regularly health education in innovative approaches within the community and ensure that the curriculum on prevention generates specific actions related to the resources and	Tanzania and Zambia	n/a	14 key informants	2 months	Africa	Qualitative data: key informant interviews and a desk review. Quantitative data: EIRs and HMISs	mixed methods	The introduction or sustained adoption of EIR is influenced by many interrelated factors including adequate staffing for facilities, training, use of data for monitoring, internet and electricity connections, and community outreach.
21	Echaubard, P., 2020	Fostering social innovation and building adaptive capacity for dengue control in Cambodia: a case study		Cambodia	n/a	community health workers (CHWs), health centre chiefs, school directors, monks, priests, teachers, farmers and members of the local education	NA	Southeast Asian	In-depth interviews, focus group discussions, participant observations, and informal conversations	qualitative study	The SI products include 1) adult mosquito traps 2) revised dengue curriculum 3) guppy distribution systems 4) dengue prevention communication material 5) community mapping.

cultural
acceptability

office as well
as students.

22	Fried, J., 2012	Hopes interrupted: accessing and experiences of antiretroviral therapy in South Africa	To study and better understand the experiences and challenges of urban and rural patients on antiretroviral therapy (ART) in evaluating this intervention in resource-limited contexts	South Africa	Cape Town	20 patients receiving ART in both urban and rural settings	NA	Africa	in-depth interviews	qualitative study	As a result all interviewees highlighted that receiving antiretroviral treatment could improve health, increase the ability to live an active life and reduce visible signs of illness. Important factors for the sustainability of the intervention included the social and economic

											support of individuals, role models and networks, and positive experiences with the health care system and the treatment itself. The main challenges relate to the difficult life circumstances of patients, particularly in relation to poverty (e.g. transport and food costs) and health system constraints, including perceived lack of compassion and flexibility by health care workers.

23	Ghiron et al. (2014) East Africa (Uganda and Kenya)	Beginning with sustainable scale up in mind: initial results from a population, health and environment project in East Africa	To demonstrate how this novel approach is being applied and the initial experiences in the ongoing Lake Victoria Basin Human and Environmental Health project in Uganda and Kenya	Uganda and Kenya	n/a	9 project team members and 13 project stakeholders	2003	East Africa	key informant interviews , desk review of documents	qualitative study	1) stakeholder involvement has a significant impact on design and implementation of complex interventions; 2) multi-sectoral projects are complex and striving for simplicity across sectors is challenging; and 3) projects are under significant pressure to scale up.

24	Gruen, R. L., 2008	Sustainability science: an integrated approach for health-programme planning	To Review existing perspectives and empirical research on health plan sustainability; further develop an empirical framework for sustainability; use this framework to generate a methodology for planning health plan sustainability and develop a robust evidence base to support refinement and implementation of the methodology	NA	NA	NA	NA	NA	systematic review	qualitative study	Sustainability of planning programmes is a key factor in promoting health and development, particularly in low- and middle-income countries, and a consensus evidence-based operational framework can promote the intervention sustainability

25	Hutchinson, C., 2010	Exploring the sustainability of obstetric near-miss case reviews: a qualitative study in the South of Benin	to develop an understanding of the barriers and facilitators to the sustainability of obstetric near-miss case reviews in five hospitals in southern Benin.	Benin	five hospitals in three regions	two Ministry of Health officials and eight health-care workers involved in a feasibility study	1998-2001	West Africa	literature review semi-structured interviews	qualitative study	Ten qualitative interviews identified six themes related to the sustainability of case reviews: the perceived advantages of ensuring quality of care, fear of blame and punishment, availability of resources, training, a supportive hospital work environment, and broader policy issues
26	Humphries et al. (2011)	Sustainability of NGO capacity building in southern Africa: successes and opportunities	To explore issues of ownership, the importance of integrating planning for sustainability within capacity-building projects, and the value of identifying	Botswana, Lesotho, Namibia, Southern Africa, Swaziland	n/a	44 internal stakeholders (trainers, managers, administrators, and technical advisors)	2004–2007	southern Africa	Surveys and qualitative interviews	qualitative study	This study examines key frameworks for the sustainability of capacity building and applies them to assessing the sustainability of HIV NGO capacity building initiatives. The NGOTI was funded by a funded

			primary capacity-building objectives								a five country program, which developed the capacity of controlling AIDS
27	Igwesi-Chidobe, C. N., 2020	Evidence, theory and context: using intervention mapping in the development of a community-based self-management program for chronic low back pain in a rural African primary care setting - the good back program	to reduce CLBP disability in rural Nigeria using the first four steps of the IM approach, (2) describe the initial implementation and feasibility testing, (3) describe the initial self-management program before feasibility testing, and (4) highlight the changes made to the program following feasibility	Nigeria	rural areas	12 unconventional practitioners – patent medicine sellers (4), herbalists (3) and pastors (2) 200 people living with CLBP in 10 rural Nigerian communities (cross sectional)	NA	West Africa	literature review in-depth semi-structured face-to-face interviews cross-sectional study	qualitative study	Influencing factors of personnel and environment including health literacy, self-awareness, self-efficacy, personal preference, health professional skills, health facility structure and family/community support.

			testing to produce a definitive program.								
28	Katz et al. (2014)	Lessons learned from stakeholder-driven sustainability analysis of six national HIV programmes	To explore lessons learned related to how countries have addressed the sustainability of HIV programmes in a stakeholder-driven sustainability analysis	Benin, Kenya, Lesotho, Sierra Leone, and South Sudan	n/a	n/a	2010–2012	Africa	Stakeholder interviews	qualitative study	Need to prioritize evidence-based interventions and apply efficiency measures is contained in the country. Three sustainability strategies including: prioritization, efficiency improvements and resource mobilization

											Identified the concepts of cost, replicability and sustainability
											Key elements of success in Cape Verde including the use of community volunteers called brigadias, their door-to-door visits, the use of evidence from the communities themselves and community ownership of the undertaking.
29	Ledogar, R. J., 2017	Mobilising communities for Aedes aegypti control: the SEPA approach	To control the Aedes aegypti by using Camino Verde (the Green Way) is an evidence-based community mobilisation tool	Nicaragua and Mexico	diverse communities	NA	NA	Central American(Nicaragua)	Notrh American(Mexico)	literature review	qualitative study

30	Leon, N., 2013	Implementing a provider- initiated testing and counselling (PITC) intervention in Cape town, South Africa: a process evaluation using the normalisation process model	to investigate how implementation factors may have influenced the outcomes of a controlled trial that aimed to use PITC to increase HIV test uptake amongst STI patients in Cape Town, South Africa.	South Africa	Cape Town	6 focus groups were conducted with 42 participants	2006 to 2007	Africa	participan t observatio n of project implemen tation processes, staff focus groups, patient interviews , and observatio n of clinical practice	qualitativ e study	Factors contributing to normalization included strong senior leadership, implementation support, appropriate accountability mechanisms, intervention design that was responsive to service needs and aligned with professional practice, positive staff and patient perceptions, and a responsive organizational environment. And challenges encountered included poor sequencing and integration of HIV and STI tasks, a focus on HIV education, tensions with patient-centred

communication
styles, and
inadequate training
to address
operational
challenges.

31	Le Gargasson et al. (2013)	Sustainability of National Immunization Programme (NIP) performance and financing following Global Alliance for Vaccines and Immunization (GAVI) support to the Democratic Republic of the Congo (DRC)	To test the hypothesis that GAVI support in the DRC has acted as a catalyst for improving and sustaining the performance and financing of routine immunisation programmes	Congo	n/a	22 key informants from the Ministry of Health Expanded Program on Immunization	2002–2010	Africa	literature review in depth interviews	mixed methods	DPT vaccine coverage increased from 2002 (38%) to 2007 (72%) and subsequently declined from 70% in 2008 (68%) to 2010 (63%). Also, the total funding for vaccines increased from US\$5.4 million in 2006 to US\$30.5 million in 2010
32	Maticka-Tyndale et al. (2010)	Sustainability of gains made in a primary school HIV prevention programme in Kenya into the secondary school years	To explore whether the beneficial effects of Primary School Action for Better Health (PSABH), an HIV prevention programme delivered in	Kenya	primary schools in Kenya	13,161 students	2001–2004	Africa	focus groups in-depth interviews	qualitative study	The intervention continued after three years of implementation. One and a half years after the intervention, the trained teachers promoted students' awareness of the risks of high-risk

			Kenyan primary schools, continue once students move on to secondary schools								sexual behaviour and female students' receptiveness to condom use.
33	Morrison, J., 2019	Implementation and fidelity of a participatory learning and action cycle intervention to prevent and control type 2 diabetes in rural Bangladesh	To assess the fidelity of the intervention to the theory and principles of the assumed change process. To examine how implementation affected the effectiveness of the intervention in order to explore the external validity	Bangladesh	Faridpur District, central Bangladesh	One hundred twenty-two groups per month were convened by 16 facilitators	July 2016 to December 2017	South Asian	quantitative data through field reports and qualitative data through observations and focus group discussions.	mixed methods	Influencing factors affecting complex interventions including community barriers, awareness of diabetes prevention and control, the high cost of health care and healthy eating, and gender barriers to exercise for women. Long-term intervention expectations and

			of the intervention.								capacity building can help remove institutional barriers to behaviour change.
					</						

		workers - a qualitative study									
35	Mutale et al. (2015)	Application of systems thinking: 12-month postintervention evaluation of a complex health system intervention in Zambia: the case of the BHOMA	to improve service quality in accordance with a complex health system intervention in Zambia known as Better Health Outcome Mentorship and Assessment (BHOMA)	Zambia	three rural districts in Zambia: Chongwe, Kafue and Luangwa	n/a	2011–2014	Africa	In-depth interview guides and focus group discussions	qualitative study	In the short term there was increased demand for services but the health worker capacity was not severely affected. However, from a systems perspective, unintended consequences also occurred during the implementation of the BHOMA

36	Perez-Escamilla, R., 2018	Becoming Breastfeeding Friendly Index: Development and application for scaling-up breastfeeding programmes globally	to describe the development of the BBFI together with remaining components of the BBF toolbox To explore components promoting and/or impairing the sustainability of the CAG model and to formulate suggestions to ensure its ongoing sustainability	n/a	n/a	14 TAG members	between August 2015 and January 2016	n/a	literature review Delphi consensus methodology	qualitative study	The BBFI including 8 gears: Advocacy; Political Will; Legislation and Policies; Funding and Resources; Training and Program Delivery; Promotion; Research and Evaluation; and Coordination, Goals, and Monitoring
37	Rassachert et al. (2014) Mozambique	Sustainability of a community-based anti-retroviral care delivery model—a qualitative research study in Tete, Mozambique		Mozambique	Tete	five main stakeholders	2008-2012	Africa	In-depth interviews	qualitative study	Community involvement and leadership are the main contributing factors. The main barriers are human resources and the resources to monitor and support the CAG model.

38	Rivière-Cinamond, A., 2018	Identifying the social and environmental determinants of plague endemicity in Peru: insights from a case study in Ascope, La Libertad	(i) plague risk perception at community level, (ii) the perceived social and ecological determinants of plague for community members as well as for decision-makers, and (iii) the actions proposed by these two groups that would facilitate preventing plague occurrence.	Peru	the rural areas of “Los Colonos”, “Santa Clara” and “San José Alto”	policy makers (n = 34).	in 2005	South America	In-depth interviews	qualitative study	The main determinants of plague are different in the eyes of different groups. 1. policymakers identified agriculture and sugarcane production as the main cause, the 2. communities perceive health status and the health sector as the main cause 3. stakeholders see the government sector (education, housing, agriculture and transport) as the main cause 4. policy makers consider social monitoring as the main cause

39	Roura et al. (2009) Tanzania	Barriers to sustaining antiretroviral treatment in Kisesa, Tanzania: a follow-up study to understand attrition from the antiretroviral program	to identify how barriers to treatment initiation could be overcome on a small scale through resource-intensive interventions, to a scaled-up version where we can longitudinally assess longer term challenges faced by national ART programs.	Tanzania	42 clients and 11 service providers and 4 participatory group activities	2006	Africa	Semi-structured interviews	mixed methods	(1) Key determinants of clinic attendance include personal willingness (motivation) and perceived competence (self-efficacy). (2) The norms and support of personal networks influenced treatment patterns. (3) In the context of severe poverty in rural Tanzania, structural factors ultimately limit the ability of individuals to sustain treatment

40	Sako, B., 2018	Exploring barriers and enablers for scaling up a community-based grain bank intervention for improved infant and young child feeding in Ethiopia: A qualitative process evaluation	to identify enablers and barriers for successful scaling up of the Grain Bank project.	Ethiopia	180 localities in Ethiopia	25 women	in December 2015 and January 2016	Africa	literature review In-depth interviews	qualitative study	Strong political support, integration into community health systems and a participatory approach were the main contributing factors to the intervention. Complex management systems, human resource constraints and the sustainability of the project in times of food insecurity were the main challenges encountered.

41	Sebotsa et al. (2007) Lesotho	Assessment of the sustainability of the iodine-deficiency disorders control program in Lesotho	To assess the sustainability of the salt iodization program in Lesotho, 2 years after promulgation of the universal salt iodization legislation	Lesotho	all ecological zones and districts of Lesotho	a total of 924 women, of whom 64 were pregnant a total of 912 children, of whom 477 were girls and 435 were boys	2000	Africa	Chemical analysis of urine samples and in-depth interviews	mixed methods	Of the 10 planned indicators for sustainability, only 4 were achieved. Key influencing factors include politics, public education, and regular monitoring. Barriers to sustainability and scaling up were underlined: management by external personnel from the health system, no financial support for the scaling-up process, insufficient national advocacy, and unsustainable activities (e.g., free care).
42	Somassee (2013) Burkina Faso	Sustainability and scaling-up analysis of community-based management of acute malnutrition: lessons learned from Burkina Faso	To highlight the challenges to sustainability and scalability of a CMAM program in Burkina Faso	Burkina Faso	180 intervention villages	28,208 admissions, including 19,009 (67.4%) children and 9,188 (32.6%) pregnant and lactating women	2006	Africa	desk review on-site observations	qualitative study	

	Study	Intervention	Comparison	Setting	Population	Time period	Health services	Methods	Outcomes
43	Teguete et al. (2012) Mali	Can visual cervical screening be sustained in routine health services? Experience from Mali, Africa: sustained cervical cancer prevention effort in Mali	To assess the feasibility of sustaining visual cervical screening and treatment services in Mali, and to evaluate their performance and impact in improving the provision of cervical cancer control, following an initial cross-sectional study.	Mali	Bamako area 14,141 women screened	2004–2009	routine health services	Descriptive method qualitative study	Over 75% of screen positive women underwent colposcopy and/or biopsy. 383 cases of CIN 1, 88 cases of CIN 2, 37 cases of CIN 3 and 83 cases of invasive cervical cancer were found 497. Over 80% of patients with CIN and 35% of patients with invasive cancer were treated. Over the 39 months of the intervention, the rate of pregnant women responding to counselling and HIV testing increased from 45% to 90% in the first year and had increased to 99% by
44	Torpey et al. (2011) Zambia	Increasing the uptake of prevention of mother-to-child transmission of HIV services in a resource-limited setting	uptake of prevention of mother-to-child (PMTCT) services in a resource-limited setting following the introduction of context-	Zambia	38 sites providing PMTCT services in five provinces of Zambia n/a	2004–2009	Africa	literature review secondary data analysis mixed methods	Increased from 45% to 90% in the first year and had increased to 99% by

			specific interventions								the third year. Patients receiving a full course of antiretroviral (ARV) prophylaxis increased from 29% to 66% in year 1 and to 97% in year 3. The proportion of HIV-positive pregnant women referred to clinical care also enhance greatly. The results of the interviews were summarised based on the CFIR and the factors influencing the figure out included the advantages of the intervention over current practice; training; capacity building; collective effectiveness in providing cessation services; workflow;
45	VanDevanter, N., 2017	Application of the Consolidated Framework for Implementation Research to assess factors that may influence implementation of tobacco use treatment guidelines in the Viet Nam public health	to (1) identify factors that may influence guideline implementation and (2) inform further modifications to the intervention that may be necessary to translate a model of care delivery from a high-income	Viet Nam	26 community health centers (CHCs)	village health workers (VHWs) in eight CHCs (n = 40)	NA	Southeast Asia	semi-structured qualitative interviews	qualitative study	

		care delivery system	country (HIC) to the local context of a LMIC.								human resources; and the external environment

health workers, nutrition and pre-school teachers and community leaders), and providers from public and private sector. The study also involved key informant interviews with 6 experts

s, and observations of immunization services.

47	Vamos et al. (2014) Zambia	Translation and sustainability of an HIV prevention intervention in Lusaka, Zambia	to (a) characterize the work environment in Lusaka CHCs participating in the Partner Program translational research study; (b) assess the relative impact of task shifting to provide the behavioral risk reduction intervention on individual factors (staff burnout and job satisfaction, and perceived clinic burden) within the CHC context; and (c) identify opportunities and challenges	Zambia	Lusaka	CHC staff participants (n = 82)	2008–2013	Africa	questionnaire interviews	qualitative study	Factors influencing the feasibility of implementing and sustaining HIV prevention interventions in Lusaka's urban community health centres included patient numbers, limited resources and space, monetary incentives, support, education and training opportunities. In addition, the provision of the intervention did not increase the perceived burden and burnout of health workers, nor did it reduce job satisfaction.

			to long-term sustainability of such intervention programs in the CHCs.								
48	Walsh et al. (2012) Zambia	“The problem is ours, it is not CRAIDS”. Evaluating sustainability of Community Based Organisations for HIV/AIDS in a rural district in Zambia	to evaluate whether or not this global programme contributed to the sustainability of CBOs working in the area of HIV/AIDS in Zambia. Lessons for optimising sustainability of CBOs in lower income	Zambia	Mumbwa rural district	representatives of all CBOs that received CRAIDS funding (n = 18) and district stakeholders (n= 10) in Mumbwa rural district in Zambia, in 2010; and national	2003–2008	Africa	In-depth interviews	qualitative study	In terms of health services, access to food for people living with HIV, transport services to and from clinics and home visits by health workers were all reduced. In terms of organisational capacity, while linkages between health facilities and the community were strengthened during

			countries are drawn			stakeholders (n=6) in 2011					the intervention, the lack of infrastructure and training led to a reduction in the skill level of volunteers, further leading to a reduction in the sustainability of the intervention
49	Wandele et al. (2012)	Outcomes of antiretroviral treatment programs in rural Southern Africa	To describe early losses and long-term outcomes in six rural programs in Southern Africa with limited access to viral load monitoring and second-line ART.	Zimbabwe, Mozambique, and Lesotho	rural areas	A total of 9271 patients	2005–2010	Africa	Descriptive method	qualitative study	During the study period, a total of 9271 patients began receiving antiviral therapy. A total of 449 patients (5.8%) cannot be followed up. In more than 9575 person-years of follow-up, 7276 patients had at least one follow-up, of which 1319 patients (18.1%) were LTFU and 698 patients (9.6%) died. The

											crude death rate was 7.3 (95% CI 6.8 - 7.9) deaths per 100 person-years.
50	Zakumu mpa, H., 2016	Accounting for variations in ART program sustainability outcomes in health facilities in Uganda: a comparative case study analysis Sustainability of cancer registration in the Kilimanjaro Region of Tanzania—a qualitative assessment	to identify facilitators and barriers to the long-term sustainability of ART programs at six health facilities in Uganda to develop a comprehensive understanding of perceived factors associated with sustainability of cancer registration	Uganda	195 (out of 394) health facilities	ART Clinic managers (N = 18) Questionnaire data were analyzed (N = 12) 11 participants, with an approximately even balance of administrators and clinical-only staff	between February and June 2015	Africa	A case-study Semi-structured interviews	qualitative study	The influencing factors of high maintainers included the scale of ART programmes, staff and patients, a 'menu' of ART services and programme leadership The sustainability of cancer registration interventions may be influenced by factors including resource availability, management, vision/goals, training, data
51	Zullig et al. (2014) Tanzania			Tanzania	Kilimanjaro Christian Medical Centre (KCMC)		2013	Africa	semi-structured qualitative interviews	qualitative study	

activities
through key
stakeholder
interviews.

(55%
administrator
s; 45%
clinical-only)

support and
international
partners

Studies obtained from the citation searching after the confirmation review

52	Arthur, K., (2021)	Process evaluation of a pre-adolescent transdisciplinary health intervention for inter-generational outcomes	To assess and report the results of the process evaluation of the implementation of <i>The CIRCLE of Life Initiative</i>	South Africa	Five Government-run South African primary schools	537 grade 6 learners and their parents	between July and September 2018	Africa	A pragmatic approach	mixed methods	The process evaluation revealed high learner penetration (97.2%), but lower learner and parent exposure (44.3% and 55.5%, respectively)
53	Buccini, G., (2021)	Scaling up of Brazil's Criança Feliz early childhood development program: an implementation	This study aimed to analyze barriers and enablers for PCF emergence, scaling up, and sustainability from the	Brazil	in 2934 of its 5570 municipalities	22 key informants	between October 2019 and January 2020	South America	in-depth interviews	qualitative study	One overarching theme related to PCF emergence, and 18 subthemes were identified within the RE-AIM

		n science analysis		perspective of key informants (KIs) at the federal and state levels.							
54	Ezezika, O., (2021)	The implementation of a maternal mHealth project in South Africa: Lessons for taking mHealth innovations to scale	To explore the barriers and facilitators to implementing the MomConnect programme in South Africa and the applicable lessons for scaling mHealth programmes in Africa	South Africa	nine provinces in South Africa: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West, and Western Cape	76 stakeholders	between November 8, 2019 and February 18, 2020	Africa	in-depth interviews	qualitative study	barriers and/or facilitators in the implementation of the MomConnect project and how they would overcome those barriers and strengthen the facilitators

55	Kiracho, E.E., (2021)	Designing for Scale and taking scale to account: lessons from a community score card project in Uganda Using Stakeholder Perceptions to Inform Future Efforts to Implement Mental Health First Aid Training in China: A Qualitative Study	To document the process of planning and adapting the design of the community scorecards (CSC) to understand the implementation issues and contextual factors among key stakeholders in order to promote future scale-up of MHFA in China	Uganda	five sub counties and one town council of Kibuku district	five female and five male and seven key informant interviews (KIIs)	June 2018	Africa	focus group discussions (FGDs)	qualitative study	The challenges encountered included limited technical capacity of stakeholders facilitating the CSC, poor functionality of existing community engagement platforms, and difficulty in promoting community participation without financial incentives.
56	Lu, S., (2021)			China	Shanghai	Twenty-four participants (women, 50%) were interviewed	2019	Asia	semi-structured in-depth interviews	qualitative study	Fifteen themes and 52 sub-themes were identified in relation to the five domains.

			in a culturally appropriate way.								
57	O'Malley, G., (2021)	Health Care Providers as Agents of Change: Integrating PrEP With Other Sexual and Reproductive Health Services for Adolescent Girls and Young Women	To describe the challenges they foresee in scaling integrated PrEP and SRH services, and the strategies they suggest to overcome them.	South Africa	six facilities across three locations: two family planning clinics in Kisumu, Kenya; a mobile clinic serving youth in disadvantaged communities and a primary care facility in Cape Town, South Africa	We conducted IDIs with 36 participants and 8 FGDs with 50 participants.	October 2019 through January 2020	Africa	in-depth interviews (IDIs) and focus group discussions (FGDs)	qualitative study	HCWs believed the biggest challenge to sustained integration and scaling of PrEP for AGYW would be lack of health care worker motivation, primarily due to a misalignment of personal and professional values and expectations.

58	Wexler, C., (2021)	Implementing at-birth, point-of-care HIV testing in Kenya: a qualitative study using the Consolidated Framework for Implementation Research	To describe the implementation of an at-birth POC testing pilot from the perspective of implementing providers and identifies the factors that might support and hinder the scale up of these promising interventions. to document the challenges and lessons learned during the planning and early implementation phases of the RTS,S/AS01E malaria vaccine introduction, according to the regional and district level	Kenya	four Kenyan hospitals	48 providers	From 2017–2018	Africa	focus group discussions (FGDs)	qualitative study	Out of the 39 CFIR constructs, 30 were addressed in the FGDs. Participants reported challenges related to the characteristics of the intervention, such as issues with the vaccine schedule and eligibility criteria, and challenges related to how it was implemented as a pilot programme
59	Grant, J., (2022)	Challenges and lessons learned during the planning and early implementation of the RTS,S/AS01E malaria vaccine in three regions of Ghana: a		Ghana	six regions of Ghana	regional and district health service managers and frontline health workers	In 2019	Africa	in-depth interviews	qualitative study	

60	Ishola, O.D., (2022)	qualitative study	health service managers and frontline health workers who planned and delivered the vaccine, to assist future wider distribution of the vaccine in Ghana and elsewhere in Africa	Nigeria	2 higher-performing states and 1 lower-performing state	subnational government leaders and managers, nongovernmental organization leaders, and TCI Nigeria staff	2019	Africa	Semi-structured interviews	mixed-methods	several TCI strategies overlapping with CFIR were critical to states' successful adoption and sustainment of interventions, most prominently external champions' contributions and strengthened state planning and coordination,
		What Underlies State Government Performance in Scaling Family Planning Programming? A Study of The Challenge Initiative State Partnerships in Nigeria	to examine how The Challenge Initiative (TCI) coaches subnational (state government) actors to scale proven family planning and adolescent and youth sexual and reproductive								

			health approaches rapidly and sustainably through public health systems to respond to unmet need among the urban poor.								especially in higher-performing states.
61	Iwelunmor, J., (2022)	Factors influencing the integration of evidence-based task-strengthening strategies for hypertension control within HIV clinics in Nigeria	To inform the adaptation strategies needed to tailor TASSH implementation to the local context.	Nigeria	Lagos, the largest city in Nigeria	healthcare providers at 29 HIV clinics	between October 2017 and January 2018	Africa	1-day stakeholder meeting	mixed-methods	Across the 29 clinics surveyed, the focus on TASSH (mean=1.77 (SD=0.59)) and educational support (mean=1.32 (SD=0.68)) subscales demonstrated the highest mean score, with good–excellent internal consistency reliability (Cronbach’s alphas ranging from 0.84 to 0.96).

62	Renzaho, A.M., (2022)	Pathways and approaches for scaling-up of community-based management of acute malnutrition programs through the lens of complex adaptive systems in South Sudan Barriers and enablers in the implementation of a quality improvement program for acute coronary syndromes in hospitals: a qualitative analysis using the consolidated	To identify pathways opportunities and approaches for horizontal and vertical scaling up of CMAM programs in South Sudan To investigate barriers and enablers in the NCPCP implementation process and provided examples and ideas for overcoming such barriers.	South Sudan	Communities in South Sudan	31 respondents from policy and implementing organisations	between August and September 2021	Africa	online qualitative survey	qualitative study	Findings from the study demonstrate that the emphasis of CMAM programs was horizontal scaling up, characterised by geographic distribution and coverage as well as operational expansion.
63	Zhou, S., (2022)			China	six cities, Suzhou, Wuhan, Changsha, Hefei, Chongqing, and Shenzhen	A total of 165 key informant interviewees, including directors and coordinators of chest pain centers (CPCs) in 90 hospitals	between July and August 2021	Asia	semi-structured interview	qualitative study	Barriers to NCPCP implementation mainly arose from nine CFIR constructs.

framework for implementation research											
64	Bright, S., (2023)	Scale-up of a novel vital signs alert device to improve maternity care in Sierra Leone: a mixed methods evaluation of adoption	This study aimed to explore in depth whether, and why, healthcare professionals in Sierra Leone adopted the device and engaged in training (or not).	Sierra Leone	Rural areas	Around half of the Champions in each district were invited to participate (total invited n = 41)	between March 2020 and January 2021	Africa	Focus Group Discussions (FGDs)	mixed methods study	Complexity related to the technology and the organisational context were found to influence the adoption of CRADLE in Sierra Leone, with substantial inter-district variation.
65	Harker Roa, A., (2023)	Implementing psychosocial support models in contexts of extreme adversity: lessons from a	to identify information around seven spheres, namely: acceptability, adoption, appropriateness	Colombia	NA	714 families	2018–2019	South America	Key Informant Interviews (KIIs); the digital platform KoboToolbox®	mixed methods study	Findings identified salient components of the program that promoted the program's acceptability, adoption, appropriateness,

		process evaluation in Colombia	, feasibility, fidelity, penetration, and sustainability								fidelity and sustainability
66	Huda, F.A., (2023)	Examining the implementatio n of Facility- Based Integrated Management of Childhood Illness and Insecticide Treated Nets in Bangladesh: lessons learned through implementatio n research	to understand how Bangladesh was able to achieve this success between 2000 and 2015	Banglade sh	NA	NA	Between 2017 and 2020	Asia	Using existing data and reports suppleme nted by key informant interviews	mixed methods study	We identified strategies which contributed to the successful implementation and wide coverage of the selected EBIs.

67	Niang, M., (2023)	Using systems thinking to understand scale-up and sustainability of health innovation: a case study of Seasonal malaria chemoprevention processes in Burkina Faso	to analyze the complex scaling and sustainability processes through adopting and implementing Seasonal Malaria Chemoprevention (SMC) in Burkina Faso from 2014 to 2018.	Burkina Faso	NA	NA	between February to March 2018	Africa	documentary analysis, individual interviews , and observation	qualitative study	Our results indicated six internal and external determinants of SMC that may negatively or positively influence its scale-up and sustainability in time and space.
68	Straw, C., (2023)	Implementation and scaling-up of an effective mHealth intervention to increase adherence to triage of HPV-positive women (ATICA study): perceptions of	To report data on perceptions of health decision-makers and health-care providers regarding the intervention implementation and scaling-up	Argentina	The province of Jujuy is located in northwest Argentina	health decision-makers (n = 10) and health-care providers (n = 10)	between December 4, 2018 and July 31, 2019	South America	individual, semi-structured interviews	qualitative study	Health decision-makers and health-care providers had a positive perception regarding implementation of the multicomponent mHealth intervention designed to increase adherence to triage among women with

health
decision-
makers and
health-care
providers

HPV self-collected
tests

Note: Due to page size restrictions, five items including topic area, discipline, referred to theories/models/frameworks or not, organization involvement, and national or international were not presented in this table.

Table 2: The factors influencing the adaptability, scalability and sustainability of complex interventions in the included studies of empirical systematic review

	Influencing factors	Sub-components	Referred studies
outer context	Sociopolitical context		8,10,13,22,24,37,39,40,53,54,67
		ethical	29
		legislation	11,14,18,24,54
		norms or regulations	6,11,14
		policies	1,6,8,11,15,16,18,20,25,36,56,60,68
		religion	32
		culture	1,6,7,8,10,17,21,23,38,52,62,65
		economic	10,24,52,56,68
	leadership		3,8,11,14,18,20,21,24,25,26,28,29,30,44,45,51,58,63,66,67,68
	funding		2,5,6,7,8,9,11,13,14,16,17,22,23,24,25,26,28,31,32,36,42,44,50,54,56,60,62,66
	Client Advocacy		18,36,42,48,59,62
	Interorganizational Networks		8,11,13,17,25,29,36,43,45,53, 54
	environmental factors		16,24,26,27,28,37,45
inner context			50

**Organizational
characteristics**
6,7,8,11,13,17,18,23,24,25,33,37,50,**53,61**

Absorptive capacity

8

Organization readiness
structure

20

6,7,27,**65**

values or visions

9,13,24,36,50

working environment

6,30

tension for change

36,45,51

Organization culture

17

Credibility and reputation

6,45

leadership
3,8,11,14,18,20,21,24,25,26,28,29,30,44,45,51,**58,63,66,67,68**
**Individual adopter or
provider characteristics**

6,9,27,29,39,41,45

ability or capacity

8

race

n/a

spoken language

8,18

training or education

1,2,3,6,7,8,10,13,16,18,21,24,25,26,29,30,32,35,36,45,48,49,51,**53,58,59,63,65**

views

12,36,50,**57,63**

tension for change

30,40,51

individual culture

8

age

1

gender

1,33

Marital status

1

Number of children

1

Occupation	1
health burden	6
mental health	6
motivation	25,57
demand	50

Supervision, monitoring and evaluation

1,3,6,11,13,15,18,20,23,36,40,41,46,49,50

staffing

2,3,6,7,11,13,14,15,16,18,20,22,30,34,43,46,47,49,50,51,63,64

intervention characteristics

communication	6,39,40,45,58
Quality and fidelity	15,21,30,43,51
monitoring/support	1,3,6,11,13,15,18,20,23,36,40,41,46,49,65,67
geographical	8,29,62
project champion	3,20,24,30,50
resources(health services, human resource, financial resource, infrastructure)	2,3,4,8,9,10,11,12,13,14,15,17,21,25,26,28,29,31,34,36,38,43,44,45,47,48,49,51, 59,61,62,63,66,67
stakeholders involvement	6,8,9,11,15,20,23,24,30,55,58,60
support system or tool	2,3,4,6,8,9,10,11,14,17,20,21,22,28,35,42,43,49,62,63,66
technology advance or environment	2,6,13,14,20,27,54
Time	19,21,25,29,33
salary/payment/Remuneration	1,55,63
governance/management	2,14,24,25,38,56

Supply and distribution/delivery	2,14,21,24,35,36,40,49,50
long-term planning	5
Personnel management	2

Bridging factors	community engagement	1,3,4,10,11,12,13,18,20,21,23,24,25,26,27,28,29,32,33,34,35,37,40,46,55,64,66
	Purveyors/intermediaries	8,11,18,21,29

The study name of the referred study number

1. Factors related to retention of community health workers in a trial on community-based management of fever in children under 5 years in the Dangme West District of Ghana
2. Evaluating health systems strengthening interventions in low-income and middle-income countries: are we asking the right questions?
3. Sustainability of community-capacity to promote safer motherhood in northwestern Tanzania: what remains?
4. Sustainability of intervention for home management of malaria: the Nigerian experience
5. Perspectives of stakeholders on the sustainability of tuberculosis control programme in Ghana
6. MSF experiences of providing multidisciplinary primary level NCD care for Syrian refugees and the host population in Jordan: an implementation study guided by the RE-AIM framework
7. Challenges and dilemmas on universal coverage for non-communicable diseases in middle-income countries: evidence and lessons from Mexico
8. Diffusion of complex health innovations - implementation of primary health care reforms in Bosnia and Herzegovina
9. Planned early delivery for late preterm pre-eclampsia in a low- and middle-income setting: a feasibility study
10. Factors affecting maternal nutrition and health: A qualitative study in a matrilineal community in Indonesia
11. A systematic assessment on COVID-19 preparedness and transition strategy in Bangladesh
12. Advancing the application of systems thinking in health: analysing the contextual and social network factors influencing the use of sustainability indicators in a health system – a comparative study in Nepal and Somaliland
13. Towards a midwifery profession in Bangladesh--a systems approach for a complex world

14. Delivery of Type 2 diabetes care in low- and middle-income countries: Lessons from Lima, Peru
15. Using a theory driven approach to develop and evaluate a complex mental health intervention: the friendship bench project in Zimbabwe
16. A Mixed Methods Process Evaluation of a Clustered-Randomized Controlled Trial to Determine the Effects of Community-Based Dietary Sodium Reduction in Rural China
17. The everyday practice of supporting health system development: learning from how an externally-led intervention was implemented in Mozambique
18. Interventions targeting hypertension and diabetes mellitus at community and primary healthcare level in low- and middle-income countries:a scoping review
19. Designing a telephone intervention program for family caregivers
20. Perceptions of factors influencing the introduction and adoption of electronic immunization registries in Tanzania and Zambia: a mixed methods study
21. Fostering social innovation and building adaptive capacity for dengue control in Cambodia: a case study
22. Hopes interrupted: accessing and experiences of antiretroviral therapy in South Africa
23. Beginning with sustainable scale up in mind: initial results from a population, health and environment project in East Africa
24. Sustainability science: an integrated approach for health-programme planning
25. Exploring the sustainability of obstetric near-miss case reviews: a qualitative study in the South of Benin
26. Sustainability of NGO capacity building in southern Africa: successes and opportunities
27. Evidence, theory and context: using intervention mapping in the development of a community-based self-management program for chronic low back pain in a rural African primary care setting - the good back program
28. Lessons learned from stakeholder-driven sustainability analysis of six national HIV programmes
29. Mobilising communities for Aedes aegypti control: the SEPA approach
30. Implementing a provider-initiated testing and counselling (PITC) intervention in Cape town, South Africa: a process evaluation using the normalisation process model
31. Sustainability of National Immunization Programme (NIP) performance and financing following Global Alliance for Vaccines and Immunization (GAVI) support to the Democratic Republic of the Congo (DRC)

32. Sustainability of gains made in a primary school HIV prevention programme in Kenya into the secondary school years
33. Implementation and fidelity of a participatory learning and action cycle intervention to prevent and control type 2 diabetes in rural Bangladesh
34. Integrating the prevention of mother-to-child transmission of HIV into primary healthcare services after AIDS denialism in South Africa: perspectives of experts and health care workers - a qualitative study
35. Application of systems thinking: 12-month postintervention evaluation of a complex health system intervention in Zambia: the case of the BHOMA
36. Becoming Breastfeeding Friendly Index: Development and application for scaling-up breastfeeding programmes globally
37. Sustainability of a community-based anti-retroviral care delivery model—a qualitative research study in Tete, Mozambique
38. Identifying the social and environmental determinants of plague endemicity in Peru: insights from a case study in Ascope, La Libertad
39. Barriers to sustaining antiretroviral treatment in Kisesa, Tanzania: a follow-up study to understand attrition from the antiretroviral program
40. Exploring barriers and enablers for scaling up a community-based grain bank intervention for improved infant and young child feeding in Ethiopia: A qualitative process evaluation
41. Assessment of the sustainability of the iodine-deficiency disorders control program in Lesotho
42. Sustainability and scaling-up analysis of community-based management of acute malnutrition: lessons learned from Burkina Faso
43. Can visual cervical screening be sustained in routine health services? Experience from Mali, Africa: sustained cervical cancer prevention effort in Mali
44. Increasing the uptake of prevention of mother-to-child transmission of HIV services in a resource-limited setting
45. Application of the Consolidated Framework for Implementation Research to assess factors that may influence implementation of tobacco use treatment guidelines in the Viet Nam public health care delivery system
46. Advancing the application of systems thinking in health: understanding the growing complexity governing immunization services in Kerala, India
47. Translation and sustainability of an HIV prevention intervention in Lusaka, Zambia
48. “The problem is ours, it is not CRAIDS’”. Evaluating sustainability of Community Based Organisations for HIV/AIDS in a rural district in Zambia

- 49. Outcomes of antiretroviral treatment programs in rural Southern Africa
- 50. Accounting for variations in ART program sustainability outcomes in health facilities in Uganda: a comparative case study analysis
- 51. Sustainability of cancer registration in the Kilimanjaro Region of Tanzania—a qualitative assessment

Studies obtained from the citation searching after the confirmation review

- 52. Process evaluation of a pre-adolescent transdisciplinary health intervention for inter-generational outcomes
- 53. Scaling up of Brazil's Criança Feliz early childhood development program: an implementation science analysis
- 54. The implementation of a maternal mHealth project in South Africa: Lessons for taking mHealth innovations to scale
- 55. Designing for Scale and taking scale to account: lessons from a community score card project in Uganda
- 56. Using Stakeholder Perceptions to Inform Future Efforts to Implement Mental Health First Aid Training in China: A Qualitative Study
- 57. Health Care Providers as Agents of Change: Integrating PrEP With Other Sexual and Reproductive Health Services for Adolescent Girls and Young Women
- 58. Implementing at-birth, point-of-care HIV testing in Kenya: a qualitative study using the Consolidated Framework for Implementation Research
- 59. Challenges and lessons learned during the planning and early implementation of the RTS,S/AS01E malaria vaccine in three regions of Ghana: a qualitative study
- 60. What Underlies State Government Performance in Scaling Family Planning Programming? A Study of The Challenge Initiative State Partnerships in Nigeria
- 61. Factors influencing the integration of evidence-based task-strengthening strategies for hypertension control within HIV clinics in Nigeria
- 62. Pathways and approaches for scaling-up of community-based management of acute malnutrition programs through the lens of complex adaptive systems in South Sudan
- 63. Barriers and enablers in the implementation of a quality improvement program for acute coronary syndromes in hospitals: a qualitative analysis using the consolidated framework for implementation research
- 64. Scale-up of a novel vital signs alert device to improve maternity care in Sierra Leone: a mixed methods evaluation of adoption
- 65. Implementing psychosocial support models in contexts of extreme adversity: lessons from a process evaluation in Colombia
- 66. Examining the implementation of Facility-Based Integrated Management of Childhood Illness and Insecticide Treated Nets in Bangladesh:

lessons learned through implementation research

67. Using systems thinking to understand scale-up and sustainability of health innovation: a case study of Seasonal malaria chemoprevention processes in Burkina Faso
68. Implementation and scaling-up of an effective mHealth intervention to increase adherence to triage of HPV-positive women (ATICA study): perceptions of health decision-makers and health-care providers

Table 3: the correlation between influencing factor mentioned in each included study and the three concepts of adaptability, scalability and sustainability

N	Name of study	Directly concerned with the core concepts of Sustainability	Concerned with non-core concepts of Sustainability	Directly concerned with the core concepts of Adaptability	Concerned with non-core concepts of Adaptability	Directly concerned with the core concepts of Scalability	Concerned with non-core concepts of Scalability
1	Factors related to retention of community health workers in a trial on community-based management of fever in children under 5 years in the Dangme West District of Ghana	Sustainability		adapted from concepts from the ecological behaviour model		scaled-up in other rural districts in the country	
2	Evaluating health systems strengthening interventions in low-income and middle-income countries: are we asking the right questions?	Sustainability			complex adaptive systems	scaling-up	

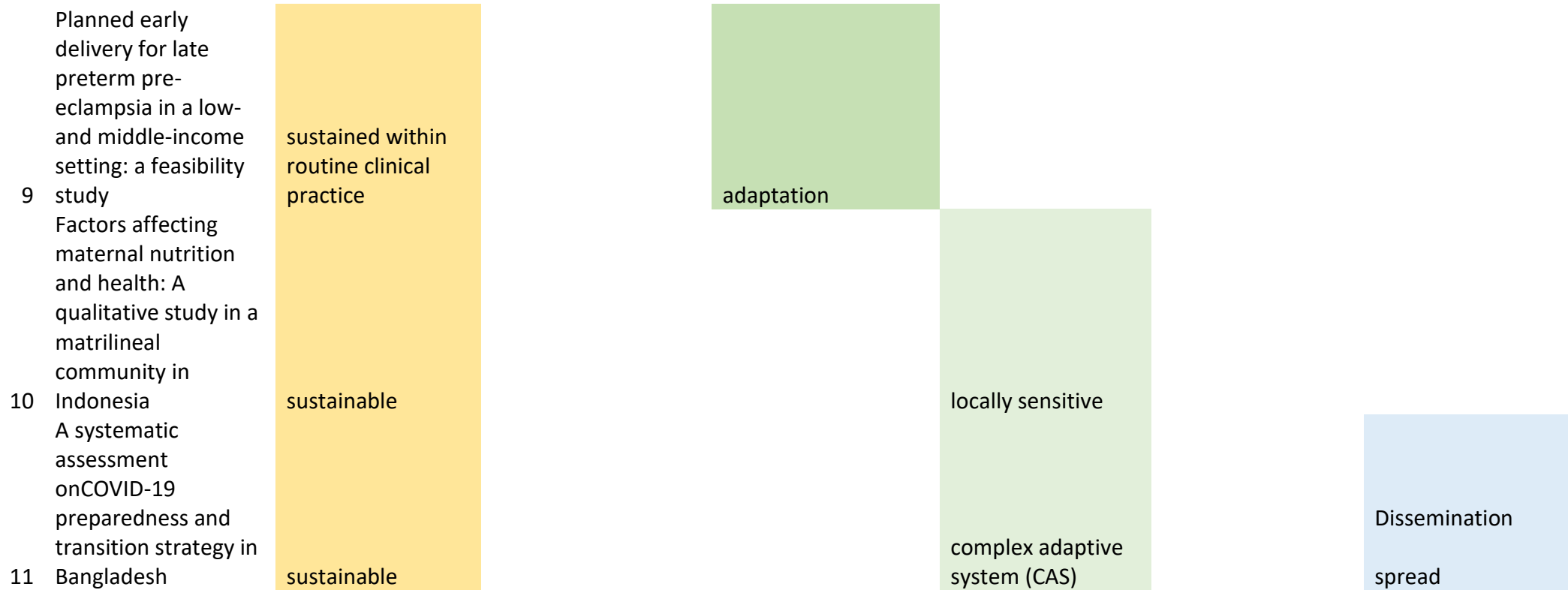
3	Sustainability of community-capacity to promote safer motherhood in northwestern Tanzania: what remains?	sustainability
4	Sustainability of intervention for home management of malaria: the Nigerian experience	sustainability
5	Perspectives of stakeholders on the sustainability of tuberculosis control programme in Ghana	sustainability

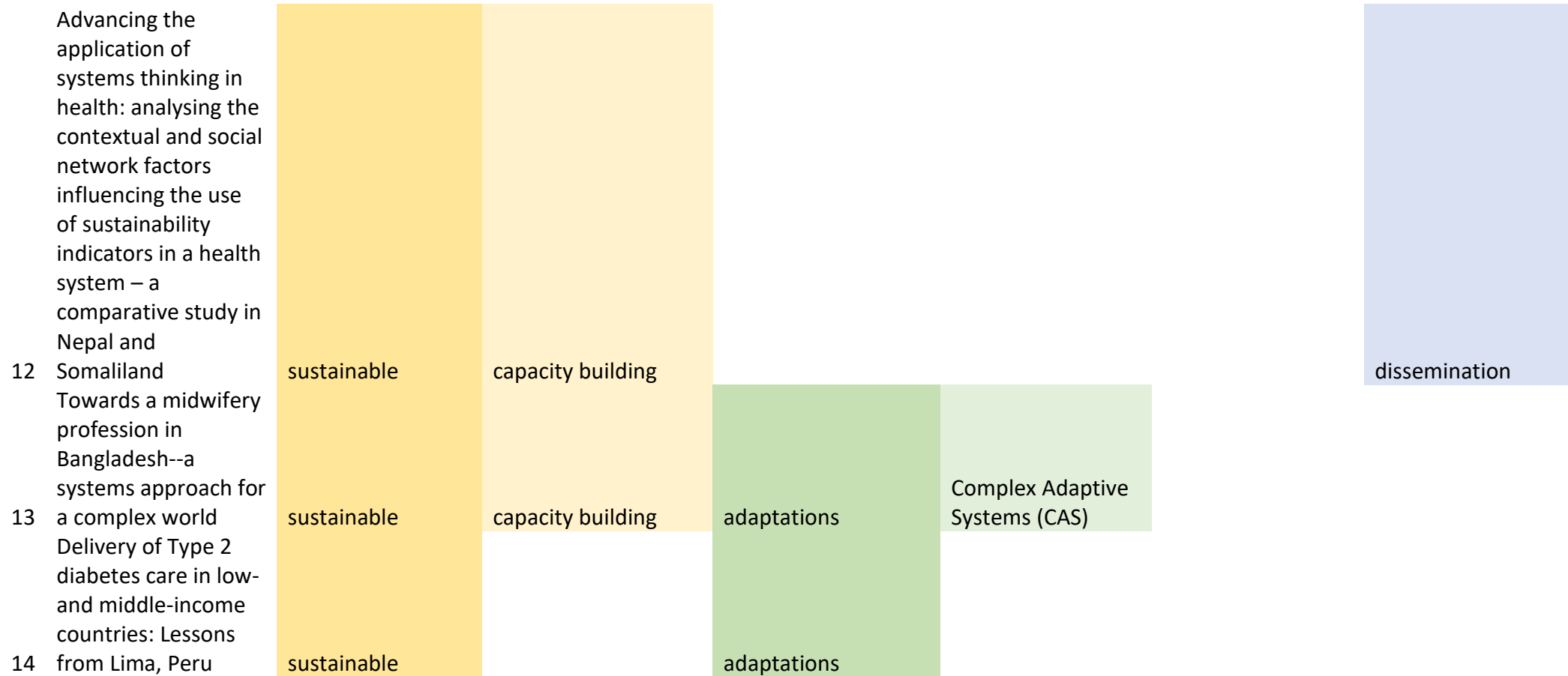
adaptations

scaling up
of HMM strategy

dissemination,
diffusion

6	MSF experiences of providing multidisciplinary primary level NCD care for Syrian refugees and the host population in Jordan: an implementation study guided by the RE-AIM framework	sustainable	programme Maintenance	adaptations	fidelity, cost	unlikely to be scalable in Jordan or reproducible in other humanitarian settings
7	Challenges and dilemmas on universal coverage for non-communicable diseases in middle-income countries: evidence and lessons from Mexico			adapted to the needs of the present century		
8	Diffusion of complex health innovations - implementation of primary health care reforms in Bosnia and Herzegovina	sustainable		adaptation	complex adaptive systems translation and assimilation	scaling up multifaceted reforms dissemination





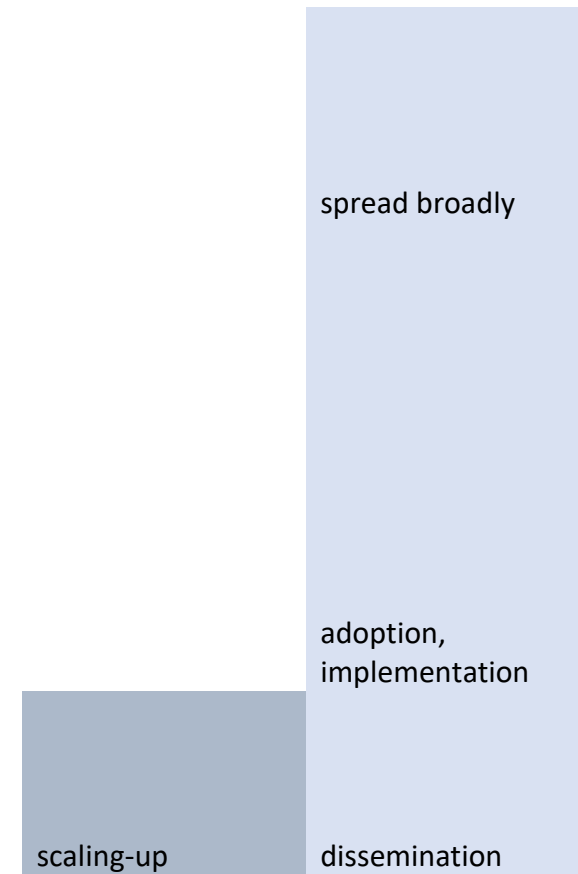
15	Using a theory driven approach to develop and evaluate a complex mental health intervention: the friendship bench project in Zimbabwe A Mixed Methods Process Evaluation of a Clustered-Randomized Controlled Trial to Determine the Effects of Community-Based Dietary Sodium Reduction in Rural	sustainability	capacity building		fidelity measurement	scaling-up
16	China The everyday practice of supporting health system development: learning from how an externally-led intervention was implemented in	sustainable		adaptation	fidelity	scalable
17	Mozambique	sustainable	maintenance capacity-development	adaptation		scaling up

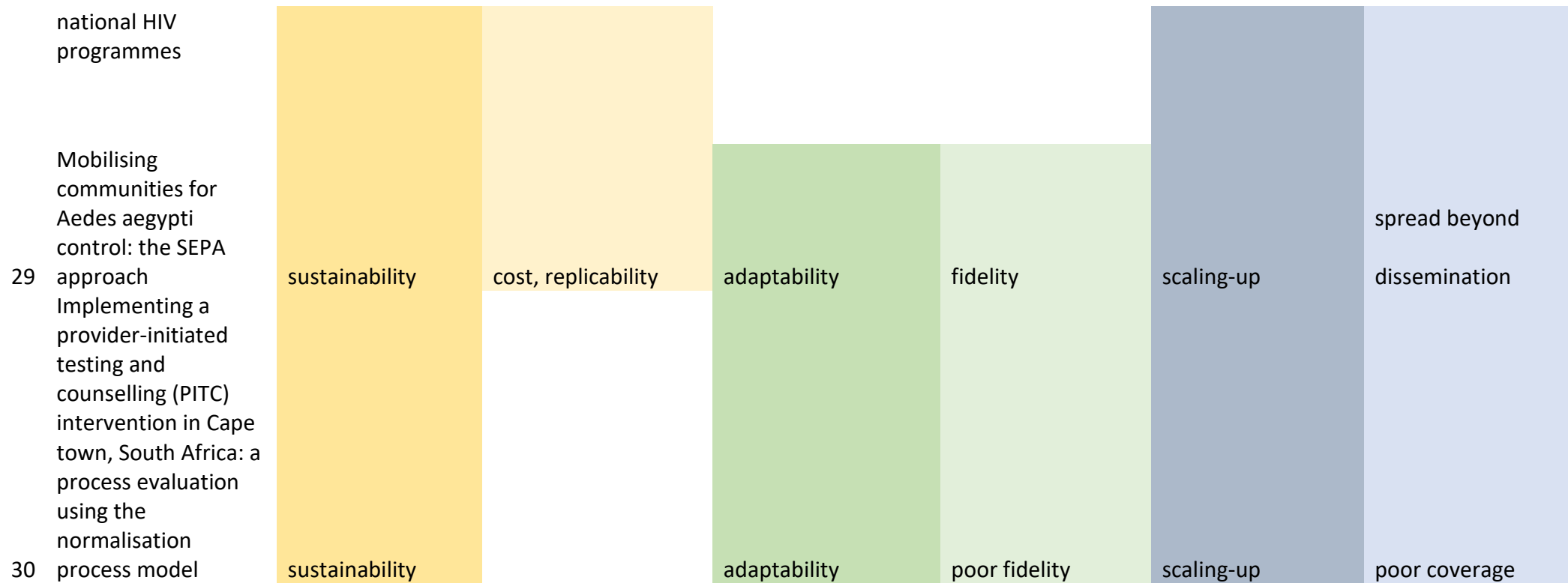
18	Interventions targeting hypertension and diabetes mellitus at community and primary healthcare level in low- and middle-income countries: a scoping review	sustainable		adaptation	fidelity	scaling-up	spreading
	Designing a telephone intervention program for family caregivers			adaptation	fidelity		
19	Perceptions of factors influencing the introduction and adoption of electronic immunization registries in Tanzania and Zambia: a mixed methods	sustainable	maintaining	adaptability		scaling-up	
20	study						

21	Fostering social innovation and building adaptive capacity for dengue control in Cambodia: a case study	sustainability	maintaining	adaptation
	Hopes interrupted: accessing and experiences of antiretroviral therapy in South Africa	sustainability		
22	Beginning with sustainable scale up in mind: initial results from a population, health and environment project in East Africa	sustainable	maintaining "continuation", "institutionalisation", "resilience", "durability", "viability", "stability", "persistence", and "main tenance"	
24	Sustainability science: an integrated approach for health-programme planning	Sustainability		adaptability

scaling-up	
scaling-up	
scaling-up	dissemination
scaling-up	

25	Exploring the sustainability of obstetric near-miss case reviews: a qualitative study in the South of Benin	sustainability	maintaining	adapt interventions to suit the context
26	Sustainability of NGO capacity building in southern Africa: successes and opportunities	sustainability	maintaining program benefits	adaptability
27	Evidence, theory and context: using intervention mapping in the development of a community-based self-management program for chronic low back pain in a rural African primary care setting - the good back program	sustainability		
28	Lessons learned from stakeholder-driven sustainability analysis of six	sustainability	maintaining	





Sustainability of National Immunization Programme (NIP) performance and financing following Global Alliance for Vaccines and Immunization (GAVI) support to the Democratic Republic of the Congo (DRC)	sustainability	maintenance			
31 Sustainability of gains made in a primary school HIV prevention programme in Kenya into the secondary school years	sustainability	maintenance			
32 Implementation and fidelity of a participatory learning and action cycle intervention to prevent and control type 2 diabetes in rural Bangladesh		capacity building	adaptation	fidelity	scalability
33					

Integrating the prevention of mother-to-child transmission of HIV into primary healthcare services after AIDS denialism in South Africa: perspectives of experts and health care workers - a qualitative study	sustainability	maintenance	adaptation	Complex Adaptive Systems framework	scalability
Application of systems thinking: 12-month postintervention evaluation of a complex health system intervention in Zambia: the case of the BHOMA	sustainably		adaptation		

Becoming Breastfeeding Friendly Index: Development and application for scaling-up breastfeeding programmes globally	sustainability			complex adaptive multilevel systems	scaling-up
36 Sustainability of a community-based anti-retroviral care delivery model—a qualitative research study in Tete, Mozambique	sustainability	maintenance	adaptation		
37 Identifying the social and environmental determinants of plague endemicity in Peru: insights from a case study in Ascope, La Libertad	sustainability		adaptability		

39	Barriers to sustaining antiretroviral treatment in Kisesa, Tanzania: a follow-up study to understand attrition from the antiretroviral program	sustainability	scaling-up
40	Exploring barriers and enablers for scaling up a community-based grain bank intervention for improved infant and young child feeding in Ethiopia: A qualitative process evaluation	sustainability	scaling-up
41	Assessment of the sustainability of the iodine-deficiency disorders control program in Lesotho	sustainability	

	Sustainability and scaling-up analysis of community-based management of acute malnutrition: lessons learned from Burkina Faso	sustainability
42	Can visual cervical screening be sustained in routine health services? Experience from Mali, Africa: sustained cervical cancer prevention effort in Mali	sustainability
43	Increasing the uptake of prevention of mother-to-child transmission of HIV services in a resource-limited setting	sustainable
44		

scaling up	dissemination
scaling up	
scaling-up	

Application of the Consolidated Framework for Implementation Research to assess factors that may influence implementation of tobacco use treatment guidelines in the Viet Nam public health care delivery system	sustainability	adaptation	scaling-up
Advancing the application of systems thinking in health: understanding the growing complexity governing immunization services in Kerala, India		complex adaptive system (CAS)	
Translation and sustainability of an HIV prevention intervention in Lusaka, Zambia	sustainability	fidelity	scaling-up

“The problem is ours, it is not CRAIDS”. Evaluating sustainability of Community Based Organisations for HIV/AIDS in a rural district in Zambia	sustainability		adaptation	
48 Outcomes of antiretroviral treatment programs in rural Southern Africa	sustainability	maintenance		
49 Accounting for variations in ART program sustainability outcomes in health facilities in Uganda: a comparative case study analysis	sustainability			
50 Sustainability of cancer registration in the Kilimanjaro Region of Tanzania—a qualitative assessment	sustainability			scaling-up
51	sustainability			

Studies obtained from the citation searching after the confirmation review (continuation sheet)

52	Process evaluation of a pre-adolescent transdisciplinary health intervention for inter-generational outcomes	sustainable			adoption	scale-up	
53	Scaling up of Brazil's Criança Feliz early childhood development program: an implementation science analysis	sustainability			adoption	Scaling up	
54	The implementation of a maternal mHealth project in South Africa: Lessons for taking mHealth innovations to scale	sustainable		adapting		scaling	
55	Designing for Scale and taking scale to account: lessons from a community score card project in Uganda					Scaling up	

56	Using Stakeholder Perceptions to Inform Future Efforts to Implement Mental Health First Aid Training in China: A Qualitative Study			adaptation		scalability	
57	Health Care Providers as Agents of Change: Integrating PrEP With Other Sexual and Reproductive Health Services for Adolescent Girls and Young Women	Sustained				scale-up	
58	Implementing at-birth, point-of-care HIV testing in Kenya: a qualitative study using the Consolidated Framework for Implementation Research	sustained		adaptations		scale up	
59	Challenges and lessons learned during the planning	sustained					

	and early implementation of the RTS,S/AS01E malaria vaccine in three regions of Ghana: a qualitative study						
60	What Underlies State Government Performance in Scaling Family Planning Programming? A Study of The Challenge Initiative State Partnerships in Nigeria					scaling	
61	Factors influencing the integration of evidence-based task-strengthening strategies for hypertension control within HIV clinics in Nigeria				integration		
62	Pathways and approaches for scaling-up of		Maintenance		Adoption	scaling up	

	community-based management of acute malnutrition programs through the lens of complex adaptive systems in South Sudan						
63	Barriers and enablers in the implementation of a quality improvement program for acute coronary syndromes in hospitals: a qualitative analysis using the consolidated framework for implementation research	sustainable		adaptability		scaling up	
64	Scale-up of a novel vital signs alert device to improve maternity care in Sierra Leone: a mixed methods evaluation of adoption	sustainability			adoption	scale-up	
65	Implementing	sustainability			adoption		

	psychosocial support models in contexts of extreme adversity: lessons from a process evaluation in Colombia						
66	Examining the implementation of Facility-Based Integrated Management of Childhood Illness and Insecticide Treated Nets in Bangladesh: lessons learned through implementation research						wide coverage
67	Using systems thinking to understand scale-up and sustainability of health innovation: a case study of Seasonal malaria chemoprevention processes in Burkina Faso	sustainability				scaling	

68	Implementation and scaling-up of an effective mHealth intervention to increase adherence to triage of HPV-positive women (ATICA study): perceptions of health decision-makers and health-care providers			adaptability		scaling-up	

Appendix 9 The first round of Delphi survey questionnaire

ASaS - eDelphi survey (round 1)

Start of Block: The ASaS consent form

The factors influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in low- and middle- income countries (LMICs):
An eDelphi survey: Consent Form

1.

Taking Part in the eDelphi survey

2.

I have read and understood the project information sheet dated 03/11/2022 or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.)

Yes (1)

No (2)

Skip To: End of Survey If I have read and understood the project information sheet dated 03/11/2022 or the project has been... = No

3.

I have been given the opportunity to ask questions about the project.

Yes (1)

No (2)

Skip To: End of Survey If I have been given the opportunity to ask questions about the project. = No

4.

I agree to take part in the project. I understand that taking part in the project will include completing several online questionnaires (minimum of 2 and

maximum of 3) as part of an eDelphi panel.

Yes (1)

No (2)

Skip To: End of Survey If I agree to take part in the project. I understand that taking part in the project will include co... = No

5.

I understand that by choosing to participate as a volunteer in this research, this does not create a legally binding agreement nor is it intended to create an employment relationship with the University of Sheffield.

Yes (1)

No (2)

Skip To: End of Survey If I understand that by choosing to participate as a volunteer in this research, this does not creat... = No

6.

I understand that my taking part is voluntary and that I can withdraw from the study at any time; I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw.

Yes (1)

No (2)

Skip To: End of Survey If I understand that my taking part is voluntary and that I can withdraw from the study at any time;... = No

7.

Page Break

How my information will be used during and after the project

8.

How my information will be used during and after the project

I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project.

Yes (1)

No (2)

Skip To: End of Survey If How my information will be used during and after the project I understand my personal details suc... = No

9.

How my information will be used during and after the project

10.

How my information will be used during and after the project

I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project.

Yes (1)

No (2)

Skip To: End of Survey If How my information will be used during and after the project I understand my personal details suc... = No

11.

I understand and agree that my words may be quoted in publications, reports, web pages, and other research outputs. I understand that I will not be named in these outputs unless I specifically request this.

Yes (1)

No (2)

Skip To: End of Survey If I understand and agree that my words may be quoted in publications, reports, web pages, and other... = No

12.

I understand and agree that other authorised researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.

Yes (1)

No (2)

Skip To: End of Survey If I understand and agree that other authorised researchers will have access to this data only if th... = No

13.

I understand and agree that other authorised researchers may use my data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.

Yes (1)

No (2)

Skip To: End of Survey If I understand and agree that other authorised researchers may use my data in publications, reports... = No

14.

I understand and agree that other authorised researchers may use my data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.

Yes (1)

No (2)

Skip To: End of Survey If I understand and agree that other authorised researchers may use my data in publications, reports... = No

15.

I give permission for the basic information and raw data that I provide to be deposited in X: drive so it can be used for future research and learning.

Yes (1)

No (2)

Skip To: End of Survey If I give permission for the basic information and raw data that I provide to be deposited in X: dri... = No

16.

Page Break

So that the information you provide can be used legally by the researchers

17.

I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield.

Yes (1)

No (2)

Skip To: End of Survey If I agree to assign the copyright I hold in any materials generated as part of this project to The... = No

18.

Name of participants (printed)

19.

Date

20.

Signature

End of Block: The ASaS consent form

Start of Block: Section 1 Basic informaiton

The factors influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in Low- and Middle- Income countries (LMICs): **An eDelphi survey**

This study plans to explore the factors influencing adaptability, scalability and sustainability in low- and middle- income countries (LMICs) and the relationship among them.

Section 1 Basic informaiton

1. What is your gender?

Male (1)

Female (2)

Non-binary / third gender (3)

Prefer not to say (4)

21.

2. What best describes your current primary position? (Please select one)

Researcher (1)

Health care provider (2)

Policy maker (3)

Funder (4)

Journal editor (5)

Librarian (6)

Commissioner of health services (7)

Other (8) _____

22.

3. Which of these best describes your place of work? (Please select one)

University (or other Academic Institution) (1)

Hospital (2)

Primary Care/General Practice (3)

Service Provider Organization (community) (4)

Research/ non-profit or governmental agency (5)

Other (6) _____

23.

4. What is your country of residence?

24.

Before you start the formal questionnaire,

If you are primarily involved in the design phase of a complex health intervention, please skip to Section 2; (1)

if you are primarily involved in the implementation phase of a complex health intervention, please skip to Section 3 & 4. (2)

If you involved in the whole phases of a complex health intervention, please complete the whole questionnaire. (3)

Skip To: Definition: If Before you start the formal questionnaire, = If you are primarily involved in the design phase of a complex health intervention, please skip to Section 2;

Skip To: Defintion: If Before you start the formal questionnaire, = if you are primarily involved in the implementation phase of a complex health intervention, please skip to Section 3 & 4.

25.

Page Break

Section

2

When designing or piloting a complex health intervention (The concept of Adaptability)

Definition of Adaptability: Adaptability in health care means being skilled at integrating a patient's cultural values or beliefs into any encounter with the awareness and ability to adapt behaviours to maximize the patient's comfort, reconcile misunderstandings, and be responsive to the patient's needs (Weller JM., 2011).

26.

5a. Please firstly list up to three factors that you generally consider particularly important when designing or piloting complex health interventions in LMICs.

Definition: Factors identified as potential facilitators or barriers to the complex health interventions implemented in the LMICs.

Example: Funding, legislation or culture are influencing factors of complex health interventions.

1 (141) _____

2 (142) _____

3 (143) _____

27.

5b. Please give a concise explanation for each of the influencing factors you listed about why you chose.

1 (141) _____

2 (142) _____

3 (143) _____

28.

6. When, in general, you design/pilot a complex health intervention, what factors do you consider in adapting an intervention to the local context?

Example: A study conducted within a decentralised public health care system describes the need to take into account the lack of electricity, water, functioning laboratories and adequate staffing in many centres when designing a complex intervention) Hernantes N (2022).

29.

7. What challenges, in general, do you meet when you encounter a situation where you need to adapt an intervention to suit a local population?

Example: In the early stages of the intervention, members of the intervention team used brainstorming and group discussions to discuss what cultural factors they needed to incorporate in order for the intervention to work well with Hispanic clients.(Cabassa, L.J., 2014)

30.

8. In general, when you pilot or design a complex intervention, what impact do you think the leaders of local organisations and/or institutions have on the local adaptation of the complex health intervention you plan to implement?

31.

9.1 Generally, do you use a conceptual/theoretical model when developing a complex health intervention?

Yes (1)

No (2)

Skip To: Q9.2 If 9.1 Generally, do you use a conceptual/theoretical model when developing a complex health interve... = Yes

Skip To: Defintion: If 9.1 Generally, do you use a conceptual/theoretical model when developing a complex health interve... = No

32.

9.2 (a) If Yes, do you choose to use an existing theory, model or framework (TMF) or do you develop your own TMF to guide the development of complex health interventions (CHIs)?

33.

9.2 (b) Please give reasons for the answer you have given above.

34.

Page Break

Section**3**

When implementing a complex health intervention (The concept of scalability)

Definition of Scalability: Deliberate efforts to increase the impact of health service innovations successfully tested in pilot or experimental projects so as to benefit more people and to foster policy and programme development on a lasting basis (WHO, 2009).

35.

10 (a). Please firstly list up to three factors that you generally consider particularly important when seeking to scale-up a complex health intervention in LMICs.

1 (4) _____

2 (5) _____

3 (6) _____

36.

10 (b). Please give a concise explanation for each of the influencing factors you listed about why you chose.

1 (4) _____

2 (5) _____

3 (6) _____

37.

11. In general, how do different cultures in the geographical areas and populations targeted for a complex health intervention impact on the scale-up when implementing interventions based on your general experience?

Example: In Indonesia, women occupy similar or even higher social status than men, and they are in control of the family finances, due to the cultural traditions of the matrilineal clans that still exist in their region. Hence, the maternal and child health related interventions are easily to scale-up in this area (Bhanbhro, S., et al., 2020).

38.

12. Generally, what are the key factors that you have to consider when seeking to communicate and co-operate with health care organisations during implementation of a complex health intervention?

Example: When asked about challenges, many professionals said that collaboration and referrals between district hospitals and the relevant agencies were not functioning properly. Despite the Ministry of Health (MOH) guidelines stating the role of each agency, there seemed to be little clarity at the ground level across partners (Colombini, M., 2012)

39.

13. Generally speaking, how is the scale up of a complex intervention affected by the structure and staffing of healthcare related organisations and monitoring institutions?

Example: Some staff at specialised and district hospitals were sometimes unsure how to proceed with intimate partner violence (IPV) cases, what injury to document, in what detail, how and what questions to ask, where to refer women (Colombini, M., 2012).

40.

Page Break

Section

4

When implementing a complex health intervention (The concept of sustainability)

Definition of sustainability: (1) continued benefits to those who received health services when the program started and to new participants when the supporting funds are discontinued; (2) continued implementation of a program activities in an organization following the discontinuation of the program financial support; and (3) community empowerment to improve their health by continuing the activities of a finished program. Together, these measures, they argue, allow one to plan for “what is to be sustained, how or by whom, how much and by when (Shediac-Rizkallah MC., 1998).

41.

14 (a). Please firstly list up to three factors that you generally consider particularly important when seeking to sustain complex health interventions in LMICs beyond their initial implementation period.

1 (4) _____

2 (5) _____

3 (6) _____

42.

14 (b) Please give a concise explanation for each of the influencing factors you listed about why you chose.

1 (4) _____

2 (5) _____

3 (6) _____

43.

15. Generally, when your complex health intervention is ongoing in the community, what factors in the community hinder or facilitate your intervention?

Example: In a complex intervention focusing on the community empowerment among sex workers, Specific intervention elements may include biomedical components (e.g., HIV and STI counseling and testing, linkages to care and treatment), behavioural components (e.g., sex worker-led outreach and community education, condom distribution), and structural components (e.g., social cohesion and community mobilisation, access to justice, socio-economic opportunities) (Kerrigan, D., 2015).

44.

16. Generally, how do you make complex health interventions as sustainable as possible with limited follow-up funding?

45.

17. Generally, please describe any monitoring and supervision arrangements that you put in place when seeking to sustain complex health interventions.

Example: Supervised programs also allow participants to access health-care provider knowledge and feedback. Working without guidance can be discouraging and, at times, dangerous (Lemstra, M., 2016).

End of Block: Section 1 Basic information

Appendix 10 The second round of Delphi survey questionnaire

ASaS - eDelphi survey (round 2)

Start of Block: Introduction

The factors influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in low- and middle- income countries (LMICs)

OVERVIEW

OF

QUESTIONNAIRE

Please complete the portions of this questionnaire in which you are expert or interested. You may omit any of these questions without affecting the analysis planned for this study.

The second round questionnaire asks for ranking the importance of the following variables using 9 point Likert scale:

1.				Context
2.				Setting
3.		Organizational		Attributes
4.		Human		Resources
5.		Provider		Factors
6.		Recipient		Factors
7.	Project		Management	Processes
8.	Monitoring		and	Supervision
9.	Embedding		in	Communities

46.

Name

End of Block: Introduction

Start of Block: 1. Context

How important are the following sub-themes within the theme of context?

47.

1a. In your opinion, how important is sociopolitical context within the theme of context?

Extremely Unimportant Extremely Important Undecided

0 1 2 3 4 5 5 6 7 8 9

Importance ()



48.

1b. In your opinion, how important is participant's accessibility to interventions within the theme of context?

Extremely Unimportant Undecided Extremely Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



49.

1c. In your opinion, how important is participant's acceptability to interventions within the theme of context?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



50.

1d. In your opinion, how important is available of resources within the theme of context?

Extremely Undecided Extremely
Unimportant Important

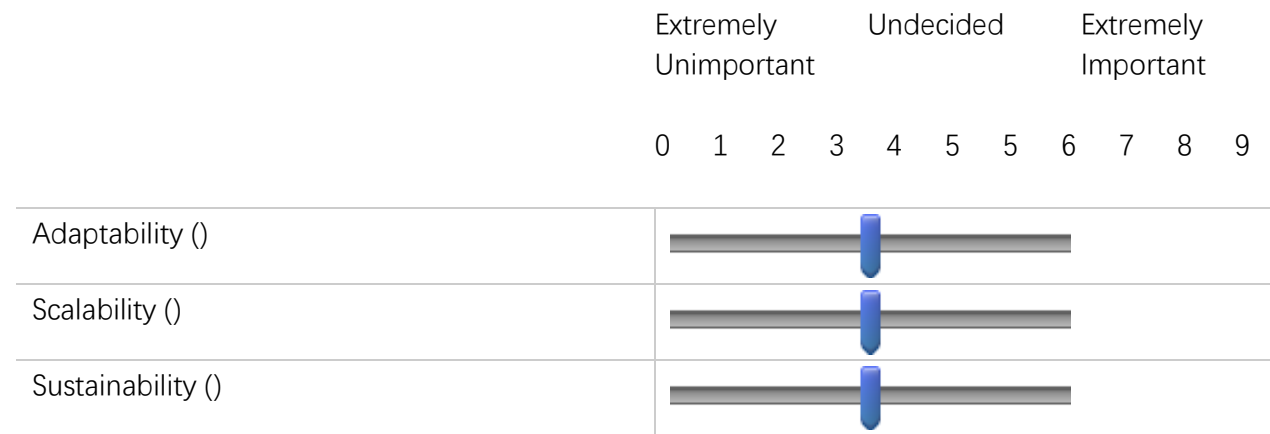
0 1 2 3 4 5 5 6 7 8 9

Importance ()



51.

1e. In your opinion, how important are contextual factors such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?



52.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 1. Context

Start of Block: 2. Setting

How important are the following sub-themes within the theme of setting?

53.

2a. In your opinion, how important is health system within the theme of setting?

Extremely Unimportant Undecided Extremely Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



54.

2b. In your opinion, how important is local legislation within the theme of setting?

Extremely Unimportant Undecided Extremely Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



55.

2c. In your opinion, how important is the geographical location of implementing interventions within the theme of setting?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



56.

2d. In your opinion, how important is local culture within the theme of setting?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



57.

2e. In your opinion, how important are local social norms or regulations within the theme of setting?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

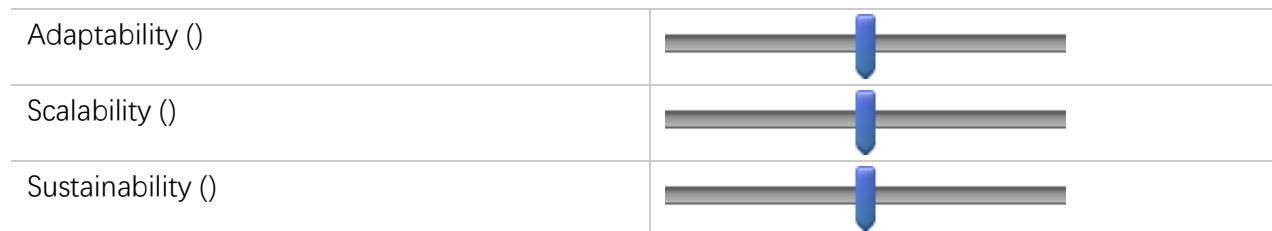


58.

2f. In your opinion, how important are setting factors such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9



59.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 2. Setting

Start of Block: 3. Organizational attributes

How important are the following sub-themes within the theme of organizational attributes?

60.

3a. In your opinion, how important are interorganization networks within the theme of organizational attributes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



61.

3b. In your opinion, how important is organizational culture within the theme of organizational attributes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



62.

3c. In your opinion, how important is organizational readiness within the theme of organizational attributes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



63.

3d. In your opinion, how important is organizational structure within the theme of organizational attributes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



64.

3e. In your opinion, how important are local gatekeepers within the theme of organizational attributes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



65.

3f. In your opinion, how important is government support within the theme of organizational attributes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

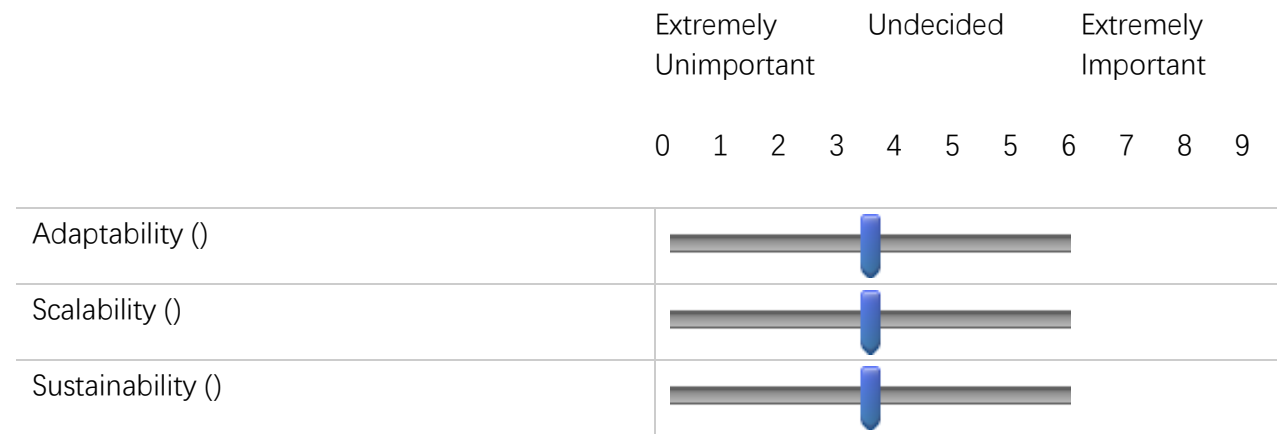
Importance ()



66.

Page Break

3g. In your opinion, how important are organizational attributes such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?



67.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 3. Organizational attributes

Start of Block: 4. Human resources

How important are the following sub-themes within the theme of human resources?

68.

4a. In your opinion, how important is training and education of staff within the theme of human resources?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



69.

4b. In your opinion, how important is staff turnover within the theme of human resources?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



70.

4c. In your opinion, how important is capacity of staff within the theme of human resources?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

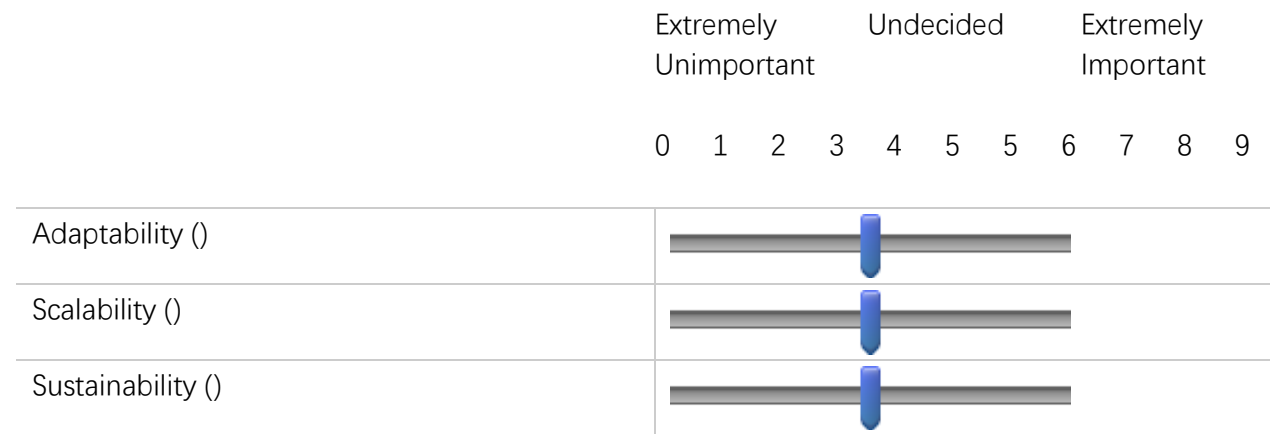
Importance ()



71.

Page Break

4d. In your opinion, how important are human resources such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?



72.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 4. Human resources

Start of Block: 5. Provider factors

How important are the following sub-themes within the theme of provider factors?

73.

5a. In your opinion, how important is the credibility and reputation of the provider or implementer within the theme of provider factors?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



74.

5b. In your opinion, how important is the implementer and local stakeholders sharing a common language within the theme of provider factors?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



75.

5c. In your opinion, how important is the local stakeholders perception of the need for change within the theme of provider factors?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

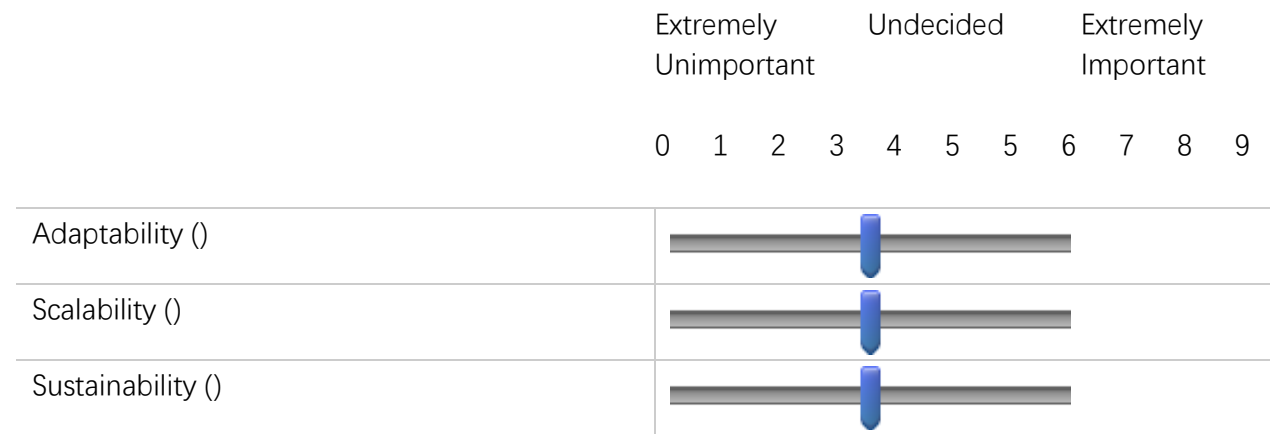
Importance ()



76.

Page Break

5d. In your opinion, how important are provider factors such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?



77.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 5. Provider factors

Start of Block: 6. Recipient factors

How important are the following sub-themes within the theme of recipient factors?

78.

6a. In your opinion, how important is participants' understanding and awareness within the theme of recipient factors?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



79.

6b. In your opinion, how important are differences between individual culture within the theme of recipient factors?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



80.

6c. In your opinion, how important is education level of participants within the theme of recipient factors?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



81.

6d. In your opinion, how important is training and education of participants within the theme of recipient factors?

Extremely Undecided Extremely
Unimportant Important

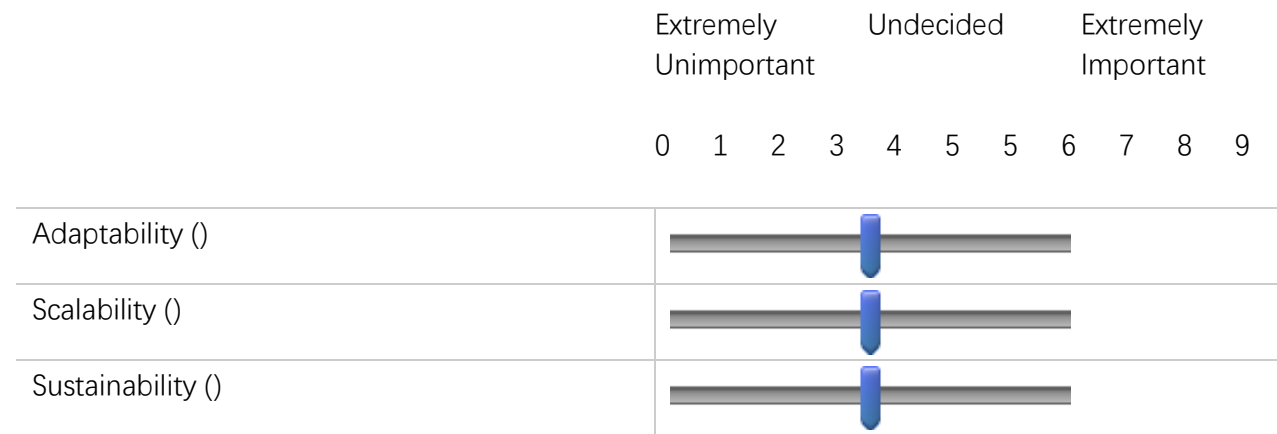
0 1 2 3 4 5 5 6 7 8 9

Importance ()



82.

6e. In your opinion, how important are recipient factors such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?



83.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 6. Recipient factors

Start of Block: 7. Project Management processes

How important are the following sub-themes within the theme of project management processes?

84.

7a. In your opinion, how important is the experience in implementing similar projects within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



85.

7b. In your opinion, how important is leadership within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



86.

7c. In your opinion, how important is resource allocation within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



87.

7d. In your opinion, how important are support systems or tools within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



88.

7e. In your opinion, how important is integrating the intervention to existing system or projects within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



89.

7f. In your opinion, how important is technology advance within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



90.

7g. In your opinion, how important is time constraints within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



91.

7h. In your opinion, how important is project champion within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



92.

7i. In your opinion, how important is local stakeholders involvement within the theme of project management processes?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

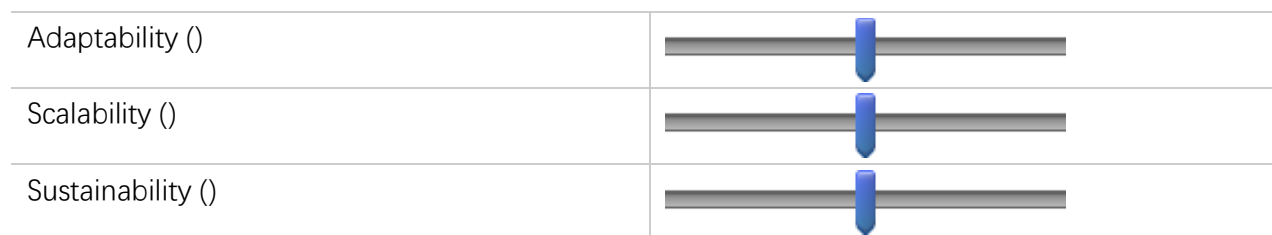


93.

7j. In your opinion, how important are project management processes such as the above above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9



94.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 7. Project Management processes

Start of Block: 8. Monitoring and supervision

How important are the following sub-themes within the theme of monitoring and supervision?

95.

8a. In your opinion, how important is the role of existing community structures and personnel within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



96.

8b. In your opinion, how important is feedback mechanism within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



97.

8c. In your opinion, how important are actionable timelines within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



98.

8d. In your opinion, how important is the empowering the state and non-state actors within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



99.

8e. In your opinion, how important is local supervisor support within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



100.

8f. In your opinion, how important is ongoing evaluation and reporting within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



101.

8g. In your opinion, how important is the remote support from intervention developers within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



102.

8h. In your opinion, how important is routine system within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



103.

8i. In your opinion, how important is training and education of staff within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



104.

8j. In your opinion, how important is using frameworks within the theme of monitoring and supervision?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

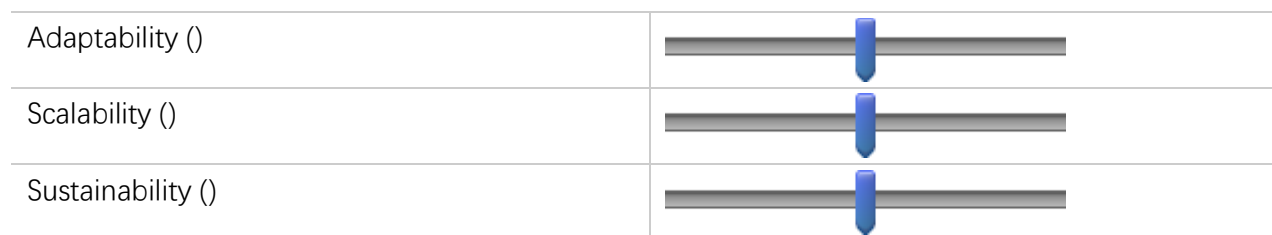


105.

8k. In your opinion, how important are monitoring and supervision such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9



106.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

End of Block: 8. Monitoring and supervision

Start of Block: 9. Embedding in communities

How important are the following sub-themes within the theme of embedding in communities?

107.

9a. In your opinion, how important is client advocacy within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



108.

9b. In your opinion, how important are community based organizations within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



109.

9c. In your opinion, how important is community acceptance within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



110.

9d. In your opinion, how important is community culture cooperation within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



111.

9e. In your opinion, how important is community education level within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



112.

9f. In your opinion, how important is regular feedback within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



113.

9g. In your opinion, how important is community ownership within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



114.

9h. In your opinion, how important is training community volunteers within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



115.

9i. In your opinion, how important is affordable and available in target community within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

Importance ()



116.

9j. In your opinion, how important is turnover of community key members within the theme of embedding in communities?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9

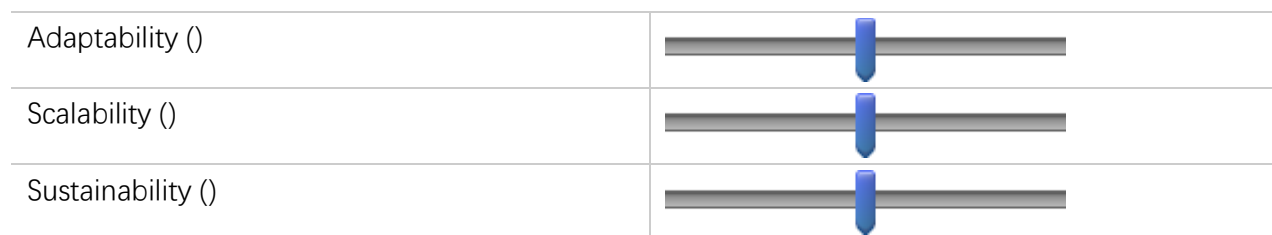


117.

9k. In your opinion, how important are embedding in communities such as the above in influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in LMICs?

Extremely Undecided Extremely
Unimportant Important

0 1 2 3 4 5 5 6 7 8 9



118.

If you have suggestions for the above sub-themes, such as whether to add new sub-themes or delete some of them, please write here. If not, please ignore this question.

119.

Thank you very much for filling out this questionnaire, this is the last page of the questionnaire, if you click continue, this questionnaire will end, if you want to continue filling out the questionnaire, you can click the back button to continue filling out.

End of Block: 9. Embedding in communities

Appendix 11 The third round of Delphi survey questionnaire

Third round of Delphi survey

Start of Block: Default Question Block

The factors influencing the adaptability, scalability and sustainability (ASaS) of complex health interventions in low- and middle- income countries (LMICs)

Many thanks for your contributions in the second round of Delphi survey! Based on the results of the second round of the Delphi questionnaire, we found that there are currently a number of influencing factors of adaptability, scalability, sustainability (ASaS) of complex health interventions on which consensus could not be reached. Therefore, in this round, we invite you to finalise whether there are any other influencing factors that need to be included.

120.

Name

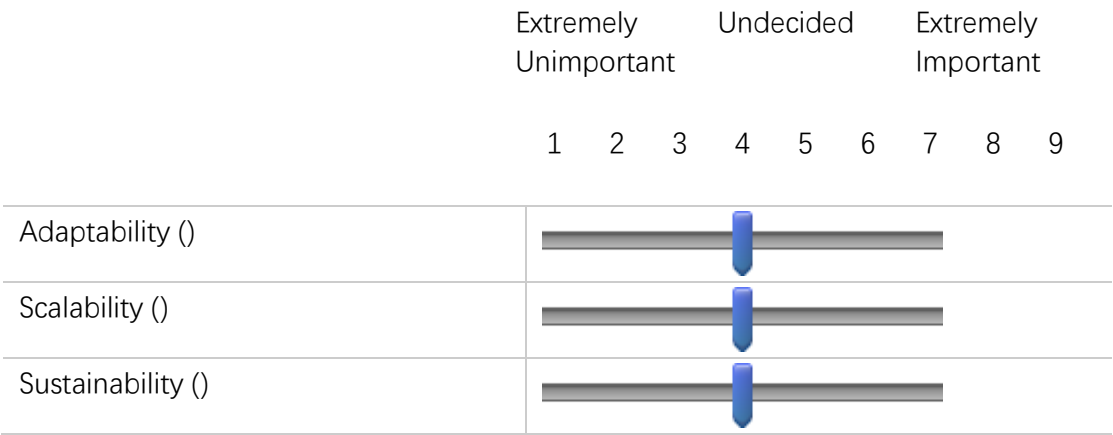
121.

Page Break

Theme

2

Do you think the geographical location has a significant impact on the adaptability, scalability, and sustainability (ASaS) of complex health interventions?

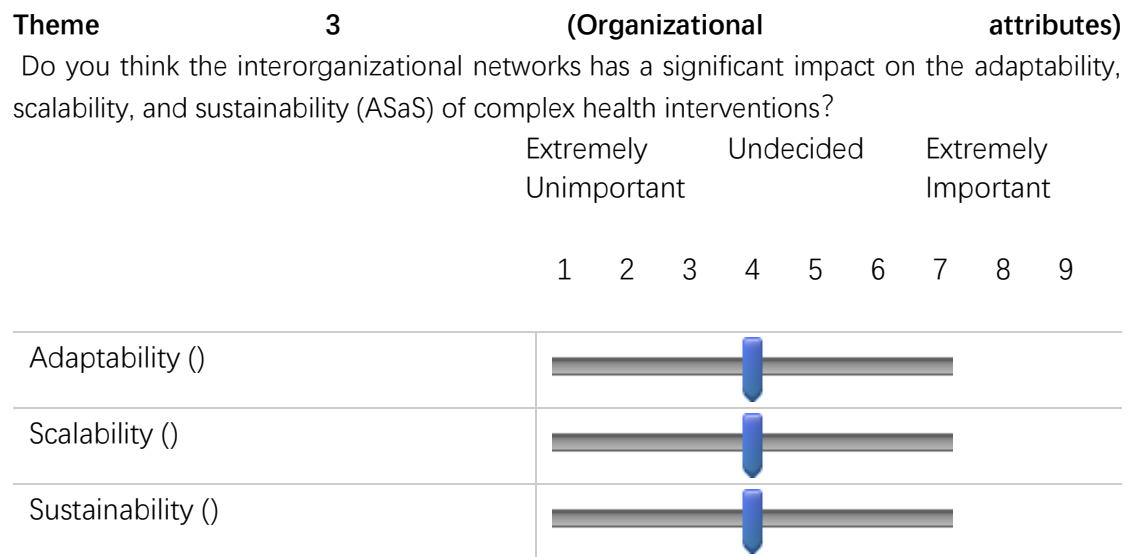


122.

According to the results of the second round of Delphi survey, consensus among the experts was only 54.8%. Can you provide your comments on this?

123.

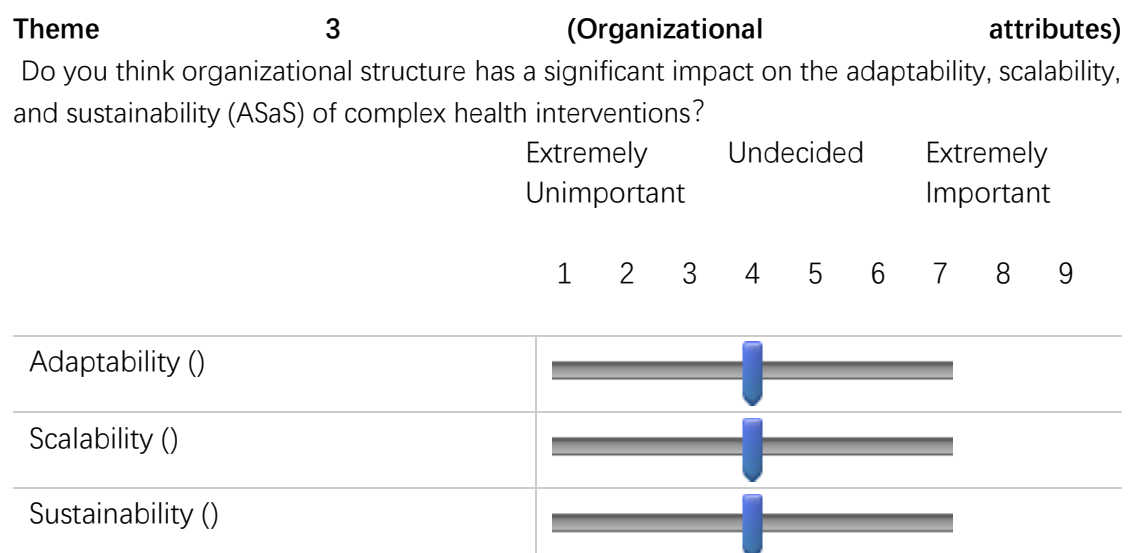
Page Break



124.

According to the results of the second round of Delphi survey, consensus among the experts was only 64.5%. Can you provide your comments on this?

125.



126.

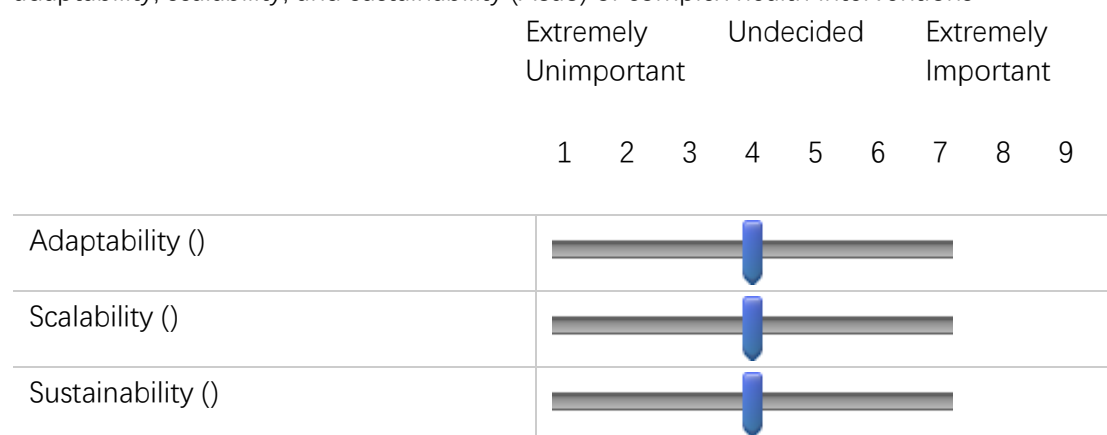
According to the results of the second round of Delphi survey, consensus among the experts was only 61.3%. Can you provide your comments on this?

127.

Page Break

Theme 6 (Recipient factors)

Do you think the differences between individual cultures has a significant impact on the adaptability, scalability, and sustainability (ASaS) of complex health interventions?



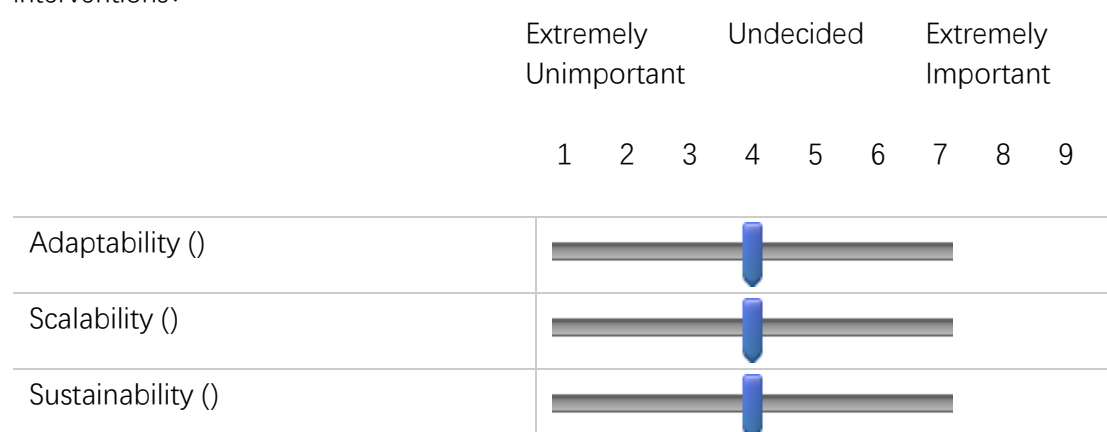
128.

According to the results of the second round of Delphi survey, consensus among the experts was only 67.7%. Can you provide your comments on this?

129.

Theme 6 (Recipient factors)

Do you think training and education of participants for implementation has a significant impact on the adaptability, scalability, and sustainability (ASaS) of complex health interventions?

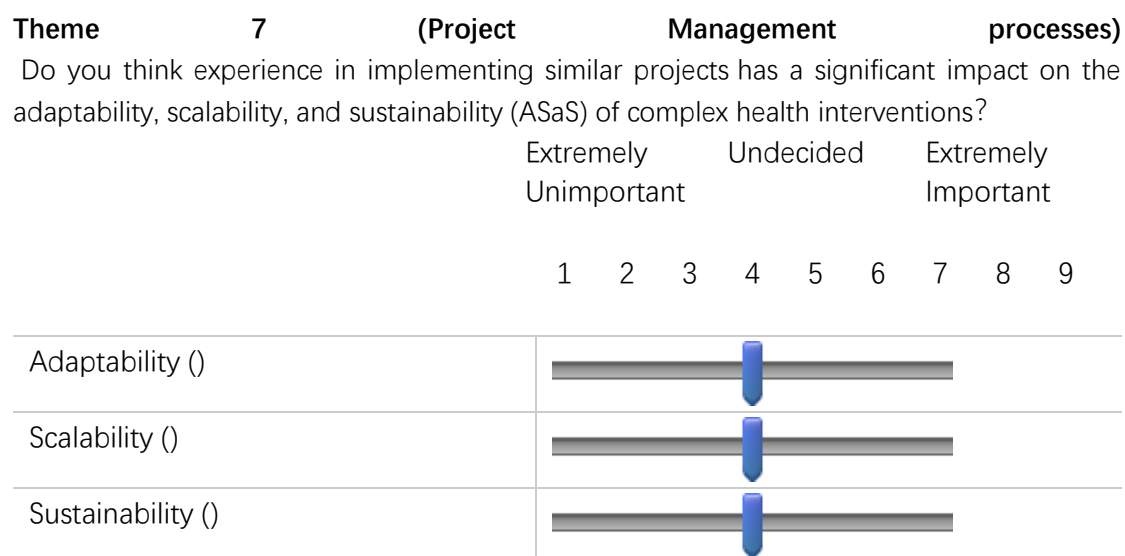


130.

According to the results of the second round of Delphi survey, consensus among the experts was only 67.7%. Can you provide your comments on this?

131.

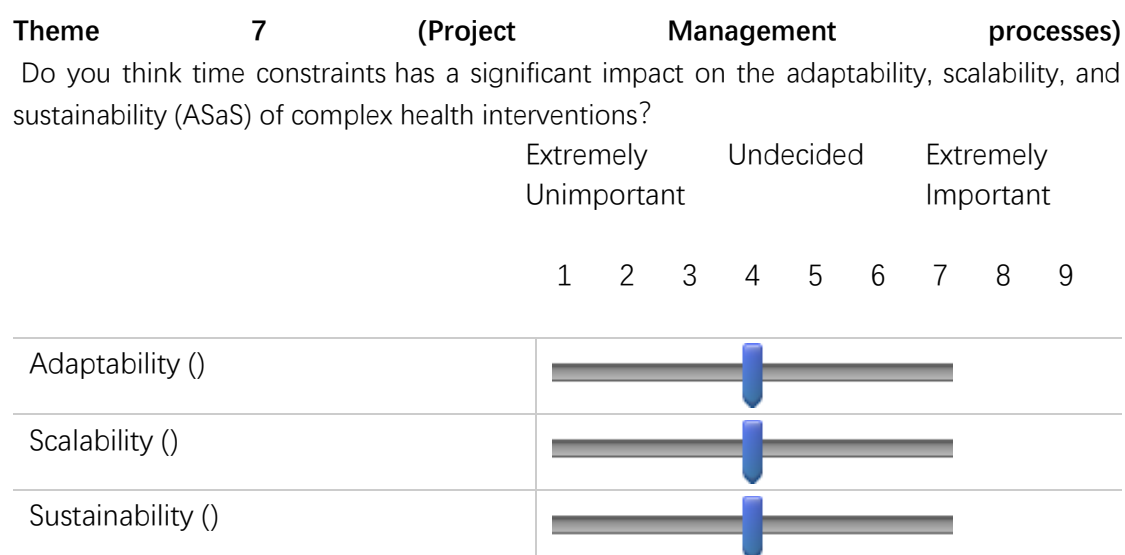
Page Break



132.

According to the results of the second round of Delphi survey, consensus among the experts was only 66.7%. Can you provide your comments on this?

133.



134.

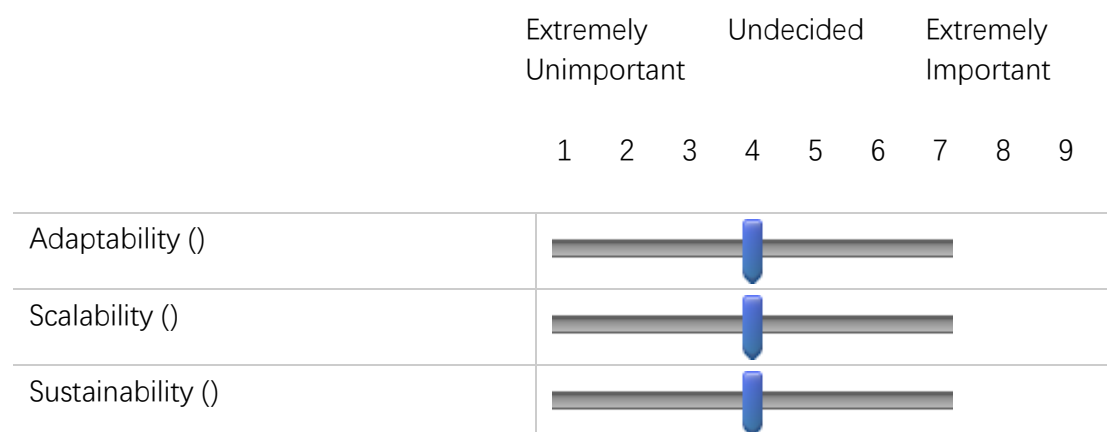
According to the results of the second round of Delphi survey, consensus among the experts was only 66.7%. Can you provide your comments on this?

135.

Page Break

Theme 8 (Monitoring and supervision)

Do you think the role of existing community structures and personnel during implementation has a significant impact on the adaptability, scalability, and sustainability (ASaS) of complex health interventions?



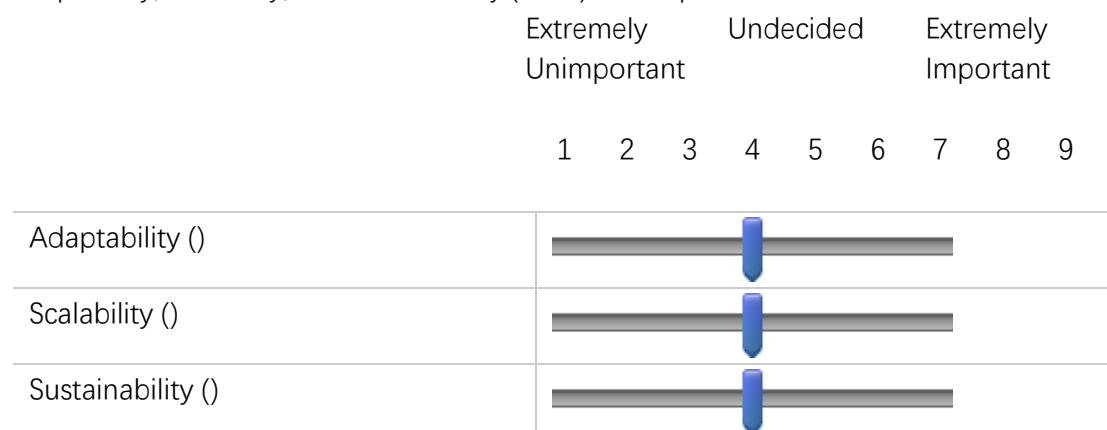
136.

According to the results of the second round of Delphi survey, consensus among the experts was only 60.0%. Can you provide your comments on this?

137.

Theme 8 (Monitoring and supervision)

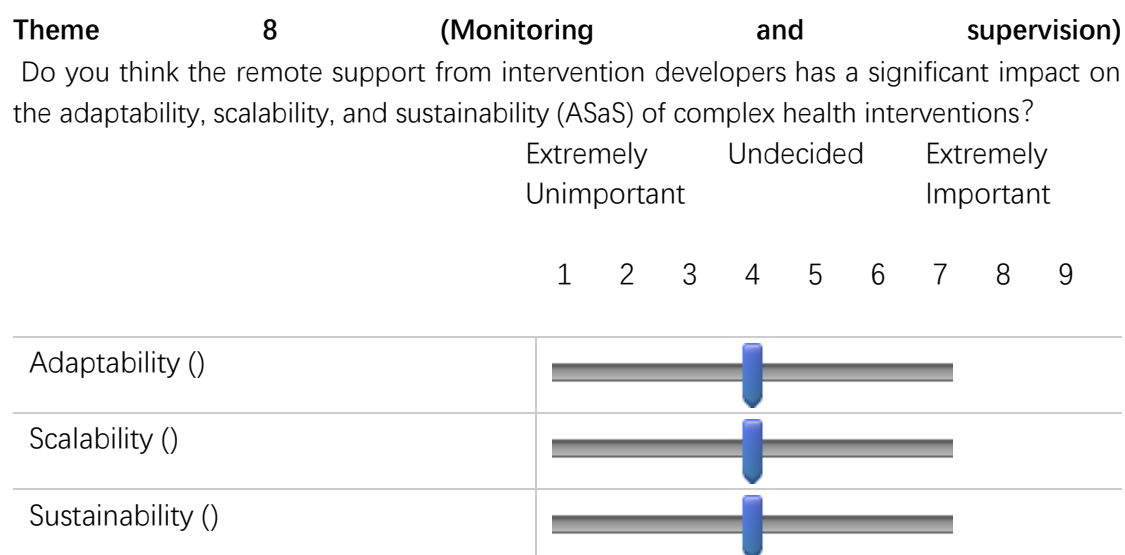
Do you think empowering the state and non-state actors has a significant impact on the adaptability, scalability, and sustainability (ASaS) of complex health interventions?



138.

According to the results of the second round of Delphi survey, consensus among the experts was only 66.7%. Can you provide your comments on this?

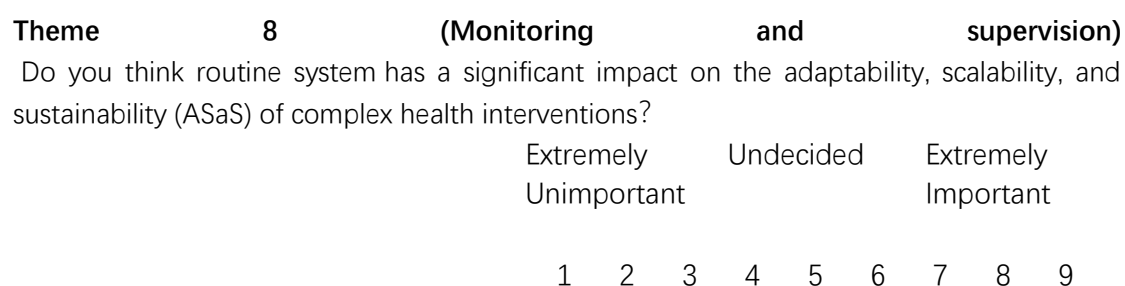
139.

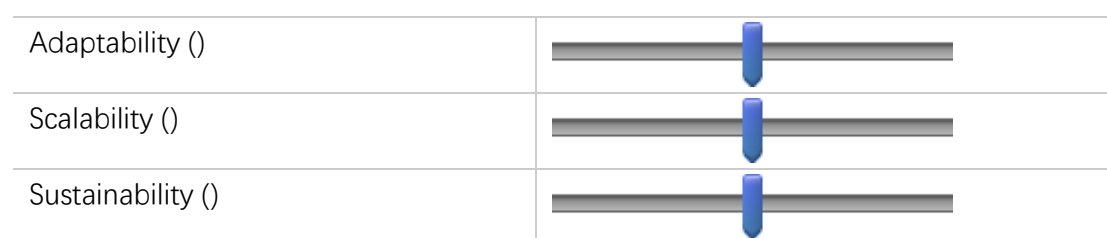


140.

According to the results of the second round of Delphi survey, consensus among the experts was only 56.7%. Can you provide your comments on this?

141.





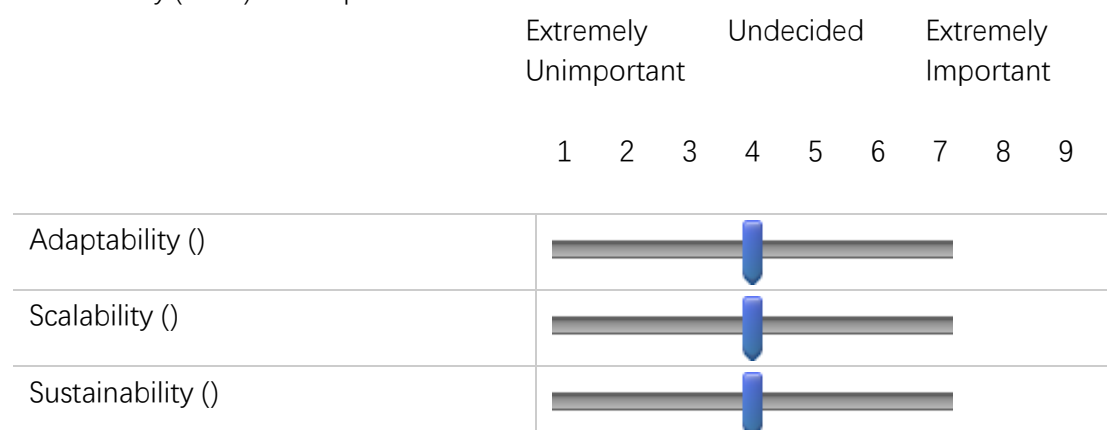
142.

According to the results of the second round of Delphi survey, consensus among the experts was only 63.3%. Can you provide your comments on this?

143.

Theme 8 (Monitoring and supervision)

Do you think using frameworks has a significant impact on the adaptability, scalability, and sustainability (ASaS) of complex health interventions?



144.

According to the results of the second round of Delphi survey, consensus among the experts was only 58.6%. Can you provide your comments on this?

145.

Page Break

(1) Factor: Technology advance

According to the results of the second round of Delphi survey, consensus among the experts was only 50.0%. Would you like to retain this influencing factor?

Yes (1)

No (4)

146.

(1) Factor: Technology advance

If you are able please give an explanation for why you retain or remove this influencing factor?

147.

(2) Factor: Education level of participants

According to the results of the second round of Delphi survey, consensus among the experts was only 41.9%. Would you like to retain this influencing factor?

Yes (11)

No (12)

148.

(2) Factor: Education level of participants

If you are able please give an explanation for why you retain or remove this influencing factor?

149.

(3) Factor: Community education level

According to the results of the second round of Delphi survey, consensus among the experts

was only 41.9%. Would you like to retain this influencing factor?

Yes (11)

No (14)

150.

(3) Factor: Community education level

If you are able please give an explanation for why you retain or remove this influencing factor?

151.

Page Break

when asked about the importance of the themes, all of the themes were considered to be sufficiently important by experts, except for the theme of recipient factors within the concept of adaptability. Have you any observations why this might be the case?

152.

Please rank the importance of the following themes.

- _____ Context (1)
- _____ Setting (2)
- _____ Organizational attributes (3)
- _____ Human resources (4)
- _____ Provider factors (5)
- _____ Recipient factors (6)
- _____ Project Management processes (7)
- _____ Monitoring and supervision (8)
- _____ Embedding in communities (9)

153.

Thank you very much for filling out this questionnaire, this is the last page of the questionnaire, if you click continue, this questionnaire will end, if you want to continue filling out the questionnaire, you can click the back button to continue filling out.

End of Block: Default Question Block

Appendix 12 The results of the First round of Delphi survey

Total frequency count of the influencing factors derived from Round One eDelphi survey in HIC and LMICs group

Influencing factors	Total frequency count					
	Adaptability		Scalability		Sustainability	
Experts' area	HIC	LMICs	HIC	LMICs	HIC	LMICs
Theme 1 (Context)						
sociopolitical context	3	9	3	null	null	null
participant's	null	2		1	1	1

accessibility to interventions						
participant's acceptability to interventions		4	1	2	1	2
available of resources	8	12	3	6	4	2
Theme 2 (Setting)						
health system	1	10	5	3	4	5
local legislation	1	2		1	2	
local culture	9	16	11	9	2	1
local social norms or regulations	null	1	1	null	1	null
Theme 3 (Organizational attributes)						
interorganizational networks	null	1	1	null	null	null
organizational culture	null	1	1	1	null	null
organizational readiness	null	null	null	null	null	null
organizational structure	null	null		4	null	null
local gatekeepers	13	19	4	1	3	6
government support	3	null	null	null	2	null
Theme 4 (Human resources)						
training and education of staff	4	1	2	7	5	2
staff turnover	null	null	null	2	1	null
capacity of staff	3	4	null	1	null	null

Theme 5 (Provider factors)						
implementer and local stakeholders sharing a common language	null	null	1	null	null	null
local stakeholders perception of the need for change	2	1	null	null	null	null
Theme 6 (Recipient factors)						
participants' understanding and awareness	null	3	3	1	null	2
differences between individual culture	null	null	null	2	null	null
education level of participants	null	1	null	null	null	1
training and education of participants	null	null	2	null	null	null
Theme 7 (Project Management processes)						
experience in implementing similar projects	null	null	null	1	null	null
leadership	2	null	null	2	1	null
resource allocation	3	null	null	null	null	2
support systems or tools	null	1	null	1	null	null
integrating the intervention to existing system or projects	null	null	3	null	6	8

technology advance	null	1	null	1	null	2
time constraints	1	null	4	null	null	null
project champion	1	null	1	null	2	null
local stakeholders involvement	7	6	5	8	5	3
Theme 8 (Monitoring and supervision)						
the role of existing community structures and personnel	null	null	null	null	2	null
feedback mechanism	null	null	null	null	null	1
actionable timelines	null	null	null	null	null	1
empowering the state and non-state actors	null	null	null	null	null	1
local supervisor support	null	null	null	null	2	null
ongoing evaluation and reporting	null	null	null	null	1	null
the remote support from intervention developers	null	null	null	null	1	null
routine system	null	null	null	null	1	null
training and education of staff	null	null	null	null	1	null
using frameworks	null	null	null	null	1	1
Theme 9 (Embedding in communities)						
community based organizations	null	null	null	1	null	null
community acceptance	null	null	null	null	null	3

community culture cooperation	null	null	null	1	null	2
community education level	null	null	null	null	null	1
regular feedback	null	null	null	null	null	1
community ownership	null	null	null	1	null	null
training community volunteers	null	null	null	null	null	2
affordable and available in target community	null	1	null	null	null	null
turnover of community key members	null	null	null	null	1	null

Appendix 13 The results of the second round of Delphi survey

Theme	Question	Likert scale (1-3)	Likert scale (4-6)	Likert scale (7-9)
Theme 1 (Context)	1a sociopolitical context	(0/32) 0%	(7/32) 21.9%	(25/32) 78.10%
	1b participant's accessibility to interventions	(0/32) 0%	(3/32) 9.4%	(29/32) 90.60%
	1c participant's acceptability to interventions	(0/32) 0%	(1/32) 3.1%	(31/32) 96.90%
	1d available of resources	(0/32) 0%	(4/32) 12.5%	(28/32) 87.50%
	Adaptability	(1/32) 3.125%	(5/32) 15.625%	(26/32) 81.25%
	Scalability	(0/32) 0%	(4/32) 12.5%	(28/32) 87.50%
	Sustainability	(0/32) 0%	(2/32) 6.25%	(30/32) 93.80%
Theme 2 (Setting)	2a health system	(0/31) 0%	(6/31) 19.4%	(25/31) 80.60%
	2b local legislation	(1/30) 3.3%	(6/30) 20.0%	(23/30) 76.70%
	2c geographical location of implementing interventions	(1/31) 3.2%	(13/31) 42.0%	(17/31) 54.80%
	2d local culture	(1/31) 3.2%	(2/31) 6.5%	(28/31) 90.30%

	2e local social norms or regulations	(0/31) 0%	(6/31) 19.4%	(25/31) 80.60%
	Adaptability	(0/31) 0%	(6/31) 19.4%	(25/31) 80.60%
	Scalability	(0/31) 0%	(1/31) 3.2%	(30/31) 96.80%
	Sustainability	(0/31) 0%	(4/31) 12.9%	(27/31) 87.10%
	3a interorganizational networks	(0/31) 0%	(11/31) 35.5%	(20/31) 64.50%
	3b organizational culture	(0/31) 0%	(9/31) 29.0%	(22/31) 71.00%
	3c organizational readiness	(0/31) 0%	(4/31) 12.9%	(27/31) 87.10%
	3d organizational structure	(1/31) 3.2%	(11/31) 35.5%	(19/31) 61.30%
	3e local gatekeepers	(1/31) 3.2%	(7/31) 22.6%	(23/31) 74.20%
	3f government support	(0/31) 0%	(7/31) 22.6%	(24/31) 77.40%
Theme 3	Adaptability	(1/30) 3.3%	(7/30) 23.4%	(22/30) 73.30%
(Organizational	Scalability	(1/30) 3.3%	(4/30) 13.4%	(25/30) 83.30%
attributes)	Sustainability	(0/30) 0%	(4/30) 13.3%	(26/30) 86.70%
Theme 4	4a training and education of staff	(0/31) 0%	(2/31) 6.5%	(29/31) 93.50%
(Human	4b staff turnover	(2/31) 6.5%	(5/31) 16.1%	(24/31) 77.40%
resources)	4c capacity of staff	(0/31) 0%	(3/31) 9.7%	(28/31) 90.30%

	Adaptability	(0/30) 0%	(3/30) 10.0%	(27/30) 90.00%
	Scalability	(0/30) 0%	(3/30) 10.0%	(27/30) 90.00%
	Sustainability	(0/30) 0%	(4/30) 13.3%	(26/30) 86.70%
	5a credibility and reputation of the provider or implementer	(0/31) 0%	(7/31) 22.6%	(24/31) 77.40%
	5b implementer and local stakeholders sharing a common language	(0/31) 0%	(4/31) 12.9%	(27/31) 87.10%
	5c local stakeholders perception of the need for change	(0/31) 0%	(6/31) 19.4%	(25/31) 80.60%
Theme 5 (Provider factors)	Adaptability	(1/30) 3.3%	(5/30) 16.7%	(24/30) 80.00%
	Scalability	(0/30) 0%	(5/30) 16.7%	(25/30) 83.30%
	Sustainability	(0/30) 0%	(6/30) 20.0%	(24/30) 80.00%
	6a participants' understanding and awareness	(0/31) 0%	(6/31) 19.4%	(25/31) 80.60%
	6b differences between individual culture	(2/31) 6.5%	(8/31) 25.8%	(21/31) 67.70%
	6c education level of participants	(3/31) 9.7%	(15/31) 48.4%	(13/31) 41.90%
	6d training and education of participants	(0/31) 0%	(10/31) 32.3%	(21/31) 67.70%
Theme 6 (Recipient factors)	Adaptability	(1/31) 3.0%	(12/31) 38.9%	(18/31) 58.10%
	Scalability	(1/31) 3.0%	(7/31) 22.8%	(23/31) 74.20%

	Sustainability	(3/31) 9.7%	(6/31) 19.4%	(22/31) 70.90%
	7a experience in implementing similar projects	(0/30) 0%	(10/30) 33.3%	(20/30) 66.70%
	7b leadership	(0/30) 0%	(2/30) 6.7%	(28/30) 93.30%
	7c resource allocation	(0/30) 0%	(3/30) 10.0%	(27/30) 90.00%
	7d support systems or tools	(0/30) 0%	(3/30) 10.0%	(27/30) 90.00%
	7e integrating the intervention to existing system or projects	(1/30) 3.3%	(5/30) 16.7%	(24/30) 80.00%
	7f technology advance	(1/30) 3.3%	(5/30) 46.7%	(24/30) 50.00%
	7g time constraints	(0/30) 0%	(10/30) 33.3%	(20/30) 66.70%
	7h project champion	(0/30) 0%	(9/30) 30.0%	(21/30) 70.00%
Theme 7	7i local stakeholders involvement	(0/30) 0%	(3/30) 10.0%	(27/30) 90.00%
(Project	Adaptability	(1/29) 3.4%	(6/29) 20.7%	(22/29) 75.90%
Management	Scalability	(0/29) 0%	(8/29) 27.6%	(21/29) 72.40%
processes)	Sustainability	(0/29) 0%	(4/29) 13.8%	(25/29) 86.20%
	8a the role of existing community structures and personnel	(3/30) 10.0%	(9/30) 30.0%	(18/30) 60.00%
Theme 8	8b feedback mechanism	(0/30) 0%	(7/30) 23.3%	(23/30) 76.70%
(Monitoring	8c actionable timelines	(0/29) 0%	(7/29) 24.1%	(22/29) 75.90%

and supervision)	8d empowering the state and non-state actors	(0/30) 0%	(10/30) 33.3%	(20/30) 66.70%
	8e local supervisor support	(1/30) 3.3%	(6/30) 20.0%	(23/30) 76.70%
	8f ongoing evaluation and reporting	(0/30) 0%	(5/30) 16.7%	(25/30) 83.30%
	8g the remote support from intervention developers	(1/30) 3.3%	(12/30) 40.0%	(17/30) 56.70%
	8h routine system	(1/30) 3.3%	(10/30) 33.3%	(19/30) 63.30%
	8i training and education of staff	(1/30) 3.3%	(7/30) 23.3%	(22/30) 73.30%
	8j using frameworks	(1/29) 3.4%	(11/29) 38.0%	(17/29) 58.60%
	Adaptability	(1/29) 3.5%	(7/29) 24.1%	(22/29) 72.40%
	Scalability	(0/29) 0%	(6/29) 10.7%	(23/29) 79.30%
	Sustainability	(0/29) 0%	(6/29) 10.7%	(23/29) 79.30%
Theme 9 (Embedding in communities)	9a client advocacy	(0/27) 0%	(6/27) 22.2%	(21/27) 77.80%
	9b community based organizations	(0/27) 0%	(6/27) 22.2%	(21/27) 77.80%
	9c community acceptance	(0/27) 0%	(2/27) 7.4%	(25/27) 92.60%
	9d community culture cooperation	(0/27) 0%	(3/27) 11.1%	(24/27) 88.90%
	9e community education level	(2/27) 7.4%	(12/27) 44.5%	(13/27) 48.10%
	9f regular feedback	(0/27) 0%	(3/27) 11.1%	(24/27) 88.90%
	9g community ownership	(0/26) 0%	(3/26) 11.5%	(23/26) 88.50%

	9h training community volunteers	(1/27) 3.7%	(4/27) 14.8%	(22/27) 81.50%
	9i affordable and available in target community	(0/27) 0%	(7/27) 25.9%	(20/27) 74.10%
	9j turnover of community key members	(0/27) 0%	(6/27) 22.2%	(21/27) 77.80%
	Adaptability	(0/27) 0%	(3/27) 11.1%	(24/27) 88.90%
	Scalability	(1/27) 3.7%	(2/27) 7.4%	(24/27) 88.90%
	Sustainability	(0/27) 0%	(2/27) 7.4%	(25/27) 92.60%