

**Understanding the Role of Information and Communication Technology (ICT) in the Shaping of Inter-organisational Knowledge Exchange (IOKE) Practice:**

**The Context of European Living Labs**

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# ABSTRACT

Inter-organizational knowledge exchange is an important process for stimulating innovation and improving collaboration among multiple organizations. With the use of information and communication technologies (ICT), this process could be greatly affected for effectiveness and efficiency. However, existing studies provide insufficient understanding of how knowledge exchange processes are shaped by the nature of ICT in the context of inter-organisational settings. Therefore, this research attempts to address this research gap through conceptualising the role of ICT in the shaping of inter-organisational knowledge exchange (IOKE) practice by investigating the context of European Living Labs, as an exemplary inter-organisational collaboration setting. In methodological terms, this study adopts an inductive, qualitative research approach, and follows a combination of Grounded Theory, Multiple Case Study and Documentary Research, making use of in-depth semi-structured interviews with European Living Labs stakeholders and analysing Living Labs project documents. The data has informed the use of Practice Theory, Sociomateriality Theory, and Technology Affordance Theory at different level of analysis to understand the research phenomena.

This research has found that 1) ICT-based IOKE practice can be characterised by ICT affordances and constraints, human knowledgeabilities, and triple-layer contexts (inter-organisational context, intra-organisational context, and wider environmental context). 2) ICT mediates such enactment of knowledgeability by affording or constraining distinct human abilities that allow actors to accomplish their knowledge work or hold them back as they engage in knowledge exchange practice. Diverse ICT affordances (e.g., cross-distance networking, instant workaround) and constraints (e.g., accessing, communication continuity) can mediate the enactment of four different types of knowledgeabilities: inter-connecting, interactive learning, co-creating, and co-ordinating. 3) Different knowledgeabilities, their associated ICT affordances/constraints, and their embedded contexts are inter-related, and they co-evolve over time across the project lifecycle. This has been conceptualised into an ICT-based IOKE practice framework (integrated) and its three variations (three variated frameworks for different project lifecycle stages). The findings have strong theoretical and practical implications that signal the salient areas for future research to study, particularly for ICT affordance studies.

**Key Words:** **ICT, Technology Affordance, Inter-organisational Knowledge Exchange, Knowledgeability, Living Labs, Open Innovation, Grounded Theory**

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# DECLARATION

I, the author, confirm that the Thesis is my own work. I am aware of the University’s Guidance on the Use of Unfair Means ([www.sheffield.ac.uk/ssid/unfair-means](http://www.sheffield.ac.uk/ssid/unfair-means)). This work has not previously been presented for an award at this, or any other, university.

# PUBLICATIONS

**Journal Articles**

Li, S., Wang, Y., Filieri, R., & **Zhu, Y.** (2022). Eliciting positive emotion through strategic responses to COVID-19 crisis: Evidence from the tourism sector. *Tourism management*, 90, 104485.

**Conference Proceedings**

**Zhu, Y.**, Zamani, E. D., Martins, J. T., & Vasconcelos, A. C. (2021, September). ICT-Based Inter-organisational Knowledge Exchange: A Narrative Literature Review Approach. In Conference on e-Business, e-Services and e-Society (pp. 411-422). Springer, Cham.

**Book Series**

**Zhu, Y.**, & Zhao, X. (2022). International Student Mobility and Employability: An Employer Perspective on the Impact of Study Abroad Experiences. STAR Scholar Book Series, 145-162.

**Paper Under Revision**

Mikalef, P., Zamani, E.D., & **Zhu, Y.** “Artificial Intelligence (AI) and User Experience (UX) design: A systematic literature review”. **(**Under Review at*Information Technology & People*)

# CHAPTER 1 INTRODUCTION

## 1.1 Background

With the development of the knowledge economy, knowledge has become a core competitiveness factor that provides significant value to many organisations and entrepreneurs (Bordeianu, 2015). Due to globalisation, organisations tend to collaborate inter-organisationally in order to acquire external knowledge to improve their competitive advantage (Le Pennec & Raufflet, 2018). Cross-boundary knowledge-exchange collaborations in particular greatly enhance new knowledge creation, where creative ideas and work are generated from different entities (Loukis et al., 2017). Consequently, existing literature is showing a growing interest in the knowledge exchange process not only within, but also across organisations (Al-Busaidi & Olfman, 2017; Fang et al., 2013), i.e., inter-organisational knowledge exchange.

In such a fast-changing environment, the combination of knowledge management (KM) and information and communication technology (ICT) has manifested itself as a systematic and effective way to leverage knowledge. Hence the role of ICT in knowledge management has been receiving much attention (Ferreira et al., 2018). ICT has been found to support effective knowledge management by allowing the systematic management of knowledge (Benard & Dulle, 2017). It has also been proved to be especially useful in knowledge exchange processes across organisational boundaries (Alavi & Leidner, 2001). However, some issues still remain for ICT aiming to facilitate this inter-organisational knowledge exchange process, for example, by its very nature knowledge is hard to codify simply via technologies (Mohamed et al., 2006). Hence, understanding the role of ICT in inter-organisational knowledge exchange can greatly help organisations co-create new knowledge and improve their own competitive advantage.

## 1.2 Problem Statement

ICT has significant impact on knowledge exchange in organisations. On the upside, the use of various digital databases allows organisations to store their knowledge and use it more effectively and safely during knowledge exchange (Nasimi et al., 2013). Workflow automation systems help create more efficient organisational routines by reducing unnecessary communication and workplace temporal barriers allowing individuals to exchange knowledge more effectively (Stohr & Zhao, 2001). However, on the downside, ICT attributes, such as data quality and security, are challenging the quality of knowledge, further inhibiting human knowledge exchange process (Bagheri et al., 2016). Hence, the impact of ICT on influencing knowledge exchange in organisations remains unclear.

In inter-organisational settings, knowledge exchange is considered as a crucial process for organisations to acquire external knowledge and improve their own competitive advantage (Blecker & Neumann, 2000). Knowledge itself has a rather dynamic nature. There are diverse views on knowledge that have reflected the multifaceted nature of knowledge mobilised in knowledge exchange practice. For example, knowledge can be viewed as an object that can be codified by ICT into different explicit forms that support knowledge exchange (Hartmann & Dorée, 2015; King & Marks, 2008). Knowledge can be also viewed as rooted in practice that is goal oriented and only emerges as people conduct actions or interactions (Nicolini, 2013). Thereby ICT supports people to accomplish these goals and their interactions with different purposes, and this in turn shapes a dynamic knowledge exchange process (Carlile, 2002; Nicolini, 2016; Orlikowski, 2002). Existing studies that look at knowledge exchange practices usually place the emphasis on exploring the dynamic movement or mobilisation of knowledge and thus foreground knowledge in a knowledge exchange process (Bagheri et al., 2016; Blecker & Neumann, 2000). These studies consider the role of ICT usually as a contextual condition that helps shape a dynamic knowledge exchange practice without considering the dynamic nature of ICT itself.

As ICT becomes more influential, organisations tend to use them to enhance this process. For example, social media such as Facebook and Twitter help organisations capture external knowledge from a wide range of actors globally (Martini et al., 2013). Various advanced communication tools, such as email, video conferencing, digital forums, allow people to exchange their knowledge regardless of organisational boundaries (Alavi et al., 2005). However, while the literature emphasises the influence of ICT in accelerating the pace and intensity of inter-organisational knowledge exchange, there is limited evidence with regards to exactly how the dynamic nature of ICT can interact with the dynamic inter-organisational knowledge exchange process. This is because current perspectives in understanding the dynamic nature of ICT are diverse and discursive (e.g., affordance, sociomateriality, materiality, and socio-technical perspectives) (Zhu et al., 2021), which foregrounds ICT and emphasises the dynamic role of ICT in knowledge work settings. For example, affordance theory has unravelled stakeholders’ action possibilities afforded by ICT as ICT is used in knowledge work (Volkoff & Strong, 2017); materiality theory emphasises the fixed digital or physical materials of ICT that endure across time and space to support knowledge work (Leonardi et al., 2012). Sociomateriality theory considers the sociomaterial assemblage of ICTs that determine knowledge work performance (Orlikowski & Scott, 2008). These different views usually emphasise the nature of ICT in supporting knowledge work without considering the dynamic nature of knowledge exchange practice.

Taken together, the above indicates that current literature emphasises either the dynamic role of ICT or dynamic role of knowledge in the shaping of inter-organisational knowledge exchange, within which a comprehensive understanding of how a dynamic inter-organisational knowledge exchange practice is co-shaped by the dynamic nature of ICT is lacking. It is this gap that motivates the present study to investigate the interactive relationships between inter-organisational knowledge exchange and ICT and to provide an understanding of their interaction dynamics.

Positioning the above discussion, Living Labs lend themselves as an appropriate context to investigate this process. A Living Lab is “an Open Innovation ecosystem frequently operating in the context of competitiveness clusters and public development agencies within social innovation environments engaging local authorities in territories such as cities, agglomerations, regions” (Pallot et al., 2011, p. 2). It is viewed as a collaborative work approach based on systematic user co-creation (European Network of Living Labs, 2019), and it is regarded as a new way to meet innovation challenges, especially ICT-based (Eriksson et al., 2006). Living Labs, as a collaborative work approach that requires the involvement of multiple stakeholders for integrating innovation and development processes (Schuurman et al., 2014), is attracting the interest of scholars as awareness of the importance of knowledge co-creation has greatly increased (Su et al., 2016). Some literature has explored how Living Labs work and integrate the perspectives offered by various stakeholders across the key phases of Co-creation: Exploration, Experimentation and Evaluation. Each phase will typically involve all relevant stakeholders and organisations (Malmberg et al., 2017). In such a context with multiple types of organisations, the usage of ICT is expected to greatly influence the inter-organisational knowledge exchange among Living Lab participants. However, the evidence from the literature on how ICT facilitates the shaping of knowledge exchange among different organisations in this context is very limited. Hence, an enhanced conceptual understanding that can help Living Lab stakeholders to exchange their knowledge using ICT across multiple organisations and work towards new knowledge creation and innovation is required.

To summarise, significant gaps exist in the current literature in terms of how ICT shapes inter-organisational knowledge exchange practices: First, existing research does not provide a comprehensive understanding of how the nature of ICT is influencing knowledge exchange practice in inter-organisational settings. Second, there is lack of an integral understanding of how ICT and knowledge is shaped over time in inter-organisational settings. Third, the literature lacks an integrated view on potential contextual factors that may influence ICT-based knowledge exchange in inter-organisational settings. It is these gaps that motivate this research.

## 1.3 Research Aims and Objectives

The aim of this research is to identify and conceptualise the role of ICT in the shaping of inter-organisational knowledge exchange practices in inter-organisational collaborations. To achieve this aim, this study investigates European Living Labs as the context of this research. The questions that this research sets out to answer are:

1) What are the characteristics of ICT-based inter-organisational knowledge exchange practice in inter-organisational collaboration?

2) How does ICT facilitate or inhibit inter-organisational knowledge exchange practice in inter-organisational collaboration?

3） How to integrate ICT into an ICT-based inter-organisational knowledge exchange framework for inter-organisational collaboration?

To answer these questions, a set of specific objectives is established and summarised below:

* To identify the facets that characterise the interorganisational knowledge exchange practice.
* To explore how ICT facilitate or inhibit inter-organisational knowledge exchange practice.
* To propose an ICT-based inter-organisational knowledge exchange framework for inter-organisational collaboration.

## 1.4 Research Method

This study is aligned with the qualitative and inductive research tradition. The rationale for this alignment lies in the set research objectives, which require exploring Living Lab stakeholders’ insights and understanding on the role and influence of ICT for inter-organisational knowledge exchange in Living Labs settings. These insights need to be explored from the perspective of Living Labs stakeholders’ perceptions, experiences and attitudes in order to explain ICT-based inter-organisational knowledge exchange processes. Concerning the research design, this study follows a combination of the Glaserian version of Grounded Theory, archival research and multiple case studies as its research strategy. A Glaserian version of Grounded Theory is followed to inductively generate a theory from the data because of the limited number of theories that can adequately explain the phenomenon under study (Glaser & Strauss, 1967). By closely looking at the empirical data and investigating the phenomena in a bottom-up way, this methodology can thus be powerful to address the research gap where limited research evidence exists regarding exploring the dynamic inter-organisational knowledge exchange practice while taking into account the dynamic nature of ICT. A combination of exploratory and explanatory multiple case studies are adopted because the selected Living Labs as cases not only provide a solid research context, but also strengthen and confirm research findings from diverse settings (Darke et al., 1998). Consistent with the Glaserian version of Grounded Theory, data collection was developed via semi-structured interviews with Living Labs stakeholders and document analysis. Document analysis was adopted because varied Living Labs project documentation can provide complementary data for strengthening interpretation of findings and for triangulation purposes (Scott, 2014). Analysis of data from interviews and project documentation will develop through constant comparison and take place iteratively until theoretical saturation is reached. The rationale for selecting this research approach and methods is introduced and described in more detail in Methodology Chapter 3.

## 1.5 Significance

This research is significant for both research and practice as its findings would be beneficial for different types of stakeholders. There are four types of stakeholders who can benefit from this research: researchers, Living Lab project managers, industrial practitioners, and policy makers. For researchers, the findings of this research can be beneficial for those who work in different fields such as technology affordance, knowledge management, collaboration, or project management studies, as its findings can enhance their understanding of the interaction dynamics between information technology and knowledge management in an inter-organisational project collaboration context. Shedding light onto the co-evolution relationship that exists between dynamic ICT and knowledge exchange practice allows researchers to form a more comprehensive understanding of the interactive relationship between technology and digital organisation/organising; it also informs them regarding future research avenues around the area of interaction dynamics. For Living Lab project managers, this research allows them to enhance their understanding of how to enrich ICT management and knowledge management in conjunction in their projects and embed ICT/knowledge management into their project management lifecycle. For industrial practitioners, this research will be particularly useful for those who are interested in designing ICT for knowledge management/information management as diverse uses and effects of ICT in managing knowledge at different project stages are unravelled. For policy makers, the uncovered contextual conditions that influence ICT-based inter-organisational knowledge exchange practice can enhance their policy-making process. At the organisational level, policy makers involved in Living Lab projects can better develop rules/routines for enhancing project collaboration/ innovation. At the societal level, policy makers who are responsible for national policies can develop national policies for enhancing investment around ICT-based open innovation projects or the advancement of ICT for knowledge work.

# CHAPTER 2 LITERATURE REVIEW

## 2.1 Introduction

This chapter will explore and assess the current scholarly discussion under the research topic by reviewing the existing literature. The purpose of the literature review is to clearly identify and interpret gaps existing in this research field and refine the proposed research questions. Therefore, this literature review covers the themes of knowledge and knowledge management (KM); knowledge exchange in inter-organisational settings; the role of Information Communication Technology (ICT) in inter-organisational knowledge exchange (IOKE) and the context of Living Labs. The ultimate goal of this literature review is to develop the study’s theoretical foundations, enhance the researcher’s theoretical sensitivity and inform future data collection and analysis.

## 2.2 Knowledge and Knowledge Management (KM)

### **2.2.1 The Nature and Definition of Knowledge**

The definition of knowledge remains an ongoing debate, and has for centuries because of its elusive nature (Bolisani & Bratianu, 2018). Many frequently adopted definitions of knowledge are constructed on the ‘Justified Truth Belief’ theory of knowledge which was primarily developed by the Greek philosopher Plato. This definition provides a philosophical underpinning of knowledge and a foundation for subsequent scholars to discuss the nature of knowledge. Nonaka and Takeuchi (Nonaka et al., 1995) define knowledge as: a “dynamic human process of justifying personal belief toward the ‘truth’” (p. 58), which reflects the significant influence from this Greek philosophical classic viewpoint.

Knowledge is an abstract concept and hence complicated and ambiguous to be defined purely from a unique theoretical point of view, especially when considering its nature (Andriessen & Boom, 2007). A useful way to grasp the complexity of defining knowledge is to understand it using metaphorical thinking (Pinker, 2008). One key perspective on the definition of knowledge given through metaphorical thinking is to view knowledge as an object or resource in organisational practices. Borgo and Pozza (2012) claim that “the idea of dealing with knowledge as an object has been already exploited in a variety of areas across knowledge management and information technology” (p. 229). In this view, knowledge can be thereby abstracted and used in practice such as being codified quantitatively for indexing or distributing in any contexts (Janicot & Mignon, 2012).

Another metaphorical basis for understanding the concept of knowledge relates it to the image of an iceberg (Nonaka & von Krogh, 2009). From this perspective, knowledge can be distinguished between explicit knowledge that can be codified or expressed in words as the visible part of iceberg, and tacit knowledge that is hard to express such as personal experiences, constituting the hidden part of the iceberg (Nonaka & Takeuchi, 2000). This view helps to abstract the nature of knowledge be understand in its different forms.

Other more hierarchical metaphors can help illuminate the nature of knowledge further, such as the distinction between knowledge, information and data (Gurteen, 1998). Data refers to raw numbers and facts, information is processed data, and knowledge is that information after being authenticated (Machlup, 2014). There are several features distinguishing the three interrelated concepts, as summarised in Table 2.1.

Table 2. 1 Key characteristics distinguishing data, information and knowledge (van Vuuren, 2011)

Table

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Drawing on the same structure but taking it further, Spiegler (2000) develops the relationship among data, information and knowledge, as showed in Figure 2.1. He notes that data is attributes, information is knowing-what, while knowledge means knowing-how and can reach to wisdom when knowing “when” or “if”. This view emphasises an evolutionary view of knowledge. These various perspectives of knowledge provide a fundamental understanding of the nature of knowledge for this research.

Diagram

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Figure 2. 1 Knowledge terms and transformations (Spiegler, 2000)

### **2.2.2 Knowledge and Knowing**

In knowledge management literature, knowledge is conceptualised from various dimensions. Schultze and Stabell (2004) suggests two epistemology perspectives to understand the notion of knowledge, which reflects a construction of the world in terms of dualism and duality. Dualism reflects a binary and mutually exclusive world (Kondo, 2009) in which knowledge is viewed as an object that can be separated from the knower (Orlikowski & Robey, 1991; Schultze & Stabell, 2004). Duality reflects an integrated and mutually constitutive world in which knowledge is viewed as a state of mind that is continually being shaped by social practices, so called ‘knowing’ (Alavi & Leidner, 2001; Tsoukas, 1996). These two worldviews underlie the conceptualisation of knowledge towards two epistemologies: objectivist perspective and practice-based perspective on knowledge (Hislop et al., 2018).

#### 2.2.2.1 Objectivist Perspective of Knowledge

From an objectivist perspective of knowledge, several assumptions can be made as to the objectivist character of knowledge. One such assumption is that knowledge is viewed as an object and can be separated from the knower who possess the knowledge (Hartmann & Dorée, 2015). Based on this assumption, knowledge as an object that can be codified into texts, documents, or technologies and made explicit by and separated from individuals (King & Marks, 2008). A further assumption about knowledge as an object is that knowledge can be objective and objective knowledge can be produced (Hislop et al., 2018). In this assumption, social phenomena is argued to be measurable and made explicit as objective knowledge, such as laws or scientific principles (McAdam & McCreedy, 2000).

Another assumption is related to two different dimensions concerning the nature of knowledge: tacit knowledge and explicit knowledge (Nonaka & Takeuchi, 1995). Tacit knowledge refers to knowledge that is rooted in personal experiences or organisational routines and is hard to be expressed in words (Polanyi, 1966). Explicit knowledge, on the other hand, is defined as articulated, codified, stored and generalised knowledge (Hélie & Sun, 2010). From an objectivist epistemology, explicit knowledge is assumed to be superior to tacit knowledge, since explicit knowledge is easier expressed, codified and thereby is regarded as more formal than objective knowledge. Tacit knowledge, however, is more difficult to articulate so that it is regarded as more informal and subjective (Marabelli & Newell, 2014). The final major assumption is that knowledge is a cognitive, intellectual entity (Hislop et al., 2018). Knowledge is argued as something held in the head and thereby is a cognitive entity (Cook & Brown, 1999; Newell, 2015).

Based on these assumptions, objectivists conceptualise knowledge more as a dichotomy. For example, from an objectivist perspective, tacit and explicit are viewed as separated types of knowledge (Nonaka et al., 2000). Explicit knowledge can be formally articulated, elucidated, and codified into a tangible form so that it can be documented and stored in technologies such as databases or files for sharing with others (McInerney, 2002). On the other hand, tacit knowledge is subconscious and based on experiences and embedded in narratives so that it is hard to articulate and only can be held within self (McInerney, 2002). Polanyi (1958) noted that all knowledge is rooted in tacit knowledge and cannot be entirely articulated. In contrast with tacit knowledge of ‘knowing how’, explicit knowledge is more concerned with ‘knowing what’ (Li, 2018). This distinction has led to KM being studied separately. For example, Asher and Popper (2019) studied tacit knowledge through the identification of different layers: hidden practical knowledge that can provide the most explicit and personal-aware knowledge but unknown to the organisation; reflective tacit knowledge that is the result of experiences and more abstract to people; and demonstrated tacit knowledge that is knowledge of which individuals are unaware of and cannot be elicited. Nonaka et al. (2000) argues that knowledge can be created through transformation processes between tacit knowledge and explicit knowledge.

Another major depiction of dichotomy on knowledge relates to individual and organisational knowledge. This depiction focuses on the distinction between individual and organisational knowledge owners (Curado, 2006). Individual knowledge is originally argued as a specialised and domain-specific knowledge (Simon, 1957). Therefore, individual knowledge is transferable and can become part of an organisation’s knowledge yet possessed by the individual (Lam, 2000). On the contrary, organisational knowledge or collective knowledge, is defined as “the accumulated knowledge of the organisation stored in its rules, procedures, routines, and shared norms which guide the problem-solving activities and patterns of interaction among its members” (Lam, 1998, p. 8). Organisational knowledge exists only between individuals instead of within individuals (Lam, 2000), and resides in social collective works such as shared practices and routines (Razmerita et al., 2014). Spender (1996) combines the tacit-explicit dichotomy of knowledge and suggests a two by two matrix to illustrate four different types of knowledge: Conscious, Objectified, Automatic, and Collective (see Table 2.2.2.1). Conscious and Automatic knowledge represents individuals’ explicit and tacit knowledge. In social groups, objectified knowledge implies explicit group knowledge that will exist in libraries or rule-based production systems. Collective knowledge implies tacit group knowledge that comprises cognitive meaning and organisational behaviours, which represent inimitable knowledge possessed by a social group, such as an organisation’s value system (Hislop et al., 2018).

Table 2. 2 Different types of knowledge (Spender, 1996)

|  |  |  |
| --- | --- | --- |
|  | Individual | Social |

|  |  |  |
| --- | --- | --- |
| Explicit | Conscious | Objectified |
| Implicit | Automatic | Collective |

From an objectivist perspective on knowledge, there are various theories that underpin KM research. For example, Grant (1996) suggests a knowledge-based theory of an organisation that views knowledge as a significant resource Organisations can provide mechanism or techniques to manage the exchange of knowledge, such as knowledge sharing between people. Simon (1960) suggests an information processing view of knowledge creation describing how new knowledge is built through a series of elementary information processes. Like a computer routine, knowledge is created through converting input information to output information in order to solve all subproblems towards a final solution (Li et al., 2006). From an objectivist perspective, knowledge normally is viewed as an asset and the role of knowledge is to progress individuals or organisations towards an ideal competitive advantage (Schultze & Stabell, 2004).

#### 2.2.2.2 Practice-based Perspective of Knowledge

A practice-based perspective of knowledge lies in a practice view on our world that is shaped by human ongoing practices and the results of performance and accomplishments (Nicolini, 2013). From this perspective, organisations are considered as a bundle of practices (Nicolini, 2017) and ongoing accomplishments as people engage in everyday activities and recurrent actions (Feldman & Orlikowski, 2011). Organisational phenomena such as knowledge “occur within and are aspects or components of the field of practices” (Schatzki et al., 2005, p. 11). Organisational researchers have increasingly used such a perspective to investigate organisational phenomena where the focus has been put on the dynamics, relations and enactment of organisational phenomena through analysis of everyday human actions. Such perspective put an emphasis on a relational construct that agencies (such as human agencies and material agencies) always come in relations and organisational phenomena always exist in relation to each other (Feldman & Orlikowski, 2011; Nicolini, 2017; Østerlund & Carlile, 2005).

From a practice-based perspective, knowledge cannot be depicted as an independent aspect of organisational life such as a codified object or entity; rather, it is embedded within the working practices and always in relation to the materials, tools and human bodies (Nicolini, 2013; Orlikowski, 2002). This perspective emphasis ‘the epistemology of practice’ (Cook & Brown, 1999), and views knowledge as “action-oriented and implicit…and acquired by experience in a specific context” (Ripamonti & Scaratti, 2012, p. 185).

Adopting a practice-based approach, Lave and Wenger (1991) proposed the Communities of Practice (CoP) theory to illustrate the situated learning through which knowledge, termed as knowledgeability, is enacted as people co-participate in the shared practices in a community. As the focus of CoP theory is evolved from the internal processes of a single community to the interactions between interconnected practices, which is further termed as the landscape of practices to describe a number of related CoPs working on a body of knowledge (Wenger et al., 2014). Participation in a landscape of practice requires members to develop their knowledgeability relevant to the landscape of practice (Pyrko et al., 2019), and thus the notion of knowledgeability becomes further important in the context of IOKE practice. This means knowledge is not only rooted in a single community of practice but also existing between CoPs. For example, in an inter-organisational collaboration team, a member who comes from a particular organisation can also claim their knowledge about the whole team as long as they connect their practice with those of other organisations/communities. As Giddens (1984) stated, knowledgeability is “inherent in the ability to ‘go on’ within the routines of social life” (p.4). Orlikowski (2006) also suggests that knowledgeability is manifest in and through human practices as a capability and thus always bound up with material objects in making up the practice. All these arguments indicate an inseparable relationship between knowledgeability and practices. Wenger (2014) formally defines knowledgeability as the “complex relationships people establish with respect to a landscape of practice, which make them recognizable as reliable sources of information or legitimate providers of services” (p. 23). Unlike the competence that describes the relationship to a practice for entering individual communities, knowledgeability describes the relationship to a landscape of practice as people engage in multiple groups, organisations or interconnected communities and develop their knowing in practice as the regime of competence (Wenger, 2000; Wenger, 2014). The above implies that knowledgeability can be viewed as a relational construct that is not only in relation to one’s own experience or competence to a community of practice (Lave & Wenger, 1991; Wenger, 2010), but also in relation to others’ perspectives and experiences so that makes it contestable and negotiable (Omidvar & Kislov, 2014; Wenger et al., 2014), and in relation to material objects that are bound up with participation in interconnected practices and boundary work that exists in a landscape of practices (Carlile, 2002; Orlikowski, 2006). Such a relational understanding of knowledgeability is essential to the present study since it provides an alternative view to understand people’s cross boundary work in inter-organisational collaboration in contrast to the objectivist collective / organisational views of knowledge.

There are several interrelated features for understanding such practice-based, relational approach to knowledge. First, knowledge is regarded as inseparable from human activities, and is embedded in the practices (Hislop et al., 2018). Challenging the objectivists perspective that views knowledge as separate object from people, the practice-based perspective of knowledge argues that knowledge is inseparably tied to people’s practices and is formed as people engage in practices (Nicolini, 2011), so called ‘knowing’ (Corradi et al., 2010). From an objectivist’s perspective, knowledge is derived from the brain as a cognitive entity, separate from the body or behaviours (Newell, 2015), i.e. thinking and doing is discrete. However, from a practice-based perspective, knowledge, or knowing, is viewed as an ongoing holistic development of the whole body through the routine activities (Strati, 2007), i.e. thinking and doing is fused in the practices.

In addition, the practice-based perspective views knowledge as multidimensional and non-dichotomous. Rather than objective perspective that conceptualises knowledge in depiction of dichotomy such as tacit-explicit knowledge or individual-organisational knowledge., practice-based perspective conceptualises knowledge as being mutually constituted by these dichotomic dimensions (Tsoukas, 1996). For example, from the practice-based perspective, explicit knowledge and tacit knowledge are fused and inseparable (Werr & Stjernberg, 2003), i.e. all knowledge has explicit and tacit dimensions rather than dichotomy of knowledge.

The practice-based perspective also assumes that knowledge is embodied within an individual. Since the practice-based perspective assumes that knowledge is rooted in one’s practices, knowledge can only be developed by the actor who undertakes the practices (Gherardi & Rodeschini, 2016). As knowledge is mutually constituted by tacit and explicit dimensions, it cannot be fully converted from a tacit into explicit form. Therefore, knowledge cannot be fully disembodied from people in an explicit form, but is only embodied by the workers who carry out practices (Yakhlef, 2010).

Another major characteristic of the practice-based perspective is that knowledge is socially constructed and culturally embedded in nature. Since knowledge is embodied in person and embedded in practices, knowledge is relatively subjective and never unbiased for interpretation, i.e. it is inseparable from those who produce it (Hislop et al., 2018). Therefore, the social constructed nature of knowledge shows that it is developed and understood by its production and interpretation. Polanyi (1961) illustrates these processes as sense giving and sense making. Furthermore, Weir and Hutchings (2005) argue that knowledge can only be understood within specific social and cultural contexts since people attach meanings to the knowledge based on their values and assumptions. Similarly, Rivera and Cox (2016)’s work reflects that cultural values are key factors in knowledge management, e.g., values of human resources practitioners limit the utilisation of knowledge management systems.

From such a perspective, knowledge is also material. As Nicolini (2011) suggests, practice as the source of knowing demonstrates that knowing and practicing are ontologically equivalent. This indicates the multiple facets that facilitate practice such as tools, objects, subjects, and power relations also facilitate the shaping of knowledge. Orlikowski (2006) drawing on the practice perspective, argues that knowledge is inherently material since people cannot achieve their everyday knowledgeable practices without the use of material forms such as artefacts, spaces, and infrastructure. Under such a view, knowledge is always bound up with material artefacts in practice and is always an ongoing achievement of human practice as people interact with these artefacts. This highlights the role of knowledge and material artefacts in practice by considering the emergence of these as equivalent to each other.

### **2.2.3 Knowledge Management Activities**

Both intentionally and unintentionally, organisations engage in knowledge management activities to improve their organisational performance (Ferreira et al., 2018). The expansion of knowledge management activities demonstrates the growing recognition that developing knowledge management capabilities is a prerequisite for organisations to survive (Hislop et al., 2018).

Knowledge management activities are rooted into two main perspectives: a human-oriented perspective and a technology-oriented perspective (Dayan et al., 2017; Maier, 2007; Shams et al., 2019). The human-oriented perspective focuses on people-derived organisational learning processes, while the technology-oriented perspective emphasises aspects of structural organisational science with the support of ICT (Maier, 2007).

Based on the tensions and complementarities given by these two perspectives, scholars developed the nature and foci of knowledge management into different streams. One stream focuses on the **knowledge life cycle**, which divides knowledge management into different knowledge activities.

Under this stream, knowledge management is viewed as “a set of distinct and well-defined approaches and processes to find and manage positive and negative critical knowledge functions” (Wiig, 1993, p. 16). There are many knowledge management activities identified in the existing literature, which are divided according to their nature into four major types: knowledge creation, knowledge sharing, knowledge storage, knowledge use. **Knowledge creation** refers to how the generation of a novel understanding of a particular phenomenon is developed from existing knowledge (Beesley & Cooper, 2008). This process emphasises how new knowledge is created through socialisation, externalisation, combination and internalisation (Nonaka et al., 2000). **Knowledge sharing** refers to the process by which knowledge is being shared between sender and receiver (Schauer et al., 2015). The shared knowledge can become a joint-treasure for both sender and receiver (Li, 2018). **Knowledge storage** is mostly used to reflect how knowledge is stored in organisational memory for future use (Jasimuddin, 2005). Memory is a system of knowledge that preserves and stores people’s perceptions and experiences for later retrieval (Probst et al., 1999). **Knowledge application** indicates the usage of knowledge as opposed to knowledge existence alone (Shaheen, 2017). This process illustrates how knowledge is applied into a new scenario for organisational knowledge management (Parikh, 2001). Finally, **knowledge exchange** is not a specific activity but a combined dynamic process by which knowledge is created, shared, stored and applied ( Davenport, 2018). Through knowledge exchange, knowledge can be mobilised into real action (van den Driessen Mareeuw et al., 2015). Therefore, knowledge exchange is viewed as the core of knowledge management (Al‐Adaileh & Al‐Atawi, 2011).

Another stream views knowledge management as a **business strategy-oriented process**, which places emphasis on organisational management functions. According to this view, knowledge managements most important mission is to serve organisational strategy, operating as “the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities” (Quintas et al., 1997, p. 387). In a similar vein, Heisig (2001) argues that the focus of knowledge management is the attainment of organisational objectives and defines it as “the sum of the procedures that determine the generation, storage, distribution, and application of knowledge to achieve organizational goals” (p. 97). The role of ICT in this body of stream focuses on the identification of ICTs that can support knowledge management activities. For example, data and information can be stored with the support of ICT where knowledge is embedded and managed (Loshin, 2001).

Combining elements from both a life-cycle and a business-oriented process understanding of knowledge management, Maier (2007) defines knowledge management as “the management function responsible for the regular selection, implementation and evaluation of goal-oriented knowledge strategies that aim at improving an organisation’s way of handling knowledge internal and external to the organisation in order to improve organisational performance” (p. 57), and it is this definition that will be applied in this study.

## 2.3 Knowledge Exchange

Knowledge exchange is the core of knowledge management (Al‐Adaileh & Al‐Atawi, 2011). However, the definitions of knowledge exchange are contested in literature as it is a complex, dynamic process (Salinas, 2018). Therefore, this section will discuss the role of knowledge exchange in knowledge management in order to understand the nature of knowledge exchange.

### **2.3.1 Knowledge Exchange in Knowledge Management**

Knowledge exchange is a broad concept encapsulating knowledge creation, sharing, storage and application. Fazey et al. (2013) define knowledge exchange as “a process of generating, sharing, and/or using knowledge through various methods appropriate to the context, purpose, and participants involved” (p. 20). Davenport (2018) similarly defines knowledge exchange as a “dynamic process by which knowledge is transferred, shared and created within the core collaboration and with wider stakeholders” (p. 297), and emphasises its iterative and multi-directional characteristics that are supportive of collaboration.

However, knowledge exchange is still considered a complex process related to all knowledge relevant processes and there is not a unified view to integrate them all. Currently, knowledge exchange is often used as an umbrella term to designate the combination of all related knowledge processes, covering knowledge sharing, transfer, creation, storage and application (Priyono, 2016; Salinas, 2018). This is because many of these practices represent a component of knowledge exchange. For example, knowledge exchange is also used to describe how new knowledge is co-created but emphasises the iterative processes that take place in multi-partner collaborations (Davenport, 2018). Knowledge exchange is used to map the movement of shared knowledge (Desouza, 2003). Knowledge storage is also argued as an important aspect in knowledge exchange as it helps to classify and backup knowledge (Lin et al., 2006). Knowledge exchange is also used to show how knowledge is used in action, but focuses more on how this is achieved through a dynamic process (van den Driessen Mareeuw et al., 2015).

Although these different terms are all relevant to knowledge exchange, knowledge exchange has its own unique characteristics when compared with them. Knowledge sharing is defined as “an exchange of knowledge between two individuals: one who communicates knowledge and one who assimilates it” (Paulin & Suneson, 2011, p. 83). This definition of knowledge sharing reflects that it places more emphasis on the knowledge sender and receiver, while knowledge exchange focuses more on interactions among various stakeholders (Fazey et al., 2014; Phillipson et al., 2012).

Contrasting knowledge exchange and knowledge transfer, Davenport (2018) notes that knowledge exchange is founded on an iterative and non-linear process of discovery and co-creation of knowledge, while knowledge transfer is a linear, sequential and staged process. In addition, knowledge exchange emphasises co-creating knowledge through working with various stakeholders, while knowledge transfer reflects the movement of knowledge to potential users. Similarly, Algeo (2014) argues that knowledge exchange is “a social process where various contingent histories, professional perspectives, and local conditions interact in a systematic, mutual way to share tacit knowledge in order for it to become explicit knowledge” (p.34). He distinguishes knowledge exchange as an omnidirectional interactive process from knowledge transfer which is “unidirectional from knowledge producers to stakeholders” (Graham et al., 2006, p. 16).

### **2.3.2 Knowledge Exchange in Facilitating Know-Do Process**

As an important activity in knowledge management, knowledge exchange can be viewed as a ‘know-do’ process that is supportive of the application of knowledge to real practice, which means knowledge-to-action (Mareeuw et al., 2015). Knowledge-to-action refers to the process through which evidence-based knowledge is interpreted and mobilised into utilisation and actions for and by users. Originating in the healthcare domain, Graham et al. (2006)’s influential knowledge-to-action model is mapped in Figure 2.2. The funnel illustrates that knowledge is being distilled with the knowledge moving through the funnel and refined to become more useful for relevant stakeholders. The accompanying action cycle illustrates seven phases that carry knowledge forward into real application. These phases in the cycle are not only interactive but also can be affected by the knowledge creation process.

Diagram

Description automatically generated

Figure 2. 2 Knowledge-to-Action model (Graham et al., 2006)

As Mareeuw et al. (2015) described, knowledge exchange is an iterative and systematic process within a multi-actor context in which knowledge is translated for knowledge users. This view also emphasises that knowledge exchange is a dynamic process in the mobilisation of knowledge into action (Wingens, 1990).

The healthcare setting is especially prolific in the development of several other frameworks of knowledge exchange that align with this ‘know-do’ perspective (Prihodova et al., 2019). This because healthcare setting is an intensive knowledge exchange setting where translating knowledge into practice has become the promising concerns over decades (Nutley et al., 2007). Ward et al. (2009) propose a knowledge transfer framework which maps five components and they later reinterpreted and reformulated it as a knowledge exchange framework, including: problem identification; knowledge development and selection; analysis of context; knowledge transfer interventions; and knowledge utilisation (Ward et al., 2012). The components interact with each other to facilitate knowledge translation, and the framework argues that knowledge exchange is “an interactive and multidirectional process” (Ward et al., 2009, p. 163), as depicted in Figure 2.3.

Diagram

Description automatically generated

Figure 2. 3 Knowledge transfer framework by Ward et al. (2009)

After modifying the original knowledge transfer framework, Ward et al. (2012) proposed that the gap between knowledge and practices is a knowledge exchange problem. They argue that knowledge exchange is “a process which incorporates distinct forms of knowledge from multiple sources” and suggest a “dynamic and iterative” knowledge exchange framework showing how knowledge unfolds over time (p. 297), as illustrated in Figure 2.4. In their framework, the **problem stream** reflects what future knowledge is required. The knowledge exchange problem should be revised as it evolves continuously over time. The **Analysis of context** reflects the evaluation of the current context. The understanding of different types of contextual characteristics should provide shared experiences and networks because knowledge exchange is a social instead of a behavioural phenomenon. The **Knowledge stream** reflects the evaluation of the existing knowledge, taking stock of existing knowledge and how this knowledge fits current needs. The **Intervention** reflects the evaluation of what knowledge exchange activities should be set in place and the engagement activities required. Finally, the **Use stream** reflects the use of knowledge towards solving problems. The overall interactive stream process and their accumulation over the time is showed in Figure 2.4.

Diagram

Description automatically generated

Figure 2. 4 Revised knowledge exchange framework by Ward et al. (2012)

Other knowledge exchange frameworks include Murnaghan et al. (2013) and its four components: **surveillance system** to support planning and collecting relevant data; **the ability to synthesise existing evidence** to interpret existing knowledge and analyse the current context; **the capacity to mobilise evidence into action**; and **the means of evidence-to-action** to evaluate such knowledge exchange practices. More recently, Prihodova et al. (2019) identified six key components embedded throughout knowledge exchange processes (depicted in Figure 2.5). **Messages** refers to shared knowledge or information; **stakeholders** include individuals involved in the knowledge exchange process; **process** covers the necessary activities of knowledge transfer, representing a ‘push-pull’ dynamic exchange process of knowledge; **local context** represents their organisational environment where knowledge exchange occurs; **social and cultural and economic context** refers to external environmental factors influencing exchanging knowledge; and **evaluating efficacy** stresses the need to evaluate the efficacy of knowledge exchange activities. The usefulness of Pridohova et al. (2019)’s model has been confirmed by its credibility, accessibility and applicability (Payne et al., 2019), which emphasises knowledge exchange as an iterative and dynamic ‘know-do’ process.

Diagram

Description automatically generated

Figure 2. 5 Evidence-based model for the Transfer and Exchange of Research Knowledge (Prihodova et al., 2019)

### **2.3.3 The Nature of Knowledge Exchange**

By exploring the nature of knowledge exchange and its processes with related key concepts, it is clear that knowledge exchange is an important process in knowledge management. The present study has proposed a new definition, in light of the multiple definitions that exist and these existing definitions are rather fragmented and lack precision and clarity to cover the nature of knowledge exchange (Zhu et al., 2021). By consolidating the existing definitions in one that combines the critical components of knowledge exchange, knowledge exchange in this study is defined as: ***an*** ***iterative, interactive, multidirectional, dynamic, non-linear and know-do process by which knowledge is created, shared, stored and applied, reflecting a mobilisation of knowledge into practice.***

By synthesising the literature, there are five phases that shape the process of knowledge exchange: knowledge exploration; existing knowledge exploitation; context evaluation; intervention; and knowledge application. These phases are explained in the ensuing narratives with more details.

**Knowledge exploration** reflects the seeking process in knowledge exchange practice. New knowledge or a problem could be sought through knowledge exploration and this can evolve continuously (Ward et al., 2012). March (1991) argues that knowledge exploration is a key process that facilitate organisational learning by recurrently seeking and requiring new knowledge from other contexts. Other scholars also argue that knowledge is exchanged when it is desired or sought (Davison et al., 2018). Knowledge exploration thus represents an important process in knowledge exchange practice.

**Extant knowledge exploitation** refers to the synthesis and exploitation of existing evidence or knowledge. In order to create new knowledge, it is necessary to synthesise existing relevant knowledge and interpret why it fits into the specific context (Murnaghan et al., 2013). Ward et al. (2009) argue that knowledge exchange needs a research development process to analyse and select existing knowledge through which new knowledge can be created. Their later work also indicates that knowledge exploitation related activities, such as tailoring knowledge and assessing knowledge, can enable a new understanding on the present knowledge (Ward et al., 2012). Therefore, existing knowledge exploitation plays a key role in the knowledge exchange process.

**Context construction** demonstrates the environment of knowledge exchange. Macro environments such as economic contexts shows the external environment of knowledge exchange, which reflects the understanding on the contextual conditions of knowledge exchange (Prihodova et al., 2019). Micro characteristics, which may include structure and workplace leadership, can also affect the people’s knowledge exchange (Cannatelli et al., 2017). These contexts provide the circumstances where knowledge exchange is taking place (Ward et al., 2012).

**Intervention** is related to the various activity patterns that intervene knowledge exchange process. During the knowledge exchange process, individuals develop their knowledge patterns through sharing, creating and tailoring new knowledge, discussing and negotiating their ideas (Prihodova et al., 2019; Ward et al., 2009). In this study, knowledge exchange is defined as a combined activities of knowledge sharing, creation, storage and application. Therefore, interventions refer to these activities and how they evolve human knowledgeable works. This is an iterative and dynamic process and is the way knowledge is accumulated over time (Ward et al., 2012).

**Knowledge utilisation** refers to the use of knowledge. Murnaghan et al. (2013) argue that organisations need to develop their capability to mobilise their knowledge in action. This is because applying knowledge is the key purpose of knowledge management and significant for promoting competitive advantage of organisations (Alavi & Leidner, 2001). Evaluation is also included in this phase because this helps to understand how effective the knowledge exchange process is and how useful the knowledge exchanged is (Prihodova et al., 2019).This phase thereby is vital in the knowledge exchange practice, which also demonstrates the ‘know-do’ nature of knowledge exchange.

The stages described above provide the foundation for this research to explore knowledge exchange process in inter-organisational settings, which will be discussed in Chapter 2.4.

## 2.4 Inter-organisational Knowledge Exchange (IOKE)

This section discusses different inter-organisational relationships (IORs) and the role of inter-organisational collaboration, in order to understand IOKE. This is because organisations have started to seek opportunities in developing IORs in order to find new solutions for their needs from collaborative knowledge exchange processes.

### **2.4.1 Inter-organisational Relationships and Collaboration**

IORs refer to the “relationships between and among organisations that are pursuing a mutual interest while also remaining independent and autonomous, thus retaining separate interests” (Ebers, 2015, p. 622). Organisations, relationships, context, and processes (Cropper et al., 2008) are constituent parts of the concept that requires analysis. Organisations have attributes from an individual perspective including their sector, size, specific investments. (Griffith et al., 2006; Gulati, 1995) and from a collective perspective such as the density of relationships among organisations (Lomi, 2002) and the number of partners involved in inter-organisational relations (Rao, 2017).

For the relationship element, most studies focus on an interactive perspective to study relations between or among organisations (Rajala, 2018). Interactive IORs help organisations implement three important features of relationships: content, governance mechanism and structure. Content refers to flows of some specific information or resources transferred among organisations such as tangible/intangible resources, or tacit/explicit knowledge etc (Cropper et al., 2008). Governance mechanisms are the means through which actors manage the content of relationships such as trust, reciprocity, equity etc (Iriyama et al., 2014; Seppänen, 2008). Finally, the structure of relationships defines the associated actors for specific actions, such as the diversity of relational types, strength of relations (Hemmert, 2019; Popp et al., 2015).

The concept of context relates to the conditions that facilitate or challenge the development of IORs (Schermerhorn, 1975). From a micro perspective, individuals influence the results of inter-organisational relations. Key attributes such as nature of ties among individuals or their social capital (Hemmert, 2019; Ko & Sienkiewicz, 2016) are influential. From a macro perspective, high-level environment aspects such as legal, political, or economic context (Cui et al., 2018) influence inter-organisational relations.

Concerning processes, micro-scale process reveals activities that are embedded in organisational members’ daily lives and vary over time, such as how inter-organisational trust unfolds or the dimensions of leadership (Smith et al., 2018; Villena et al., 2019). Macro-scale processes reveal the evolution in inter-organisational relations, and include different phases of IOR lifecycles, including its dissolution. (Sullivan et al., 2007; Takimura et al., 2017). The attributes analysed above provide a holistic view of inter-organisational settings.

There are different types of IORs, for example, social networks, alliance networks and organisational networks (Wijk et al., 2015). Social networking is a way to examine relations between organisations (García Sánchez et al., 2017). Alliance network is a governance mode through which organisations obtain access to complementary resources and knowledge (Walter et al., 2007). Organisational networks are a form of organising different organisations. There are three important organising modes within inter-organisational networks: inter-organisational collaboration, coordination and cooperation (Heath & Isbell, 2017). Inter-organisational cooperation is based more on reciprocity and thereby relationships could be more informal (Westra et al., 2016). Inter-organisational coordination indicates a formalised relationship among organisations with a very formal agreement about detailed tasks and processes. Inter-organisational collaboration refers to a more indeterminate role between cooperation and coordination (Heath & Isbell, 2017). The agreement or arrangements will not have been decided yet but are typically discussed later among collaborative partners. This relationship helps to capitalise the differences among stakeholders in order to facilitate creative ideas (Lalic et al., 2016). Compared to cooperation that focuses more on a strategic joint effort against competition, collaboration entails a more tactical interactive process. In cooperation, organisations reach a mutual agreement and activities are mutually agreed but not necessarily for mutual benefit. However, in collaboration, the mode of joint planning, joint implementation, and joint evaluation among organisations are developed in order to achieve a mutual goal (Hord, 1981). Such distinction between collaboration and cooperation makes studying knowledge exchange more useful in inter-organisational collaboration settings. In more recent studies, Lindenfors (2017, p. 5) states that cooperation is the “collective functioning of some kind of units for the benefit of themselves and/or their component parts”. Tuomela (2013) considers cooperation as a collective activity of two or more agents cooperating to achieve a shared end, and such may include an individual or common goal, a maximum reward, a labour division, conflict avoidance, or a system integration (Khamis et al., 2006). These definitions reflect that cooperation is more focused on the achievement of a final goal through collective work. In cooperation, participants can do these collective works separately by being responsible for their assigned parts and finally bringing them to the table (Kozar, 2010). However, when collaborating, people work together for a mutual goal as well, but hold an emphasis on respecting each participant’s contribution to the whole (Roberts, 2004). Nelson (2008) distinguishes collaboration from cooperation as collaboration implies more direct interaction among participants through discussion and negotiations. Such a ‘working together’ process thereby requires more knowledge creation and sharing activities in the process of knowledge exchange (Dillenbourg et al., 1996; Nelson, 2008). Therefore, inter-organisational collaboration tends to be an increasingly important approach that many organisations pursue towards knowledge exchange and innovation (Gustafsson & Magnusson, 2016). These various definitions and foci of inter-organisational collaboration encountered in the literature are summarised below in Table 2.3.

Table 2. 3 Inter-organisational collaboration definitions

|  |  |
| --- | --- |
| Emphasis  and orientation | Definitions |
| *Innovation outputs* | “Inter-organisational collaboration is conceptualized as a feature of the innovation process related to the extent to which other organisations—firms or institutions—take an important part in the innovation process” (Alexiev et al., 2016, p. 975) |
| *Problem-solving* | “Social problem-solving mechanisms among organisations” (Waddock, 1989, p. 79) |
| *Achieving unique outcomes* | “The linking or sharing of information, resources, activities, and capabilities by organisations to achieve an outcome that could not be achieved by the organisations separately” (Bryson et al., 2006, p. 44) |
| *Acquiring necessary resources* | “In a situation where industry forces propel firms into internationalisation, firms are prepared to collaborate with competitors to acquire resources” (Chetty & Wilson, 2003, p. 77) |
| *Working across organisational boundaries* | “Any situation in which people are working across organisational boundaries towards some positive end” (Huxham & Vangen, 2005, p. 4) |
| *Using information and communication technologies* | “The use of information and communication technologies to support sharing of information among business partners to attain predetermined objectives” (Ned, 2007, p. 319) |

These different views of inter-organisational collaboration emphasise three important aspects of inter-organisational collaboration: intentions, involvement of organisations, and tools to support collaborations. First, organisations involved in collaboration can be diverse. These organisations could be businesses, governments, NGOs, end-users or communities (Gray & Stites, 2013). Concerning varying intentions, different collaborating organisations may do so with the intention to focus on innovations (Alexiev et al., 2016), problem-solving (Waddock, 1989) or acquiring external knowledge (Bryson et al., 2006; Chetty & Wilson, 2003). Finally, the ways through which inter-organisational collaboration is constructed are also diverse such as the use of ICT to support organisations achieve this goal (Ghosh & Fedorowicz, 2008).

Based on these different viewpoints towards inter-organisational collaboration, several core characteristics were identified to be significant in defining the role of inter-organisational collaboration in this research. First, the aim of inter-organisational collaboration is focusing on creating new knowledge; second, the parties involved in inter-organisational collaborations should originate from two or more types of entities such as government, community, NGOs or business; third, information and communication technologies can support the achievement and development of inter-organisational collaborations.

### **2.4.2 Inter-organisational Knowledge Exchange**

Inter-organisational collaboration can provide a setting in which knowledge exchange takes place across organisational boundaries. However, existing literature has not provided a comprehensive discussion on the nature of the knowledge exchange process in inter-organisational collaboration. As knowledge exchange is the core of knowledge management, this section explores the nature of inter-organisational knowledge management and relevant activities in order to understand the potentially important factors in the IOKE processes.

#### 2.4.2.1 Inter-organisational Knowledge Management

Inter-organisational knowledge management (IOKM) is defined as “designing, controlling and developing a purpose-oriented knowledge order together with partners” (Blecker & Neumann, 2000, p. 75). As indicated in Blecker & Neumann (2000)’s IOKM framework, Five phases are important in inter-organisational knowledge management: an *intention phase* describes the determination of knowledge targets and its measuring criteria. This phase reflects that a knowledge-based management strategy should be established and is a prerequisite for effective inter-organisational knowledge management. *The identification phase* describes the identification of existing knowledge distributed throughout different organisations. This phase reflects that different organisations possess various knowledge bases which should be explored to form learning across different organisations. Intention and identification are both strategic phases which determine whether the organisations can successfully compete based on their core competences in the future. *The modification phase* mainly deals with knowledge ecology and reflects what type of environments is supporting inter-organisational knowledge related activities. *The organisation phase* describes knowledge-oriented management including managing and organising inter-organisational knowledge creation, transfer, sharing, storage, diffusion etc. This phase reflecting inter-organisational knowledge management is an iterative process since these knowledge-oriented processes show how knowledge is managed and reproduced over time. Modification and organisation are both normative phases, which support the generation of inter-organisational knowledge and learning-intensive processes. And finally, *the interaction phase* describes how knowledge becomes integrated and used inter-organisationally towards final outputs. This phase is an operative phase and reflects that inter-organisational knowledge management should finally contribute to the practices in real life settings. This inter-organisational knowledge management framework confirms the dynamic and iterative ‘know-do’ process of knowledge exchange in inter-organisational settings, as mapped in Figure 2.6.

Diagram

Description automatically generated

Figure 2. 6 Inter-organisational knowledge management process (Blecker & Neumann, 2000)

#### 2.4.2.2 Influencing Factors of Inter-organisational Knowledge Exchange

In this study, knowledge creation, sharing and transfer have been defined as components of knowledge exchange. Therefore, it is posited that the factors that shape these components will naturally influence the overall IOKE process.

Concerning *inter-organisational knowledge creation*, ICT can be a contextual factor that highly affects this process (Berente et al., 2010). Two components are of particular significance from Berente et al. (2010)’s work: Information pooling and interaction. Information pooling describes the explicit knowledge exchanged in inter-organisational collaboration or coordination, and this could be supported by technologies, such as electronic data interchange (EDI), while interaction describes the extent of collocated work practices that allow tacit knowledge to be exchanged.

**Leadership** is also an influential factor for inter-organisational knowledge creation. For example, distributed leadership can formalise the SECI process of knowledge creation (Socialisation, Externalisation, Combination, and Internalisation), and motivate inter-organisational knowledge creation (Cannatelli et al., 2017). However, distributed leadership may also result in inactive sharing of knowledge, which may also inhibit people’s knowledge creation (Timperley, 2005). Centralised leadership can enhance coherence of knowledge works and orient knowledge creation works (Krogh et al., 2012).

**Inter-organisational trust** and **conflict** are also influential factors. Trust helps to improve the quality of discussions and minimise the risk of uncertainty, information, and hence facilitate knowledge sharing (Davenport et al., 2000; Panteli & Sockalingam, 2005). Conflicts can make people realise the lack of their knowledge repository and thus encourage them to learn from others, which helps to facilitate the sharing of knowledge between people and across organisational boundaries (Panteli & Sockalingam, 2005).

**Extrinsic benefits** such as **rewards** can also stimulate individuals’ intrinsic motivations to share knowledge between organisations (Fullwood & Rowley, 2017). However, rewards may lead to competition, which may generate resistance to exchanging knowledge with others (Barua et al., 2007; Bock et al., 2005).

Magnusson (2005) argues that **culture** and **language** are problematic in exchanging knowledge in inter-organisational collaboration, because the multiplicity of organisational cultures and languages leads to conflicts among organisations. Therefore, organisations in inter-organisational collaboration may shape their own culture and language within their inter-organisational network. Similarly, Camarinha-Matos (2013) argues that a common language and a common **operability of ICT** infrastructure is important to a collaborative business ecosystem.

*For Inter-organisational knowledge transfer*, Easterby‐Smith, Lyles and Tsang (2008) suggest an influential framework to elaborate this process and integrate relevant influential factors. **Trust** or **inter-organisational trust** in the framework is important to motivate people to share knowledge and engage knowledge transfer in inter-organisational collaborations (Easterby‐Smith et al., 2008; Ingene et al., 2019). In addition, **absorptive capacity** plays a moderating role in managing external knowledge flows (Escribano et al., 2009). Based on the absorptive capacity perspective, Miller et al. (2016) argue that factors such as **prior investment**, **human resources**, and **prior internal and external knowledge base** can influence the ability to develop linkages with external knowledge sources. Factors such as **diversity of stakeholders’ background**, and **education level** can influence the ability to understand external knowledge and factors such as **bureaucracy** can influence the ability to use new knowledge. Miller et al. (2016) identify these factors from an open innovation context where multiple stakeholders are interacting, and argue that these factors have great influence on inter-organisational knowledge transfer. In addition, the authors further argue that **organisational learning** is also an important factor in facilitating organisations to learn knowledge from others, which influences the process of inter-organisational knowledge transfer as well. In inter-organisational settings, aforementioned knowledge transfer processes may also take place among different organisations as a form of inter-organisational knowledge exchange. Thereby those contextual factors (i.e., culture, language, or leadership) may also influence IOKE.

Based on the literature on knowledge exchange and inter-organisational collaboration, there is less study that can provide a comprehensive definition of IOKE for enquiring its dynamic nature. Therefore, IOKE in this research is defined as ‘*a dynamic, multi-directional and iterative, know-do process by which inter-organisational knowledge is created, shared, stored and applied in inter-organisational collaborations and with stakeholders who possess distinct forms of knowledge’.* The IOKE process consolidates the knowledge exchange phases summarised in Section 2.3.3. However, the knowledge exchanged in inter-organisational collaboration serves inter-organisational collaboration purposes. The intersection of these dimensions is presented visually in Figure 2.7

Diagram

Description automatically generated

Figure 2. 7 Inter-organisational Knowledge Exchange Process

## 2.5 Conceptualising ICT in Inter-organisational Knowledge Exchange Practice

There is no doubt that the current digital age has tremendously transformed the way people communicate, work, learn and access information to innovate. The technological revolution has led to advances of ICT, and nowadays these ICTs allow organisations to strengthen their competitiveness as well as their work practices (Valdez-Juárez et al., 2018). Lubbe and Singh (2009) define ICT as “[a]n umbrella term that includes all technologies for the communication of information (p. 853)”. Technically, these technologies comprise hardware such as equipment, software such as applications, and communication policies such as communication protocols (Berce et al., 2007).

The term ICT is often used interchangeably with the term IT (Information Technology). Spacey (2016) indicates that IT is defined as technology related to computing data, while ICT is defined as technology related to computing data and communications. Weigel and Waldburger (2004) claim that ICT encompasses a full range of technologies including both information technologies and communication technologies, from traditional devices such as radios to more sophisticated technologies such as internet and computers. For the purposes of this study, ICT is considered as a broader term that incorporates both Information Technology and Communication Technologies (Sein & Harindranath, 2004).

Various knowledge management studies have emphasised the role of ICT. Holsapple (2005) adopts an *inclusive* view to the role of ICT (noted as computer-based technology in his article, but referred to all types of ICT such as IT and information systems) in KM and argues that: 1) researchers who study IT or ICTs are KM researchers, i.e., KM is an enveloping field that includes the IS domain; 2) there are great opportunities to study technologies in KM, e.g., devising improvement in technologies to facilitate KM initiatives; 3) there is great space for understanding users and the usage of technology in KM, e.g., why a particular technology does not work well for KM; and 4) there is great space for understanding outcomes of usage of technologies, e.g., what are its impacts for KM activities.

Due to aforementioned gaps that require fresh understanding of ICT in KM, Hoslasapple (2005)’s work calls for a re-conceptualisation of ICT in the context of KM. Over the years, scholars have made contributions to the conceptualisation of ICT in the KM field. For example, an empirical study of Bolisani and Scarso (2016) shows that Wiki is used for exchanging explicit knowledge, while telephone calls are used for exchanging tacit knowledge, which reflects that Wiki is playing a complementary role to other systems. ICT here, such as Wikis or the telephone, are treated as a tool that is separated from their human user for studying how they are used for knowledge sharing. Suh & Wagner (2017) claim that ICT itself as a an enterprise collaboration system (ECS) can provide gamification affordances, such as rewardability that can influence employee’s perceived hedonic value of ECS, which can increase knowledge contribution. These views show that ICT hold a crucial and dynamic role in knowledge exchange research, and thereby a comprehensive conceptualisation of ICT in the knowledge exchange field is necessary to study its role in IOKE for this research.

The concept of ICT artefacts has been developed for many years, especially since the call by Orlikowski and Iacono (2001)’s work which calls for a focus on the nature of ICT in understanding workplace organising. By reviewing the literature on knowledge exchange, it appears that most studies conceptualise ICT as a tool and focus on how technologies can be used as a concrete entity, separate from their user, to affect knowledge exchange activities. However, in light of the multiple approaches to ICTs that have been developed over time within other domains, it is important to adopt a more dynamic perspective for the KM field. Some prominent views are introduced in the ensuing subsections.

### **2.5.1 Discrete Entity view**

A discrete entity view focuses on the macro-level study of ICT on organisational practices. This view treats ICT artefacts broadly as a discrete entity that can influence knowledge management. ICT artefacts here are classified by type such as communication technologies or computing technologies, and by applications such as document management system (Sein & Harindranath, 2004). Studies that adopt this view focus on how ICT as an influential entity can independently affect knowledge management processes. For example, Orlikowski and Iacono (2001) indicate that from a discrete entity perspective, ICT artefact is seen as an independent tool which could be used to substitute labour, enhance productivity, process information, and alter social relations. Similarly, Uden and He (2017) argue that devices connected to the internet help to create the ‘internet of things’, which facilitates exchange and store of data. ICT in these studies can make contributions to KM independently and are separated from social contexts.

### **2.5.2 Mutually Dependent Ensemble view**

An mutually dependent ensemble view conceptualises ICT as “part of [a] complex process through which organising is accomplished” (Orlikowski & Scott, 2008, p. 446), and focuses on the dynamic interactions between people and technology. Such interconnections and their outcomes are mutually dependent and evolve over time. Studies adopting this view normally emphasise the interplay between aspects of ICT and organisational practices, e.g., how ICT serves as objects that enable knowledge sharing across boundaries (Carlile, 2002). Goldkuhl (2013), based on this ensemble view, conceptualises ICT as a communication tool. He argues that the ensemble view reflects a view of ICT artifacts embedded in the contexts without considering their pragmatic aspect. A communication tool view can broaden such ensemble view by not only acknowledging the interaction between artefacts and their social context, but also emphasising their pragmatic aspects in terms of social communication (Goldkuhl, 2008, 2013). He argues that an ICT artefact can “explicitly or implicitly carry interactor relationships” as a consequence of transforming messages among people (Goldkuhl, 2013, p. 63). Silver and Markus (2013) concur with this view, whilst arguing that IT artefacts have the same importance in both technical and social characteristics that together shape the anticipating consequences of the technology. They thereby reconceptualised ICTs as Socio-Technical artefacts (ST artefacts), which indicates that both social and technical characteristics need to be equally treated to mutually impact organisational practices.

### **2.5.3 Structure View**

A structure view conceptualise ICT as technology that embody social structures (Orlikowski & Iacono, 2001). In light of social structuration theory proposed by Giddens (1984), the structure view argues that social structures conceptualised as rules and resources are constructed into technology by artefact designers and appropriated finally by users as they interact with the technology (Tchounikine, 2017). DeSanctis and Poole (1994), based on this theory, propose an adaptive structuration theory (AST) in which the use of technology is also a modality of structuration. The structure that a technology provides can be classified in two ways: by its structural features and by its spirit. Structural features are specific types of capabilities provided by the technology, while spirit refers to the normative frame in relation to behaviours that are appropriate for the ICT, i.e. something that is interpreted by users as a value of the technology (e.g., how people interpret ICT’s features, how to interact as they use the ICT) (DeSanctis & Poole, 1994; Fulk & Steinfield, 1990). Markus et al. (2008) argue that DeSanctis & Poole’s work is a very insightful start point to explain ICT use and its effects for organisational practices, but also that ICT use requires more comprehensive understanding.

### **2.5.4 Materiality view**

The materiality view focuses on micro-level studies of technologies in organisational practices, which emphasises the materiality as something intrinsic to the technology (Küchler, 2008). Volkoff (2007) argues that there are material aspects introduced by technologies that impact organisational routines. These material aspects are claimed to be material properties of technologies that are inscribed into technological artefacts, and reflect the epistemological and ontological worldview of technology developers (Jarrahi, 2015). Therefore, a materiality view of ICT artefacts refers to ICT’s digital or physical materials that “are arranged into particular forms that endure across differences in time and place” (Leonardi et al., 2012, p. 29). In other words, the materiality view conceptualises ICT as technologies that have a fixed materiality and that their features will be available to all users in the same way. A materiality view of ICT shows that ICT with its materiality can facilitate knowledge works in the same way that endure over time and space for all users in collaborations. For example, Lee and Amjadi (2014) argue that objects such as email or project management system have material knowing (e.g. activating interpretations, stimulating collaborative practices, and sparking experimental activities), and these things can be used for all users to support their knowledge exchange works.

### **2.5.5 Sociomateriality view**

A sociomateriality view is proposed mainly to combat the problem that technology with only material properties cannot always bring predictable effects to organisational practices (Leonardi et al., 2012). Materiality takes on meaning and has effects as it becomes enmeshed in a variety of social phenomena. Therefore, all materiality should be considered as social, since materiality is created, interpreted and used in social processes (Leonardi et al., 2012). Sociomateriality indicates an enactment of a set of activities that meld materiality with social contexts (Ayoko & Ashkanasy, 2019). A sociomateriality view thereby conceptualises ICT artefacts as technologies whose materiality is shaped by social practices, and the focus is on how materiality is intrinsic to organisational activities or relations (Orlikowski & Scott, 2008). Technologies are constituted through the particular imbrication of social and material agencies in practice (i.e., sociomaterial practice) (Leonardi, 2011; Orlikowski, 2007). Social agency refers to the coordinated human intentionality, formed in partial response to perceptions of technologies’ material agency (Leonardi, 2013). Material agency is distinct from materiality in that materiality refers to the arrangement of physical or digital materials into particular forms, while material agency refers to the way in which technology’s materiality acts (Hassan, 2016). Materiality refers to the fixity of an artefact that will not change over contexts, while material agencies refer to the function of a technical artefact that will and often changes over different contexts depending on how people perceive the affordances and constraints of the artefact. The material agency and social agency are entangled and mutually constitute intra-action of ICT (Barad, 2007). Building on the view of sociomateriality, Orlikowski (2006) argues that knowledge also can be viewed as not only social but also material (material knowing).

### **2.5.6 Sociotechnical System View**

Technologies are always used in some specific context (Fuenfschilling & Truffer, 2016). This view conceptualises ICTs in terms of the technology itself and its social context. Information systems are involved in local contexts in which social actors and commitments can greatly shape the form of ICT artefacts (Kallinikos, 2002; Pozzebon & Diniz, 2012). Fuenfschilling and Truffer (2016) argue that technology evolves with a social system that emphasises an institutional change, and a socio-technical system can reflect such co-alignment of technology and institutions. ICTs are thereby conceptualised as sociotechnical systems that encompass both a technical subsystem and a social subsystem (Leonardi et al., 2012). A technical subsystem refers to the ICT artefact and the tasks conducted by engaging the artefacts (i.e., sociomaterial practices). A social subsystem refers to the unfolding social constructions in relation to institutions (Fuenfschilling & Truffer, 2016), i.e., how communication patterns, hierarchies or power relations change as people relate to each other. A sociotechnical system view raises the degree of a technical subsystem to a macro-level understanding. Studies adopting this view focus on how properties of social subsystem (e.g. norms, rules) can be strengthened through an imbrication of material agencies and social agencies in technical subsystem of ICT towards a ‘joint optimisation’ (Leonardi et al., 2012). Studies embracing this view consider ICT artefacts as embedded into both technical system and social system towards a joint optimisation.

### **2.5.7 Affordance View**

An affordance view considers ICT as having properties that afford goal-directed actors certain action possibilities to meet their goals (Volkoff & Strong, 2017). Affordances are perceived as action possibilities that ICT afford actors to achieve their goals (Fayard & Weeks, 2014). As a relational construct, ICT affordances only exist in the relation between actors and ICTs – how actors with a certain purpose may perceive an ICT in terms of how it can be used (Gibson et al., 2021). In light of Affordance Theory, defined as “the acts or behaviours that are afforded or permitted by an object, place, or event” (Michaels & Carello, 1981, p. 17), Markus & Silver (2008) extended those concepts in adaptive structuration theory to technical objects, functional affordance, and symbolic expressions. Technical object refers to real things that constitute the ICT artefact such as materials in both physical and digital (e.g., printers, representation on screen). Functional affordance refers to a relationship between technical objects and users, defined as “the possibilities for goal-oriented action afforded to specified user groups by technical objects” (Markus & Silver, 2008, p. 622). Functional affordance can be viewed as a relational concept that links ICT artefacts to how users may utilise them. Symbolic expressions refer to “the communicative possibilities of a technical object for a specified user group” (Markus & Silver, 2008, p. 623). This is also a relational concept that links ICT artefacts to how users may interpret them. Further, Stendal et al. (2016) approaches functional affordances as distinguishable from non-functional affordances that are independent of a specific functionality (e.g. social affordances).

There is a temporal-causal relationship that is rooted in the enactment of a technology affordance: affordances existence, perception, actualization, and effects (Pozzi et al., 2014). Affordance existence shows a cognitive process through which ICT users realise action possibilities when they interact with the ICT (Davern et al., 2012). Affordance perception indicates a process of recognition of the affordance existence (Greeno, 1994). For example, the symbolic expression of an object allows actors to recognise whether an affordance is exist or not (Markus & Silver, 2008). Affordance actualisation shows a process of how actors actualise affordance, “the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals” (Strong et al., 2014, p. 70). As actors appropriate ICTs for their IOKE practice, the distinct abilities afforded or constrained by ICT allows them to perform or fail to perform their intended interactions. Affordance effects shows achievement of multiple outcomes observed in the empirical domain. This demonstrates a view of critical realism that affordances emerge in the real domain and are “actualized over time by organizational actors and lead to various effects we observe in the empirical domain” (Volkoff & Strong, 2013, p. 819). An affordance view of ICTs for knowledge exchange practice accordingly demonstrates how ICT can provide actors with certain abilities to accomplish their knowledge work when they use ICT for knowledge exchange. On the contrary but similarly to technology affordance, as indicated by Majchrzak and Markus (2012), technology constraints indicate the ways in which actors are inhibited to accomplish their goals when they use certain ICTs. This demonstrates how ICTs can constrain certain abilities of actors to accomplish their knowledge work and hold them back in terms of engaging in knowledge exchange. Existing literature has demonstrated diverse ICT affordances/constraints that facilitate/inhibit organisations’ knowledgeable practices. For example, reviewability allows actors to review and manage the content of texts over time (Faraj et al., 2011); editability allows actors to modify existing or create new content to support knowledge sharing (Treem & Leonardi, 2013); association ability allows actors to connect people or other contents and thus develop networks (Sun et al., 2019); notified attention ability allows actors to receive signals such as notifications (Gibson et al., 2021; Oostervink et al., 2016); and pervasiveness ability allows actors to share and communicate with each other anywhere anytime (Rice et al., 2017). These diverse abilities afforded by ICT indicates that ICTs can have a significant impact on actors’ knowledge work as part of their IOKE practices.

## 2.6 ICT Impact on Inter-organisational Knowledge Exchange Practice

In the knowledge management field, the literature has emphasised the importance of ICT as a key success factor for enabling approaches to knowledge management (Kim & Trimi, 2007). ICT can support approaches to knowledge exchange through two perspectives which are compatible with the views on the notion of knowledge: an objectivist view of ICT-enabled knowledge exchange and a practice-based view of ICT-enabled knowledge exchange (Sefollahi, 2018).

### **2.6.1 Objectivist view of ICT-enabled Knowledge Exchange**

An objectivist perspective of knowledge conceptualises knowledge as an object separated from the human. Following this perspective, an objectivist view of ICT-enabled knowledge exchange treats knowledge as a discrete object that can exist separately from human, and much knowledge is explicit or can be made explicit (Sefollahi, 2018). Knowledge sharing under this perspective is based on a transmitter-receiver model where knowledge is shared from a separate sender to a separate receiver via a specific transfer mechanism (Hartmann & Dorée, 2015). In light of the objectivist view of knowledge, there are mainly two assumptions underpinning ICT-enabled KM studies (Hislop et al., 2018). First, knowledge can be codified, and thereby can be captured in ICTs. Second, the codified knowledge is understandable to others, and thereby can be transferred or shared among people via ICTs. Based on these assumptions, there are various approaches that can be enabled via ICTs in KM. These are discussed next.

**Repository-based Approach**

A repository-based approach argues that ICTs can support knowledge management by enabling a knowledge repository where knowledge can be codified and become searchable. A knowledge repository can enable KM by saving time and increasing efficiency of work. For example, Bolisani and Scarso (2016) argue that Wikis have flexibility for inserting content and can offer a good trade-off between efficiency and automation (e.g. searching tool, pre-classification of coded data). A knowledge repository also helps to increase work quality. For example, a knowledge repository can provide proven solutions from previous cases for employees in organisations so that their work quality can be improved (Hislop et al., 2018). Scholars are also providing algorithms to design knowledge repositories that focus on assessment of work quality (Velichety et al., 2019). In addition, Farida et al. (2015) argue that technology in institutional repositories can facilitate user queries and motivate users to self-archive their work into systems, which enhance the learning process. Zamani and Lzhar (2017) further claim that knowledge repositories can collect and store scholarly work worldwide in digital form for retrieval, which shows that a repository can provide worldwide access for knowledge exchange. These various views show that ICT can act as a knowledge repository that makes knowledge easily accessible to people and thereby contribute to knowledge management.

**Process and Domain Knowledge Approach**

A process and domain knowledge approach considers ICT as an enabler that facilitates knowledge management initiatives such as knowledge exchange for task execution. ICT can help to clarify tasks and processes during the task execution. For example, ICT such as a workflow management system helps to identify the order of tasks in a process and the deliverables for each step (Alavi & Leidner, 2001). Andersen (2019) further assesses the impacts of workflow management systems and claims that such systems can greatly support KM initiatives, e.g. activities are assigned and tracked, and the progress of task execution is available in the dashboard for everyone to review. Becerra-Fernandez and Sabherwal (2014) also argue that process-enabled ICT helps to guide users who are less qualified to follow and execute the process, which makes the process-based knowledge understandable and accessible to users.

ICT also helps to acquire and use domain knowledge during task execution. For example, through a knowledge-based system, people can access a knowledge domain about a specific task and then make decisions (Joram et al., 2017). A case-based system, as a type of knowledge-based system, can create a case domain where similar cases can be sourced and help with insights for a new case (Becerra-Fernandez & Sabherwal, 2014). Contrary to a knowledge repository that can also be used to search for knowledge albeit with a focus on making all knowledge available, a knowledge-based system focuses on domain knowledge in each step and supports decision making during task execution.

**Sensor-based Approach**

A sensor-based approach considers ICT as intelligent sensors that create knowledge from big data. ICT such as social media or websites can help to generate knowledge from data via data analytic techniques. Uden and He (2017) argue that devices or equipment in organisations that are connected to the internet help to store and exchange massive amount of data. This data can be explored by analysing their relations o patterns., in order to generated knowledge, i.e. IT-enabled combination of knowledge (Hislop et al., 2018). Hajighorbani et al. (2016) argue that knowledge hidden in data can be extracted by data mining which can deal with a great bulk of data evidencing complicated data relations. There are three data mining techniques known as: supervised learning, unsupervised learning and semi-supervised learning (Sloan & Quan-Haase, 2016). Supervised learning deals with labelled data and requires a dataset that is known as pre-determined class, and all data can be detected and learnt by allocating them into those pre-determined classes. Unsupervised learning deals with unlabelled data and does not require such a predetermined class, but formulates clusters extracted from the unlabelled data (Provost & Fawcett, 2013). Semi-supervised learning deals with data including both labelled and unlabelled (Hajighorbani et al., 2016). By understanding different data mining analytics, organisations can explore and create knowledge from big data via technological infrastructures such as data governance practices which ensure the quality of data (Lis & Otto, 2020), and through processes such as ‘knowledge discovery from data’ (KDD process) to harvest knowledge from data (Kasemsap, 2017). From these studies, it is clear that ICT can enable knowledge management by managing knowledge among data rather than directly from people.

### **2.6.2 Practice-based view of ICT-enabled Knowledge Exchange**

A practice-based view of ICT-enabled KM follows the notion of knowledge that is embedded in practices. The transmitter-receiver model is inappropriate for knowledge sharing as it only contributes to the sharing of the explicit dimension of knowledge (Bosua & Scheepers, 2007). In order to enable knowledge sharing, people need to construct meaning from active interactions where ICT may play a role. Under this view, the role of ICT is less direct, and the focus is to enable an interactive social relationship and facilitate communication processes where people can develop their understanding based on each other’s knowledge in practice (Sefollahi, 2018). Studies reporting on the practice-based view thereby assume that ICT can support the process of sense-making and sense-giving, which enables various approaches to knowledge management (Hwang et al., 2015; Walsham, 2001).

**Network-based Approach**

A network-based approach considers ICT as a map of expertise, which allows people to reach experts who possess specific knowledge domains. In this approach, ICT such as transactive memory system (TMS) can support people to establish and develop contacts with experts they are looking for (Choi et al., 2010). For example, TMS can provide information related to the distribution of expertise so that team members get to understand who possess what specialist knowledge and where to find them (Hood et al., 2016). Understanding the location of expertise can facilitate the establishment of communication so that knowledge sharing can take place via inter-personal interactions (Hislop et al., 2018). The role of ICTs here is therefore to enable locating the experts rather than codifying expertise into technology, so this network-based approach focuses on people but cannot guarantee people’s knowledge.

Over the years, ICTs for locating experts for knowledge exchange have been developed from traditional database technologies such as electronic yellow pages (Cheung et al., 2007) to more modern social media technologies such as enterprise social networks (e.g. Yammer, Facebook) (Rahman et al., 2020). Horne et al. (2019) argue that users on social media can self-create profiles that help to point knowledge seekers to knowledge experts. In this way, knowledge sharing can be stimulated via these various digital channels.

**Collaboration Tool Approach**

In a collaboration tool approach, ICT can facilitate knowledge exchange activities from two perspectives by creating conditions for interactions among people (Alavi et al., 2005). For example, technologies such as intranets, discussion boards, and forums. allow the creation of virtual spaces on which interactive discussions and communications can take place among people who are geographically dispersed (Hislop et al., 2018). Accordingly, rich knowledge exchange activities can be stimulated. In addition, ICTs can also help to create online communities of practice through which knowledge sharing and learning processes can be facilitated across geographic and hierarchical boundaries (Hwang et al., 2015; Salleh et al., 2020). For example, social media, defined as “a web-based service or platform based on web 2.0 technology that enables the sharing, co-creation, discussion and modification of user-generated content” (Werder et al., 2014, p. 3), can be considered as an interactive technology. Contrary to Web 1.0 where users can only access content from websites, Web 2.0 provide technologies that allow users to interactively communicate and co-create knowledge, so called ‘user-generated content’ (Kietzmann et al., 2011). Technologies based on Web 2.0 such as Wikis, or social media. provide people with more opportunities to interact regardless of geographic boundaries, which greatly helps the success of practice-based knowledge management.

**Crowd-based Approach**

Crowd-based approach to ICT-enabled knowledge exchange focuses on external knowledge sourcing outside of the organisation. This approach is mainly based on the concept of crowdsourcing, defined as “the use of IT to outsource any organisational function to a strategically defined population of human and non-human actors in the form of an open call” (Kietzmann, 2017, p. 3). The functions of outsourcing can be varied, from simple task to complicated R&D project (Ghezzi et al., 2018). This approach, in line with the idea of open innovation, assumes that organisations cannot rely only on their own internal knowledge but need more external knowledge via collaborations with other organisations (Brabham, 2013). In this approach, organisations can acquire new insights and engage in knowledge co-creation via inter-organisational collaboration, i.e. collaboration with other organisations across organisational boundaries (Islam et al., 2017).

Helms et al. (2012) identify five distinct approaches for involving crowds in innovation where ICT, such as social media, can find a place: general community engagement, ideas competitions, interactive value creation, participatory design, and product design. In general community engagement, users are involved in an online environment such as a forum where they can be engaged with by organisations to share their knowledge and insights. The ideas competition approach focuses on idea generation and evaluation processes where web-based applications such as Accenture GrapeVine can support people to show their ideas and evaluate them by digital crowd voting such as ‘liking’ (Bayus, 2013; OLeary, 2013). Participatory design is also an important ICT-enabled approach to crowdsourcing through which organisations develop a much closer collaboration with end users. Under this approach, users become involved in the design process and engage with organisations to provide their knowledge to the product directly (Wilkinson & De Angeli, 2014). ICT here can build online communities of users for acquiring their knowledge for crowdsourcing. For example, based on such a user-centred innovation approach, the idea of Living Lab-based projects need ICT such as Co-space to construct virtual teams so that networks with users can be established for future knowledge co-creation (Walt & Buitendag, 2009).

## 2.7 The Context of Living Labs

### **2.7.1 Definitions of Living Labs**

The concept of Living Lab has become a new arena to explore how to involve users in innovations and development (Chayabunjonglerd & Torkabadi, 2015). The term ‘Living Labs’ is a user-centred research concept and was originally introduced by Bill Mitchell at the Massachusetts Institute of Technology (Hawk et al., 2012). Scholars has conceptualised Living Labs from many perspectives such as an organisation, a platform, a system, or a methodology, as summarised in Table 2.4.

Table 2. 4 Perspectives and definitions of Living Labs

|  |  |  |
| --- | --- | --- |
|  | Living Labs perspectives | Definitions of Living Labs in Studies |
| *Milieu Perspective on Living Labs* | Public-Private-Partnership (PPP) Environment | “Living Labs are an emerging Public Private Partnership (PPP) concept in which firms, public authorities and citizens work together to create, prototype, validate and test new services, businesses, markets and technologies in real-life contexts, such as cities, city regions, rural areas and collaborative virtual networks between public and private players.” (Niitamo et al., 2006, p. 1) |
| Open-innovation Networks | A Living Lab is a network that integrates both user-centred research and open innovation (Leminen et al., 2012) |
| Open Innovation Ecosystem | “Living Labs are defined as user-centred, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings.” (ENoLL, 2019 official website) |
| Open innovation Environment | “A Living Lab is an open innovation environment in real-life settings in which user-driven innovation is the co-creation process for new services, products, and societal infrastructures. Living Labs encompass societal and technological dimensions simultaneously in a business-citizens-government-academia partnership” (Kareborn & Stahlbrost, 2009, p. 2) |
| Socio-technical Ecosystem | “A combined lab/household system that involves the creation of a real-life, user-driven, and open innovation environment” (Shin, 2019, p. 265) |
| Milieu | “A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values. (Bergvall-Kåreborn et al., 2010, p. 4) |
| *Approach Perspective on Living Labs* | Methodology | “A Living Lab is a design research methodology aimed at co-creating innovation through the involvement of aware users in a real-life setting” (Dell’Era & Landoni, 2014, p. 139) |
| Approach | “A human-centric research and development  approach whereby ICT innovations are cocreated,  tested, and evaluated in open, collaborative, multi-contextual real-world settings.” (Bui, 2009, p. 2) |

From these definitions, two important terms need to be clarified: open innovation and user-driven innovation. Open innovation refers to a distributed innovation process in which knowledge is managed across organisational boundaries, so both inbound and outbound knowledge flows are considered to engage creative ideas towards final innovation (H. Chesbrough & Bogers, 2014). Laminin (2013) argues that open innovation is used by firms to manage innovation and thereby could be a company-led or top-down approach. Schuurman, Marez and Ballon (2016) argue that Living Lab projects yield maximal value of open innovation by opening up the organisations’ boundaries and fostering inter-organisational collaborations. Similarly, Hossain et al. (2019) indicate that Living Labs is distinguished from open innovation by stressing public-private-people partnerships while open innovation includes more limited collaborations among different organisations.

User innovation refers to innovation that involves users (Bogers et al., 2010). Leminen (2013) argues that user involvement in innovation may be an approach that is community-led, or bottom-up, while Living Labs stress a user-driven innovation whereby users are involved as co-creators. User-driven innovation refers to “the process of tapping users’ knowledge in order to develop new products, services and concepts” (Wise & Høgenhaven, 2008, p. 7). This user-oriented view emphasises the role of user involvement in context and engages the understanding of true user requirements towards innovation. Kristensson et al. (2010) argue that a Living Lab is a context in which users are involved inside situations rather than outside. This reflects that a user plays a driving role in innovation instead of being an enabler, which distinguishes Living Labs from other innovation approaches with user involvement (Hossain et al., 2019). Such an emphasis ensures that user-driven innovation becomes an important approach in meeting a user’s needs in current dynamic business environments (Tacer et al., 2018). Living Labs have become a popular pragmatic approach to involve users and help companies to achieve innovation and product development (Guzmán et al., 2013). These terms reflect the key benefits and contributions of Living Labs for the whole society and therefore render them a rather new and significant research area to study.

### **2.7.2 The Characteristics of Living Labs**

Based on the definitions of Living Labs, their concept could be viewed from two schools of thought: a milieu; and an approach (Bergvall-Kåreborn et al., 2010). The *milieu* school describes a Living Lab as a user-centric context with unique characteristics that support collaborative activities, and thereby involves aspects of environments, networks, and ecosystems. Extant literature highlights that there are five crucial components embedded in the context of Living Labs. **Users** reflect the end users/potential end users involved in innovation processes (Hossain et al., 2019). **Real life Environment** represents the collaborative platform where users interact and provide reflections on the real world (Gascó, 2017; Veeckman et al., 2013). Følstad (2008) indicates that a Living Lab is a real-life environment in which various stakeholders co-create, validate and test existing products or services, and develop new outcomes. Leminen et al. (2017) argue that real life settings represent a landscape intertwined with stakeholders and Living Lab activities. **ICT & Infrastructure** represents information and communication technologies that facilitate a co-creation process (Hossain et al., 2019; Pallot et al., 2011). Bergvall-Kåreborn et al. (2010) argue that Living Labs provide the existing and new ICT to facilitate the co-operation and co-creation of innovation processes among stakeholders. **Organisation & Methods** represent proposed rules and methods for the innovation process in context (Bergvall-Kåreborn et al., 2010; Kröse et al., 2012), and **Partners** represent resources of external knowledge for co-creation (Bergvall-Kåreborn et al., 2010; Schuurman, Baccarne, et al., 2016). **Networks** refer to the structure of Living Lab networks (Leminen et al., 2012). Nyström et al. (2014) define Living Labs as networks because they involve multiple stakeholders in the innovation process. Shin (2019) defines Living Labs as an ecosystem as it combines people, organisations, technologies, activities and resources towards innovation. Leminen et al. (2015) argue that Living Lab networks include inter-organisational collaborations and single/dual Living Labs. Their later work describes three Living Lab network structures: a distributed multiplex network structure, distributed network structure, and centralised network structure. These structures construct the relationships among organisations constituting Living Labs (Leminen et al., 2016).

The Living Lab concept is also argued as an *approach* or an organisation-specific methodology through which inter-organisational co-creation activities take place (Malmberg et al., 2017). Living Lab approach stimulate co-creation by involving multiple stakeholder groups (Franz, 2015). People who adopt the approach attempt to cultivate a structured environment for innovation, and inviting and engaging with end users through co-creation activities (Dell’Era & Landoni, (2014). Such a structured environment is composed of a number of key features that several studies have in recent years attempted to map, which are summarised below in Table 2.5.

Table 2. 5 Key characteristics of Living Labs

|  |  |  |
| --- | --- | --- |
| **Key Characteristics** | **Brief implications** | **References** |
| *Real life settings* | User’s real living environment | (Dell’Era & Landoni, 2014; Hakkarainen & Hyysalo, 2013; Hossain et al., 2019; Malmberg et al., 2017) |
| *Stakeholder involvement* | Various stakeholders from different organisations get involved in the Living Labs | (Ballon et al., 2015; Leminen et al., 2012; Malmberg et al., 2017; Veeckman et al., 2013; Westerlund & Leminen, 2011) |
| *Living lab activities* | Innovation activities conducted by the Living Lab | (Almirall & Wareham, 2008, 2011; Hossain et al., 2019; Leminen & Westerlund, 2016) |
| *Methods, tools and approaches* | User-centric methodology towards innovation | (Bui, 2009; Dell’Era & Landoni, 2014; Franz, 2015; Kröse et al., 2012; Veeckman et al., 2013) |
| *Outcomes* | Diverse results of Living Lab innovations | (Ballon et al., 2015; Buhl et al., 2017; Hossain et al., 2019; Leminen et al., 2017; Mulder et al., 2008; Nyström et al., 2014; Rodrigues & Franco, 2018; Veeckman et al., 2013) |
| *Sustainability* | Sustainable development of Living Labs | (Bergvall-Kåreborn et al., 2010; Hossain et al., 2019; Nevens et al., 2013; Rodrigues & Franco, 2018) |

Among these characteristics, scholars argue that **Real-life settings** refers to a user’s real life environment in which Living Lab approaches are applied towards innovation (Hakkarainen & Hyysalo, 2013; Hossain et al., 2019). Malmberg et al. (2017) argue that Living Labs are used to co-create outcomes in real-life contexts. Similarly, Dell’Era and Landoni (2014) define Living Labs as a methodology to identify and experiment with a user’s needs in various real-life environments.

**Stakeholder involvement** refers to the presence of different stakeholders and partnerships of public, private and people (Malmberg et al., 2017; Veeckman et al., 2013). Ballon et al. (2015) indicate that there are various stakeholders in Living Labs including academics, developers, industry representatives, citizens and users, and public sector and private organisations. Westerlund and Leminen (2011) argue that four types of stakeholders are involved in co-creating knowledge: enablers such as public actors, governmental organisations that support Living Labs activities; providers such as universities or consultants that bring knowledge to develop Living Labs activities; users such as citizens or end users; and utilisers such as private organisations that benefit from the results of Living Lab activities (Leminen et al., 2012).

**Living Lab Activities** describe the innovation activities conducted by the Living Lab approach (Hossain et al., 2019). This means a Living Lab is used to conduct inter-organisational collaborations towards innovation solutions. For example, Leminen and Westerlund (2016) argue that Living Labs are used for developing, co-creating, validating and testing technologies. Policy makers use the Living Labs approach to design, explore and refine new policies (Hossain et al., 2019). Almirall and Wareham (2008) indicate three Living Lab activities: 1) Living Labs engage organisations to achieve outcomes based on user experiences; 2) Living Labs support lead users as entrepreneurs; and 3) Living Labs manage users towards innovation. Almirall and Wareham (2011) argue that Living Labs activities are a knowledge-based process: the exploitation phase includes targeting, selecting, refining knowledge and the exploration phase includes capturing, creating and exchanging knowledge.

**Methods, tools and approaches** refers to the use of Living Lab as an approach to involve users towards innovation. Bui (2009) argued that Living Labs are a human-centric approach by which ICT innovation is created and tested. These perspectives emphasise the functional aspects of Living Labs. Other scholars also stress the Living Lab as a tool to engage ICT innovations such as artificial intelligence (Kröse et al., 2012; Veeckman et al., 2013).

**Outcomes** describe the diverse results of Living Lab innovations from the perspectives of tangible/intangible innovation and a diversity of innovation (Hossain et al., 2019). It is argued that tangible innovation includes design (Buhl et al., 2017), prototypes (Leminen et al., 2017), products (Veeckman et al., 2013), solutions and systems (Ballon et al., 2015). Intangible innovation includes ideas, concepts (Nyström et al., 2014), knowledge and services (Mulder et al., 2008). Diversity innovation covers market innovation, social innovation, radical innovation, and technical innovation (Almirall & Wareham, 2011; Rodrigues & Franco, 2018).

**Sustainability** indicates sustainable development in Living Labs (Hossain et al., 2019). For example, Transition labs provide an arena for sustainable development in urban contexts such as sustainable cities (Nevens et al., 2013). Rodrigues and Franco (2018) argue that Living Labs act as a vehicle for economic and social development and continuity. Bergvall-Kåreborn et al. (2010) argue that Living Labs focus on creating sustainable value by inter-organisational collaborations.

### **2.7.3 Defining Living Labs as the Context**

Both school of thoughts (Milium and Approach) in understanding the notion of Living Lab are perceived valuable in this research. However, to fully capture the context of Living Labs, an integral understanding of both school of thoughts is needed. Therefore, based on the previous analysis of Living Labs and their characteristics, this study builds on Bergvall-Kåreborn et al. (2010)’s definition and defines Living Labs as below:

*A Living Lab is an approach that facilitates user influence in open and distributed innovation processes by providing a user-centric innovation milieu built on a real-life context, engaging all relevant organisations to collaborate across organisational boundaries, where they can exchange knowledge for creating sustainable values.*

This definition considers Living Labs as an approach that integrates specific characteristics from both schools of thought. The milieu aspect is proposed in the definition because in this research Living Labs are used as a context to study IOKE practices. Since Living Labs involve different organisations in co-creating values, this definition stresses the collaboration across organisational boundaries, which fits the needs on interpreting the role of multiple stakeholders from organisations in an inter-organisational collaboration process. In addition, in order to collaboratively create sustainable values, organisations need to engage in knowledge exchange, which emphasises the role of Living Labs activities in this research. Finally, this definition focuses on the ICT-based values in the Living Labs innovation, since ICT is an important characteristic as a factor and as an outcome of Living Labs. The above highlights in the Living Labs definition help delineate the research field within which the role of ICT towards shaping IOKE is to be explored.

### **2.7.4 Living Labs in Europe**

In Europe, the development of Living Labs has experienced a significant evolution from scattered initiatives in the EU to a European-wide movement. Based on interviews with Living Lab experts, Leminen & Westerlund (2019) map a brief history of European Living Labs. Originally, Living Labs were mainly developed in the U.S with the first ‘Living Lab’ introduced by Bill Mitchell in MIT. The earliest European Living Lab was first established in the Nokia Corporation in Finland, in 2001, and was named NokiaSpacelab real-life research environment. Until 2004, more Living Labs were established in European countries such as Finland and Sweden, and more Living Lab-based projects and ideas were initiated to understand creative works with various technologies in real-life settings. After 2004, the emergence of open innovation practices extended the concept and work of Living Labs towards an open collaborative innovation environment teamed up by various types of collaborators such as universities, governmental agencies, and end users (Chesbrough & Appleyard, 2007). Various research conducted in the field of open innovation and Living Labs in Europe show a need of Living Lab’s environment from ‘semi-closed’ environment (i.e. internal innovation ran by company with external testing tasked to users) towards innovation by ‘the crowd’ (Leminen et al., 2012; Leminen & Westerlund, 2019), e.g. user-driven innovation in Living Labs (Guzmán et al., 2013).

After realising the opportunities to develop innovation with Living Labs in 2005, the European Union (EU) and European Commission (EC) played an important role in the further development of Living Labs. The fourth EU framework outlined by the EC enabled larger Living Lab funding in 2005. As a result of a larger Living Lab portfolio (over 60 million Euros), a Living Labs Portfolio Leadership Group (LLPLG) was shaped, considered as “the primary form and structure of European Network of Living Labs (ENoLL)” (Leminen & Westerlund, 2019, p. 257). In the eighth EU framework (Horizon 2020) outlined by the EC (2015), the EU provided considerable funding (over 68 billion Euros) to promote research and innovation in Europe during 2014-2020 aiming to help achieve smart, sustainable and inclusive growth within the continent (Europe 2020 Strategy). Currently, many Living Lab projects have acquired funding from Horizon 2020, and some can be identified in both the EU transparency register system (ec.europa.eu) and the website of the Living Labs certified by ENoLL (www.enoll.org).

An important step of the Living Labs movement is the establishment of ENoLL in 2006, which now has been developed to “a formalised network and international federation of benchmarked Living Labs in Europe and worldwide” (Ruijsink & Smith, 2016, p. 4). In a Conference committed to the Helsinki Manifesto organised in 2006, the ‘Lisbon Strategy’ was noted to have limited impact on economic growth of Europe (The Helsinki Manifesto, 2006). The Conference argued for the advancement of European Living Labs as a way to enhance European innovation and stressed an urgent need for a network of European Living Labs. One month later, the Presidency of European Union launched a pan-European network of 19 Living Labs, which indicated the formal establishment of a European Network of Living Labs (ENoLL) (Dutilleul et al., 2010). Since then, an increasing number of Living Labs has joined the membership during an enrolment wave of ENoLL (i.e. calling Living Lab applicants), and today there are over 400 Living Labs enrolled in the ENoLL (Leminen & Westerlund, 2019; Santonen et al., 2017). The majority of these Living Lab initiatives are located in Europe but there are also initiatives worldwide across five continents (Zavratnik et al., 2019).

Strict criteria was compiled by ENoLL to select Living Lab members during each enrolment wave every year (ENoLL, 2016). Following an expert assessment by ENoLL with a peer-review process, all successful applicants need to meet five criteria: Organisation, Openness, Resources, Users/Reality, and Value. Table 2.6 shows the specific criteria list. All accepted Living Labs can acquire the ENoLL quality label and be shown on the official website of ENoLL ([www.enoll.org](http://www.enoll.org)) where the public can access their official Living Lab website and projects.

Table 2. 6 ENoLL Living Labs Selection Criteria (ENoLL, 2016)

|  |
| --- |
| * Evidence of co-created value from research, development and innovation |
| * Values/services offered/provided to LL actors |
| * Measures to involve users |
| * Reality usage contexts, where the LL runs its operations |
| * User-centricity within the entire service process |
| * Full product lifecycle support – capability and maturity |
| * LL covers several entities within value – chains |
| * Quality of user-driven innovation methods and tools |
| * Availability of required technology and/or testbeds |
| * Evidence of expertise gained for the LL operations |
| * Commitment to open processes |
| * IPR principles supporting capability and openness |
| * Openness towards new partners and investors |
| * Business-citizens-government partnership: strength and maturity |
| * Organisation of LL governance, management and operations |
| * Business model for LL sustainability |
| * Interest and capacity to be active in EU innovation systems |
| * International networking experience |
| * Channels (e.g. web) supporting public visibility and interaction |
| * People/positions dedicated to LL management and operations |

### **2.7.5 The Use of ICT in Living Labs**

As analysed in the previous section, Living Labs provide a focal environment in which various stakeholders and organisations collaborate and exchange their knowledge towards innovation. ICT plays an important role in the context of Living Labs as an outcome. Leminen and Westerlund (2016) argue that Living Labs are suitable to develop, co-create, validate and test ICT technologies. Hossain et al. (2019) argue that Living Labs provide an environment in which technologies are validated and thereby the development of Living Lab outcomes are improved. Følstad (2008) argues that new ICT solutions such as technologies or information systems are tried out in Living Labs by which ICT providers can involve and collect data from users to stimulate ICT innovation.

ICT as a tool is used widely in the context of Living Labs. Veeckman et al. (2013) argue that ICT infrastructure is one of the building blocks of a Living Lab environment for assessing or co-creating innovations, for example, for monitoring technical performance during usage and non-usage of ICT based innovation. Veeckman et al. (2013) provide a Living Lab environment framework in which, from a technical infrastructure perspective, Living Labs could be classified as: having no technical infrastructure; or having infrastructure without/with basic/with in depth monitoring and technical testing. Eriksson et al. (2006, p. 5) argue that the emerging Living Lab concept is to “enhance innovation, usability and usefulness of ICT and its application in the society”. Edwards‐Schachter et al. (2012) argue that ICT can foster the co-creation process by facilitating communication channels. For example, in their case study, a Living Lab Cvida project uses online questionnaires to collect data and ICT platforms such as free-accessible websites to identify people’s needs.

Existing research into Living Labs indicates that ICT significantly supports their inter-organisational collaborations. Diverse technologies, ranging from Geographical Information Systems to wireless services, are shared and customised following an open source approach to foster inter-organisational collaborations towards innovation (Ballon et al., 2018; Schaffers & Kulkki, 2007). Schaffers & Kulkki (2007) argued that a Living Lab provides an experimentation and validation environment in which stakeholders work together to create ICT-based innovation. In addition, Leon et al. (2006) used the Living Lab approach to create a distributed mobile networking environment in which mobile intelligence allowed end users to be actively involved in a complex wireless environment.

The current literature emphasises the significance of ICT as an outcome or facilitator of co-creation processes in Living Labs. However, few studies place attention on how ICT shapes IOKE practice in this context. As Schuurman et al. (2016) note, Living Labs are an open innovation system that can greatly enable ICT to foster innovation by knowledge exchange among diverse stakeholders and organisations. Therefore, this research source projects from ENoLL as a context to study the role of ICT in the shaping of IOKE practices.

The ENoLL covers project topics that range from smart cities, health care, electronic games, to education. Furthermore, ENoLL is a platform for knowledge sharing in inter-organisational collaborations across Europe, and fosters multiple methodologies and technologies to stimulate a co-creative innovation process (Pieter, 2015).

## 2.8 Literature Review Summary and Implications for Research

This literature review chapter has reviewed and discussed existing research in relation to the present research topic, mainly in four areas: knowledge management, ICT, inter-organisational setting, and the context of Living Labs. By reviewing the literature, the present study is able to highlight and clarify the research gap in existing knowledge in relation to the co-shaping dynamics between inter-organisational knowledge exchange practice and ICT in the context of European Living Labs. In this thesis, the review of the literature has not been conducted in order to identify an appropriate theoretical lens nor develop a distinct conceptual position to follow; rather, reviewing the literature was an important step to inform the design of data collection (e.g., interview questions design) and set out the context for the ensuing analysis and discussion in relation to the research topic. In other words, in terms of the literature review, this study maintains an open mind in terms of the relevance of established theories, whereby their review supports the development of theoretical sensitivity for future analysis and as data emerge but does not pre-determine it. Although the distinct theories are not pre-determined at literature review stage, the present study would like to claim the theoretical stances that have been finally employed in this research based on later data analysis. Specifically, Practice Theory, Sociomateriality Theory, and Affordance Theory are identified appropriate and employed to understand the research phenomena at different levels of analysis (i.e., the how and why these theories are used to support the data analysis are discussed in more detail in the Discussion Chapter).

By reviewing and synthesising the literature, the present study identified a major theoretical gap. On the one hand, existing literature has indicated the dynamic nature of inter-organisational knowledge exchange practice (Bouncken & Aslam, 2019; Davenport, 2018; Ward et al., 2012) where the significance of ICT is emphasised (Bautista et al., 2018; Priyono, 2016; Sefollahi, 2018). On the other hand, current perspective on the nature of ICT are rather fragmented (Orlikowski & Iacono, 2001; Zhu et al., 2021), and these include among others the discrete entity view, ensemble, structure, materiality, sociomateriality, sociotechnical, and affordance views, many of which have reflected the dynamic nature of ICT for IOKE practice (e.g. affordance view, sociomateriality view, or ensemble view). However, there is less evidence to show how the dynamic nature of ICT interacts with the dynamic IOKE practice which together shape the ICT-based IOKE practice dynamics. The theoretical challenge was accordingly how to understand the co-shaping dynamics of dynamic inter-organisational knowledge exchange practice when taking into account the dynamic nature of ICT. A more comprehensive understanding on how ICT shapes and is shaped by inter-organisational knowledge exchange practice is thus required, which informs and motivates the present study.

The following research questions are enquired: 1) What are the characteristics of ICT-based inter-organisational knowledge exchange practice in inter-organisational collaboration? 2) How does ICT facilitate or inhibit inter-organisational knowledge exchange practice in inter-organisational collaboration? And 3) How to integrate ICT into an ICT-based inter-organisational knowledge exchange framework for inter-organisational collaboration? This research investigates the European Living Labs as the context of this research because there are intensive inter-organisational collaboration takes place in European Living Lab projects. The next chapter will discuss in detail how this research is designed and relevant methodology that this research adopts to answer the above research questions.

# CHAPTER 3 METHODOLOGY

## 3.1 Introduction

This chapter introduces the methodology that guided the development of this study. Based on the research aim of understanding the role of ICT in the IOKE practice, a qualitative research approach was applied combined with Grounded Theory, case studies and archival research as the research strategy. The rationale for such a choice is elaborated on through the discussion presented in the following sections: Section 3.2 discusses the underlying philosophical commitments by taking into consideration ontological and epistemological assumptions, deductive and inductive approaches, and qualitative and quantitative research approaches; Section 3.3 reviews different qualitative research strategies and elaborates on the choice of methods employed in this research. Section 3.4 illustrates how this research was designed, the sampling strategy and decisions in relation to data collection and data analysis. Section 3.5 discusses the ethical considerations for this study.

## 3.2 Research Philosophy

### **3.2.1 Philosophical Assumptions**

Research philosophy refers to “a system of beliefs and assumptions about the development of knowledge” (Saunders et al., 2015, p. 124). In other words, it helps to understand how knowledge is developed to answer a specific research question in a particular field when embarking upon research. There are two major types of philosophical research assumptions to distinguish research philosophy: epistemological assumptions and ontological assumptions.

Ontology concerns the nature of reality encountered in the research (Burrell & Morgan, 2011). Ontological assumptions provide a view on what social realities exist and are amenable to study as research objects (Creswell, 2015). Ontology is classified into two categories: objectivism and subjectivism (Saunders et al., 2015). The objectivist position implies that only one true social reality is confronted by all social actors. In other words, objectivism argues that social phenomenon and social actors exist independently and thereby need to be studied separately. On the other hand, subjectivism considers that the social reality is constituted by the perceptions and subsequent actions of social actors (Saunders et al., 2015). Subjectivism embraces nominalism and social constructionism assumptions. Nominalism considers that researchers and other social actors together construct the social phenomenon under study. Social constructionism considers that social reality is constructed by social interactions. Social actors provide partial meanings which are continuously revised in order to create and shape the social world (Li, 2018).

This research aligns with the ontological assumption that IOKE practice could acquire benefits or be held back under the influence of ICT. In terms of its ontological position, this research is aligned with constructionism and subjectivism, as it aims to explore the perceptions of multiple stakeholders engaged in Living Labs concerning what role ICT are playing in the shaping of IOKE practice.

Epistemology considers human knowledge related assumptions, including what constitutes acceptable, valid and necessary knowledge and how that knowledge could be elaborated to others (Bryman, 2012). There are two main epistemological positions: positivism and interpretivism. Positivism considers knowledge as an objective reality and advocates the application of natural science methods into social reality studies (Saunders et al., 2015). Only observable and measurable facts can provide credible and acceptable knowledge. In contrast to positivism, interpretivism emphasises the role of human beings and the explanation of human behaviours in the construction of social knowledge (Bryman, 2012). Interpretivism focuses on understanding the interactions between social knowledge and social actors (Li, 2018). Therefore, the exploration of social actors’ viewpoints to understand social phenomena can lead to acceptable knowledge in the interpretivism position.

In this research, there was a need to obtain insights from Living Lab stakeholders on how they apply ICT in their knowledge exchange practices. Different Living Lab stakeholders might have different perspectives on the use of ICT and thereby hold different perceptions on the influence of ICT to their Living Lab knowledge exchange process. This implied a need to explore these stakeholders’ interpretation on their use of ICTs and their viewpoints to the influence of ICT on their knowledge exchange works. Therefore, an interpretivist epistemology was applied in this research.

### **3.2.2 Deductive and Inductive Research Approaches**

Following on from the identification of a constructivist ontology and interpretivist epistemology, the next logical step is the identification of the research approach for the development of the research design. There are two main different research approaches that represent the nature of the relationship between theory and research: deductive approach and inductive approach.

The deductive approach is concerned with deducing hypothesises based on existing knowledge in a particular domain and relevant theoretical considerations (Bryman, 2012). In other words, the deductive approach explores a known theory or phenomenon and proceeds towards its validation through testing deduced hypothesises in a specific context. The process of deductive research consists of six phases: exploring theory, deducing hypothesis, collecting data, generating findings, confirming or rejecting hypotheses, and revising the theory (Bryman, 2012). This can be viewed as a top-down method, as this approach starts from an established theory, and then narrows down to specific hypotheses, in order to finally confirm or reject the original theory via testing the hypotheses (Trochim, 2002).

Contrary to the deductive approach, the inductive approach focuses on generating theory based on the research data and findings (Bryman, 2012). Theory in this approach is an outcome of research, and it is established through the analysis of data. Compared to the deductive approach, the inductive approach usually starts from observations in a particular domain, then these observations are analysed to formulate tentative hypotheses, and finally a theory is generated based on these hypotheses (Saunders et al., 2015).

Examining the research domain of Living Labs, and after reviewing the existing literature, it seemed that an appropriate theory for understanding the role of ICT in IOKE practice occurring in Living Lab settings did not exist. Therefore, this study aims to develop a theory based on data collected from Living Lab settings. Based on data inductively generated from interacting with Living Labs stakeholders, the study analysed how Living Lab stakeholders perceive and apply ICT to their IOKE practice and what factors may influence this process in order to formulate ICT-based IOKE practice as findings. Finally, based on an iterative processes of constant comparison, a theory was developed (Bryman, 2012). This iterative process is characteristic of the inductive research process and reflects in particular the Grounded Theory methodological approach, which is discussed in section 3.3.

### **3.2.3 Quantitative and Qualitative Research Approaches**

In empirical terms, research can be generally distinguished between quantitative and qualitative research methods (Bryman, 2012). Quantitative research emphasises the quantification in data collection (e.g., through the use of questionnaire surveys) and data analysis techniques (e.g. statistical tests), which implies a deductive approach in order to test relevant hypotheses and theory (Saunders et al., 2015). Qualitative research emphasises qualitative meaning in data collection and analysis rather than quantifications, as in quantitative research. Qualitative research is usually associated with the interpretivism research philosophy, because it focuses on how the researcher develops socially constructed meanings concerning a phenomenon and making sense of subjective experiences, which entails an inductive approach in order to generate theory focused on producing understanding of a social situation (Saunders et al., 2015). This study followed an interpretivist research philosophy and an inductive research approach. It focuses on data related to the perceptions of Living Lab stakeholders, normally expressed qualitatively through reflection and discourse rather than numerically. Therefore, this research followed a qualitative research approach to conduct an inductive study based on a constructivist and interpretivist research philosophy.

## 3.3. Research Strategies

### **3.3.1 Overview of Qualitative Research Strategies**

There are different qualitative research strategies for researchers to consider, which in broader terms may involve archival and documentary research, ethnography, action research, narrative inquiry, case study and Grounded Theory (Saunders et al., 2015).

**Ethnography** is most relevant when studying the manifestations of culture and society in a group setting (Beach et al., 2018). Unlike other research strategies, the researcher in ethnography strategy is not an uninvolved observer. This strategy allows the researcher to collect data and acquire insights from participation directly in the research setting with the research subjects or informants (Atkinson et al., 2001). Therefore, the ethnographic method operates through interacting with research participants through direct communication, conversations and/or interviews. This allows the researcher to study a cultural and social phenomenon in action from shared emotions and perceptions or mutual experiences with informants (Beach et al., 2018).

In this study, in order to understand the role of ICT in IOKE process, an ethnographic research design was possible and potentially interesting. However, the researcher was temporally limited and unable to directly engaged as an active participant in the operation and development of Living Labs and therefore this methodology was not considered feasible.

**Action research** strategy is an emergent and iterative process by which inquiry is designed to provide solutions for real organisational problems (Saunders et al., 2015). The purpose of action research strategy is to promote organisational learning to achieve practical outcomes and solve practical issues through the action research process (Coghlan, 2019). There are five main phases in typical action research projects: purpose, process, participation, knowledge and implications, and this is an emergent and iterative cycle in which the research question and focus may change according to the development of research. Action research is normally suited to medium - or long term - research projects, as the researcher needs to undertake the research in their own organisations and needs enough time to decide if action research cycles are sufficient (Saunders et al., 2015).

In this thesis, action research strategy was not suitable because the researcher aimed to undertake investigation into the context of Living Labs but was unable to gain access to any Living Labs projects and was not interested in imprinting change to ongoing Living Lab projects. In addition, the duration that this research strategy requires does not fit comfortably within a three-year PhD research project, therefore, action research strategy was not considered appropriate.

**Narrative inquiry** is a qualitative research strategy that focuses on the potential of storytelling. Research participants need to be facilitated by the researcher to provide a complete narrative of their experiences through in-depth interviews (Denzin & Lincoln, 2011). This strategy needs to follow a chronological storytelling perspective to reflect the sequence of events, which helps to understand the phenomenon or research field better for later in-depth analysis. Normally, a narrative inquiry strategy is applied when a small number of participants is selected. The selected participants should therefore be representative of a larger population with whom there are cultural affinities, or be considered as critical cases, as the focus is on “understand[ing] the complex processes which people use in making sense of their organisational realities” (Cassell & Symon, 2004, p. 42). In this research, although this strategy may help provide an in-depth understand of the role of stakeholders in Living Lab inter-organisational knowledge exchange, narrative inquiry, however, was considered as less ideal for answering the research questions. This is mostly because the small number of participants typically involved in narrative inquiry may not provide sufficient evidence to understand how different stakeholders from various organisations perceive and use ICT for knowledge exchange. In addition, the sequence of events for storytelling in narrative inquiry was not seen as necessary and significant for the research aim. Therefore, narrative inquiry strategy was not applied in this study.

**Archival and documentary research** strategy describes the use of recorded and archival data to increase the range of data sources (Mcculloch, 2004) available to the researcher. The increasing availability of digital archives expands the possibility of accessing more varied data sources, including: communications such as email, letters, social media and blog postings; individual records such as diaries, electronic calendars and notes, organisational sources such as administrative records, agendas, policy statements etc.; government sources such as publications and national statistics; and media sources such as online articles (Saunders et al., 2015). These different types of sources allow the researcher to locate archives and collect data more cost-effectively (Lentz, 2012).

Archival and documentary research strategy could have been useful for this research. This is because there are many archival and documentary data that may provide insights for understanding how Living Lab stakeholders use ICT to promote their knowledge exchange. For example, many official websites of Living Labs publish articles to reflect their work in real terms. The European Network of Living Labs (ENoLL) also publishes reports that provide information about their partners and their working methodologies. Some internal archives or documents such as organisational reports and project logs are very helpful to explore the Living Labs’ real knowledge exchange process and personal perceptions related to this research topic. Some of these internal sources are also accessible after getting contact with Living Labs during the research. All of these could provide useful sources as a secondary data to provide complementary data for analysis in this research, and therefore this strategy was applied.

The **Case study** strategy is considered to be an in-depth inquiry into a specific phenomenon (Yin, 2003). The ‘case’ may refer to a person, an organisation, a joint venture, a change process or an event. The case study thereby entails determining a specific case, producing a deep study and analysis of the selected case and getting insights about the case in a specific context (Saunders et al., 2015). Therefore, choosing an appropriate case and determining an appropriate scope of research field become key factors of the case study research strategy (Denzin & Lincoln, 2011). Case study research aims to understand the dynamics of the research field in a specific context (Eisenhardt & Graebner, 2007). Therefore, this strategy is often applied when the boundaries between the phenomenon the research aims to explore and the specific context that is being studied are not very apparent. Understanding the context can help gain insights from intensive research into the phenomenon being studied and the development of theory, and thereby is crucial for case study strategy (Eisenhardt & Graebner, 2007). In other words, applying the case study strategy can help the researcher focus on a specific context, and employing detailed analysis to such a context can help the researcher to illuminate theoretical issues and finally reach to the development of theory (Cassell & Symon, 2004).

In this research, there are over 200 different Living Labs in ENoLL, but their projects cannot all be explored because of time constraints. Therefore, case study strategy was helpful to collect data from several single projects of Living Labs in order gain a more detailed understanding of how different stakeholders perceive and apply ICT for exchanging knowledge across organisational boundaries. Hence, case study strategy can help this research to determine an appropriate context, and thereby was considered as an appropriate research strategy to follow.

**Grounded theory** can be viewed as a methodological approach, a method or the outcome of a research process in qualitative research. From a methodological perspective, Grounded Theory refers to a research strategy used to conduct the research process (Parry, 1998). From a method perspective, Grounded Theory refers to a technique that is used for data collection and a procedure that is followed in data analysis (Glaser & Strauss, 1967). From an outcome perspective, Grounded Theory refers to a theory that is developed inductively from data (Saunders et al., 2015). Grounded Theory was originally developed by Glaser and Strauss (1967), with the aim of generating a theory by focusing on how social actors interact with the phenomenon under study. Social actors construct their reality through the meanings they develop in order to make sense of their experiences. Grounded Theory thereby is developed to explain these meanings abstracted from social interactions and processes from a wide range of contexts (Charmaz, 2014). Overall, Grounded Theory strategy enables qualitative research to generate new theory from the data grounded in the accounts of social actors (Glaser & Strauss, 1967).

As opposed to other qualitative research strategies, Grounded Theory should avoid keeping a stabilised theory as the starting reference point (Li, 2018). This is because theory derived from emergent data is more likely to depict reality than theory “derived by putting together a series of concepts based on experience” (Strauss & Corbin, 1998, p. 12). Hence, Grounded Theory strategy can help the researcher to collect and analyse emergent data and discover new theory without considering preconceived theoretical foundations or hypothesis (Li, 2018).

In this thesis, based on the literature review, it appears that there are few theories or foundations in the existing literature that can provide a comprehensive understanding of the role of ICT in the shaping of IOKE in the context of Living Labs. Therefore, Grounded Theory was considered to be an appropriate strategy to conduct data collection and data analysis in this research.

### **3.3.2 Combination of Grounded Theory, Case Study, and Archival and Documentary Research**

As discussed earlier, archival and documentary research strategy, case study and Grounded Theory seems to be suitable in this research. This section introduces these three strategies in more detail. A combination of these three strategies with specific selection is considered to be more suitable for this research, which is also explained in this section.

#### 3.3.2.1 Archival and Documentary Research

There are many different forms of documentary sources that can be used in qualitative research: personal documents, official documents, mass-media outputs and virtual outputs (Bryman, 2012).

Personal documents refer to personal diaries, letters, and autobiographies. Personal diaries and autobiographies reflect the author’s historical events and can be employed when they are specifically elicited from the authors. Letters are a form of communication between people, but the use of letters has declined predominantly due to the emergence of telecommunication technologies such as email (Scott, 2014). Official documents refer to official documents deriving from the state such as public inquiries, and official documents derived from private sources such as company reports. These types of documents could help to find information about organisational events and behaviours recorded by organisational members (Scott, 2014). Mass-media outputs refer to sources such as newspapers, magazines, and television programmes. Content analysis is usually conducted for analysing data abstracted from these sources. As the mass media outputs are often deemed to be genuine, the authenticity and credibility is often unclear and problematic (Bryman, 2012). Virtual outputs refer to sources from the internet. Digital platforms such as the internet greatly expand the range of accessible data to the researcher and allow both qualitative and quantitative data analysis to be conducted. Documents such as email, websites, blogs, digital messages, etc. allow the researcher to acquire a wide range of data related to the research topic. However, for authenticity, outputs may not be published by the real author e.g., anyone can set up a website. For credibility, the content of outputs may be distorted due to different organisational purposes (Scott, 2014).

In this research, the main types of existing documents were digital format documents originating in Living Labs (e.g., Living Lab project descriptions, diaries, and project logs.). In addition, the researcher gained access to some internal and official project documents. This data was useful for conducting analysis (such as providing initial ideas for interview questions) and developing theory (such as reflection on how Living Lab project apply information communication technologies in workplace from Living Lab website or articles).

#### 3.3.2.2 Case Study

Case study strategy is normally used when the boundaries between studied phenomenon and its context is not particularly clear. Applying an in-depth case study can greatly help to understand interactions between a phenomenon and its context (Dubois & Gadde, 2002). There are different ways to apply case study strategy based on different research purpose. This means that the case study can be used deductively or inductively for exploratory, explanatory or evaluative research purposes (Thomas, 2015). Exploratory case study aims to explore a distinct phenomenon that lacks detailed investigations or studies in order to establish or develop theory inductively (Yin, 2014). Explanatory case study refers to the development of insights on ‘why’ and ‘how’ to explain a phenomenon, normally through a deductive approach. Evaluative case study aims to evaluate “how well something is working or has worked” (Thomas, 2015, p. 99). When a change appears to a phenomenon, this type of case study could be considered to find out what the change has led to, based on previous hypotheses or expectations.

A case study can be separated into intrinsic case study or instrumental case study (Stake, 2005). Intrinsic case study focuses on the subject being studied purely because of the interest to the case (Thomas, 2015), i.e., the researcher conducts an intrinsic case study to investigate a particular case because understanding the case itself is of primary interest. On the contrary, an instrumental case study is conducted not because the study of the selected case is the purpose; rather, the case study is used as an instrument or tool to serve another particular purpose (Thomas, 2015), i.e., the researcher conducts an instrumental case study aiming to understand another phenomenon via the support of the case, and the case itself is of secondary interest.

The use of case study can be applied for a single case or multiple case studies. A single case study is often considered when a case is critical or unique, or when there is a case that allows the researcher to observe and analyse a phenomenon which has not been studied in-depth before (Yin, 2014). Single case study can be adopted in intrinsic case studies that focus on the case itself, or instrumental case studies that investigate a phenomenon with the support of the case (Thomas, 2015). Multiple case studies are normally considered in instrumental case studies (Stake, 2005). The use of selected cases would be able to provide sufficient evidence and insights to comprehensively understand the research object via cross-case analysis. Cross-case analysis is an important analytical method that can mobilise knowledge from individual case studies; Khan and Van Wynsberghe (2008) suggest that cross-case analysis could help the researcher accumulate case knowledge via comparing and contrasting cases in order to produce new knowledge.

In this research, as analysed and discussed in literature review chapter, there are limited theories to understand how Living Lab stakeholders use and perceive ICT to shape IOKE. Therefore, the researcher expects to generate a theory inductively based on the perceptions and experiences of Living Lab stakeholders and their working performance. Understanding of this phenomenon is limited in the existing literature, and thereby using an exploratory case study is an important step for this research. In addition, this research also seeks to explain the different functions and various characteristics of ICT in IOKE practice, various characteristics of ICT-IOKE, and the relationships between them, based on an in-depth understanding of the phenomenon. Therefore, the purpose of this research is also to develop an in-depth understanding and potential explanations on ICT-based IOKE practice. Overall, this research uses a combination of exploratory and explanatory case studies.

As the main aim of this research is to explore the role of ICT in knowledge exchange, identifying an instrumental case study is central for this study. The case study of Living Labs is thereby considered to be an instrument to support investigating this phenomenon and provide a solid context to conducting this research. A single case study may help this research to understand in-depth this phenomenon from the perspective of Living Lab stakeholders and their working performance in order to generate a theory for this phenomenon. However, as the Living Lab projects are conducted normally over three years, it is impossible due to PhD time constraints to do a longitudinal study for a 3-year project. Therefore, in order to trace the phases and consider any changes at different phases of Living Lab projects, this research needs to identify and sample projects that are found at different project phases. In order to map the richness of exchanges and use of ICT across various stages of Living Labs, this research applied a multiple case study covering multiple Living Labs projects at different project lifecycle stages: inception project, middle-stage project, and completed project.The rationale of selecting multiple case studies was that this research seeks to investigate and understand this phenomenon in-depth – including variations in and the intensity of use of ICT for knowledge exchange - and thereby different cases can be used to complement each other and help shape a comprehensive understanding. In this way, cross-case analysis can assist that purpose.

#### 3.3.2.3 Grounded Theory Methodology

There are mainly three different perspectives on Grounded Theory methodology. The Classic Grounded Theory (CGT) is the original version proposed by Glaser and Strauss (1967), known as Glaserian Grounded Theory (Matavire & Brown, 2013). This version suggests that the researcher should keep an open mind from the start of the literature review in order to avoid the influences of existing established theories. This is because established theories might force the researcher to have preconceived theories in mind, such as established concepts and relationships between themes and concepts. This is likely to affect the researchers’ ability to generate their own ‘concepts’ grounded in data (Glaser, 2002). In addition, the coding for data analysis in the Glaserian version follows an open, selective and theoretical coding process. Open coding is the initial coding process through abstracting codes from data in order to describe phenomenon with meaningful expressions (Glaser, 1992). Selective coding starts after identifying the core categories from the codes. The researcher is then encouraged to selectively code data using the of core categories as a guide, which makes the research move and generate concepts fast (Glaser, 1992). Theoretical coding integrates different concepts into theoretical codes that can work together in a theory. This process encourages the researcher to generate theoretical schemes from grounded data to explain the research phenomenon (Glaser, 1992).

The Straussian version of Grounded Theory is another Grounded Theory perspective developed by Strauss and Corbin (1998). The Straussian version of Grounded Theory emphasises the use of literature and considers that literatures can be used in a more flexible way, while Glaserian Grounded Theory is trying to avoid the influences of literature. Strauss and Corbin (1998) argue that reviewing the literature does not mean that the researcher has to use established theories, but develop a general awareness of the research field. Lack of adequate understanding to such a field is claimed as a fundamental flaw for research (Heath & Cowley, 2004). Data analysis in the Straussian version also differs from the Glaserian version. The coding process in Straussian Grounded Theory includes open, axial and selective coding. Open coding refers to a line-by-line data analysis to identify concepts and link them into relevant categories (Corbin & Strauss, 1990). Axial coding aims to identify relationships between categories and subcategories, and encourages the researcher to code data around the axis of a specific category (Strauss & Corbin, 1998). A paradigm is used as a tool to group and map the relationships of these categories. The purpose of selective coding is to integrate all categories into a central category in order to develop a theory (Strauss & Corbin, 1998). Both CGT and the Straussian version are positioned on the objectivist philosophical stance that view the researcher as a neutral observer (Charmaz, 2014).

A more recent Grounded Theory was developed by Charmaz (2008), and is referred to as Constructivist Grounded Theory. This version argues that researchers need to reflect on meanings of values and beliefs from the interactions between researchers and participants (Li, 2018). In contrast to CGT and Straussian Grounded Theory, constructivist Grounded Theory emphasises that researchers need to actively interact with the participants in order to reflect how historical moments, situations, interactions and social structures can influence the study (Charmaz, 2014).

In this research, the Glaserian version of Grounded Theory is followed. Although there are different versions of Grounded Theory, the fundamental principles of developing theory from emergent data is common in all versions (Glaser & Strauss, 1967; Strauss & Corbin, 1998). As Niekerk and Roode (2009) state, the improvement and application of Grounded Theory is much more important for researchers. This research follows Glaserian version as it is the original, and CGT avoids forcing data to paradigms. Glaser (1998) emphasises data emerging naturally to generate a theory instead of accurately describing a phenomenon, and therefore any analytic tools such as paradigms are avoided, unlike in the Straussian version of Grounded Theory. As Seidel and Urquhart (2016) state, paradigms may force data to occur in emergence, and may cause the researcher to reach conceptual descriptions instead of a Grounded Theory. Therefore, the Straussian version is not followed in this research. In addition, based on the purpose of this thesis, the researcher expects to explore how ICT is perceived and used in IOKE among Living Lab stakeholders. Thereby regarding constructivist Grounded Theory, the focus on interactions between researcher and participants is not necessary.

### **3.3.3 Summary**

After comparing different research strategies, this study considered a combination of Grounded Theory, case study and archival and documentary strategy as the research strategy. Glaserian version of Grounded Theory is the major research strategy used to conduct the research process, involving theoretical sampling, data collection and data analysis, which is discussed in Section 3.4. A combination of exploratory and explanatory and multiple case studies was adopted in order to provide a solid research context. An archival research strategy was also used to find out relevant data located in records and documents of Living Labs.

## 3.4 Research Design

The research design integrated a set of methods based on selected research strategies to provide a logical way for addressing the research problem and answering research questions. It provided a blueprint for research sampling, data collection and data analysis. The research design of this study followed the guidance of the Glaserian version of Grounded Theory. This involved the sampling method, data collection and data analysis, with the support of a multiple case study and archival research.

### **3.4.1 Theoretical Foundation Exploration**

As required by the Grounded Theory method, the researcher kept an ‘open mind’ at the start of the research. ‘Open mind’ means there should not be any established theories or theoretical frameworks influencing the analytical process (Glaser & Strauss, 1967). This was to help the researcher generate theory from grounded data without being constrained by previous theories or concepts.

Being open minded does not mean that the researcher should not review any literature on the topic, rather that the researcher needs to conduct the literature review cautiously in order to explore theoretical foundations as the background to the research (Glaser & Strauss, 1967). As Glaser and Strauss (1967) state, researchers need to have theoretical sensitivity to discover theory from the data analysis. Reviewing literature in the field can greatly expand the theoretical background of the researcher. This enhanced the ability of the researcher to conceptualise theory from the data and thereby improves the researcher’s theoretical sensitivity.

Studies in three main fields are discussed and explored as theoretical foundations to formulate the research questions: knowledge exchange, inter-organisational collaboration and ICT. First, knowledge is the core object for knowledge management, and knowledge exchange is an important process in knowledge management. Therefore, understanding the nature of knowledge, knowledge management and knowledge exchange helps to understand what type of knowledge is exchanged and how it is exchanged. This provides a foundation for studying how to conceptualise knowledge exchange processes in Living Labs contexts. Second, inter-organisational relationships, inter-organisational collaboration and the context of Living Labs are discussed, which provide a foundation for empirically exploring collaboration in inter-organisational settings and Living Labs. Third, the discussion of the literature on ICT in relation to IOKE provided a foundation on the overlapping influences of ICT tools on IOKE practices. These theoretical foundations provided insights for the researcher to know how to conduct this research in a specific context (Living Lab), rather than what relevant theories could be considered for data analysis. These foundations help the researcher to “formulate questions that act as a stepping off point during initial observations and interviews” (Strauss & Corbin, 1998, p. 51).

### **3.4.2 Data Collection**

#### 3.4.2.1 Sampling Methods

For a qualitative research, Bryman (2012, p. 418) states that “most sampling in qualitative research entails purposive sampling of some kind”. Purposive sampling refers to a non-probability sampling strategy by which the researcher aims not to include participants at random, but to sample cases/participants who are relevant to the research and may provide insights for answering research questions. There are three types of sampling methods for qualitative research including generic purposive sampling, theoretical sampling, and snowball sampling.

**Theoretical sampling** is an ongoing sampling process by which the researcher jointly collects, codes, and analyses data to generate theory (Glaser & Strauss, 1967). In contrast to other traditional research sampling where data analysis starts after all data is collected, theoretical sampling refers to a process in which data collection and data analysis take place at the same time (Fernández, 2005). Once data is collected at the first stage, it is coded and analysed immediately, and then the researcher determines what data is needed next and where it can be collected from (Glaser & Strauss, 1967). In this way, the theory can be generated from the data as data emerges. Theoretical saturation is the main criterion for theoretical sampling and helps the researcher to decide whether they need to stop collecting new data (Strauss & Corbin, 1998), which is discussed in section 3.4.3.

**Generic purposive sampling** refers to sampling being conducted purposively, but not necessarily with regard to the generation of theory (Bryman, 2012). In generic purposive sampling, the researcher establishes criteria to select appropriate cases and participants from the case for investigation. However, the criteria employed need to be informed by the research questions in order to provide the basis of samples that can provide insights and answers.

**Snowball sampling** refers to a sampling method in which the researcher initially samples only a small number of participants to help encourage more participants to join the study for answering research questions (Taherdoost, 2016). When the primary group of participants are investigated, they can suggest others who may provide further insights and engage them into the study (Bryman, 2012). This sampling approach is often employed when the sample is difficult to access due to its closed nature (Brewerton & Millward, 2001).

This research considers employing both generic purposive sampling and theoretical sampling. This is because there is a need to purposively determine which Living Lab project will be the first context to be investigated and which individual will be the first key informant to be interviewed. Based on the research questions, the important criterion for selecting appropriate cases is that the case of Living Lab project needs to be an ICT-based Living Lab project. The first participant from the project needs to be familiar with their ICT-based IOKE activities. There are currently several ICT-based Living Labs projects affiliated with the ENoLL, covering both completed and active projects. The initial interviewee will likely be the project manager of the selected Living Lab, who is entirely familiar with the organisations that compose the collaboration, the objectives and the project activities. As this research adopts a multiple case study approach, the same process is followed for the selection of the initial participants for each case. These samples are decided purposively, and thereby a generic purposive sampling is employed.

Once data is collected from the project manager, analysis is conducted. The decision on the next sample is always made after the analysis of data collected from the previous participant and will stop when theoretical saturation is reached. This reflects the theoretical sampling process, espoused by the Glaserian Grounded theory. Snowball sampling might also be useful to engage additional participants into the research. However, as this research mainly follows Grounded Theory methodology, the next relevant sample needs to be decided based on the results of data analysis, rather than being suggested by previous participants. Therefore, snowball sampling is not appropriate for this research.

#### 3.4.2.2 Data Collection Methods

As this research is designed as a qualitative and inductive research for exploratory and explanatory purposes, data collected needs to reflect the practice of reality. Therefore, this research adopts qualitative research data collection methods. There are various different qualitative data collection methods such as qualitative interviews, observations, focus groups and many more (Bryman, 2012). This research considers interviews as an appropriate data collection method for this research, as explained below:

**Qualitative Interview**: There are two types of qualitative interview: Unstructured, and Semi-structured. Unstructured interview refers to a non-directed interview in which interview questions are not predetermined (Bailey, 1994). This type of interview guides a more informal and free-flowing interview process, like a conversation. But probing in relation to the research topic is the nature of such an interview based on interviewee’s responses. This allows the researcher to encourage interviewees explore research questions further regardless of prearranged boundaries, which facilitates probing into complicated issues (Corbin & Morse, 2003). However, as the process is more informal, loss of reliability (Chilisa, 2012) and difficulties for comparing data (Patton, 2002) are potential disadvantages. Semi-structured interviews are also an open qualitative process that allows the researcher to explore new ideas as compared to structured interview questions (Edwards & Holland, 2013). Unlike unstructured interviews, semi-structured interviews are normally accompanied with an interview guide which lists some initial predetermined interview questions to cover specific topics in advance (Bryman, 2012). This type of interview not only helps the researcher and interviewees to focus on specific research topics, but also allows them to express their ideas with greater freedom and in more detail (Edwards & Holland, 2013). However, the preparation of the interview guide needs to be done carefully to make sure that predetermined questions are not prescriptive or leading (Cohen, 2008).

The core advantage of both unstructured and semi-structured interviews is that they are flexible in dealing with qualitative research questions. However, in this research, the knowledge exchange process in Living Labs is not a concrete process, therefore an unstructured interview process is too informal to ensure that the topics discussed always remain in focus. Semi-structured interviews can guide the interview process better in relation to the research questions and allows discussions to go further to better understand the phenomenon. Therefore, the semi-structured interview technique was adopted as a data collection method in this research. This research collected 28 valid in-depth interviews, each lasting around 1 hour. The initial interview questions were well prepared based on the theoretical foundations discussed in section 3.4.1.

The interview had been intended to preferably take place face-to-face with public health permit (considering the Covid-19 outbreak), but due to pandemic related restrictions, it became impossible to collect face-to-face interview data. Therefore, all interviews had to be conducted online via digital techniques such as Skype, Google Meet, and Teams at participants’ convenience. In addition, there were three different interview guides to help the researcher ask questions related to this research topic: Interview guides for inception stage, middle stage, and completed stage of the project. Such interview guides work to remind researchers about the research topic and were perceived useful for semi-structured interview. They did not work as a structured question checklist but allowed room for many open and follow-up questions depending on different interviewees’ answers. The interview guide covered topics such as: how do they prepare their work with ICT, which ICT do they frequently use and how do they use the ICT for conducting their project work, and how do they find their usage of ICT or effects of ICT However, besides the common questions for all three different stages, there were also distinctive questions designed for particular project stages (See Appendix A-B for different interview guides).

**Observations**: Observation is described as “one of the oldest and most fundamental research methods approaches. This approach involves collecting data using one’s senses, especially looking and listening in a systematic and meaningful way” (Given, 2008, p. 573). This approach requires the researcher to immerse themselves in the setting, but only observe and collect further data relevant to the research phenomenon through taking notes or recording (Dudovskiy, 2016). There are two types of observation data collection methods: structured observation, and unstructured observation. Structured observation, also known as systemic observation, is an approach in which the researcher uses specific collection techniques to observe research phenomenon from afar (without directly being involved in the research setting) (Mintzberg, 2019). The collection techniques need to be well-defined and follow a well-structured procedural manner in advance in order to code correctly when a specific behaviour occurs. Unstructured observation refers to a casual observation which is conducted in an open, free manner where every relevant behaviour is observed and recorded (Dudovskiy, 2016). There is no pre-determined collection techniques or pre-defined schedule.

Observation had been also considered as an interesting and useful method to apply in this study. Compared to qualitative interview, one important rationale for selecting observation as a data collection method is that the researcher can gather further data through observations from overt or hidden activities which might be helpful to answer research questions not reflected enough by the interviewees (Bryman, 2012). In addition, observation allows the researcher to instil an element of comparability from what they have observed into their questioning of different people (participants), which can make the data more reliable. On the other hand, the presence of an observer might influence the behaviour of research participants, which may impact on primary data (Dudovskiy, 2016), and so is a potential drawback of the observation method.

The application of the observation method for this research would have been interesting. However, considering the Covid-19 outbreak during the data collection period, most countries were experiencing a lockdown period at this time, and physical workplaces of Living Labs in those places had been closed and so there were less physical workplace activities to observe. Therefore, observations to the real workplace activities of target Living Labs had to be postponed until the Living Labs reopen to the public. An alternative observation approach was therefore requested, that being to observe Living Labs through online web-based meetings. However, there the researcher was not given access to observe online meetings/activities during data collection.

**Focus Group**: A focus group is a group interview technique that allows the researcher to involve more than one participant to join the interview (Bryman, 2012). This method emphasises a particular and tightly defined topic that needs to be explored and discussed in-depth in during the group interview. Therefore, participants involved in the focus group normally are required to have certain amount of experience related to the topic. The researcher in a focus group normally plays a moderator role to engage participants to answer research questions. Focus group can be used to explore interactions among different participants and their responses to the topic. In qualitative research, one advantage of using a focus group for data collection is that the researcher can learn how participants exchange their views based on one another’s viewpoints (Romm, 2014). However, a dominant group member such as a highly opinionated individual may monopolise the discussion and affect the views and responses others to the topic (Langford & McDonagh, 2003). In addition, the researcher themself may influence the result of the discussion as the participant’s are led by the researcher, and thereby may provide answers that they feel are expected of them. The bias of the researcher or dominant group members can significantly influence the result of discussion in the wrong direction. For ethical considerations, focus groups also cannot guarantee a confidential environment as the focus group setting lacks of anonymity (Frankfort-Nachmias & Nachmias, 2008).

Although focus groups constitute an interesting method this research, however, did not adopt this approach to collect data. This is because it is difficult to organise all relevant stakeholders together to discuss this research topic, since Living Lab project normally need stakeholders to collaborate cross distance. In addition, the study focus here is on how Living Lab stakeholders use ICT to exchange their knowledge, however, the interaction between different stakeholders in focus groups cannot provide many insights into this research topic. Lastly, interviews are assumed to provide sufficient data for this study. Considering the ethical issues, focus groups were not adopted for data collection in this research.

#### 3.4.2.3 Sampling Criteria

In order to select cases that are representative for studying the context of European Living Lab, an inclusive criterion is designed as follows:

Firstly, selected cases need to be projects with Living Lab aspects and located in Europe. Since this research defines the concept of Living Lab as an approach, projects can adapt their Living Lab methodology to fit their own needs: they may use Living Lab either by strictly following a formal Living Lab methodology or having side use of Living Lab approach. Therefore, any projects that have Living Lab aspects can be representative in the context of Living Labs. The location where the project was initiated and organised should be based in Europe, which means only Europe-based Living Lab projects are selected in order to represent cases in the context of European Living Labs.

Secondly, selected cases need to be initiated by Living Lab members qualified by ENoLL. ENoLL is recognised as the largest formalised network of Living Labs in Europe and worldwide, registered in the European Union, and aligning with European strategy (Dutilleul et al., 2010; European Commission, 2015; Ruijsink & Smith, 2016). Through a strict assessment process of enrolment based on the Living Labs selection criteria (ENoLL, 2022), Living Labs qualified by ENoLL are more likely to initiate Living Lab-based projects in reality (ENoLL, 2016). As registered in European Union, ENoLL has qualified many Living Lab projects including those funded by European 8th framework programme - Horizon 2020. These projects are organised by specific Living Labs teamed up with various collaborative organisations. Therefore, these projects are also considered as suitable cases for this research to study the context of European Living Labs.

Thirdly, selected cases need to align with some sort of European policy or contribute to address some European objectives. Living Labs created in Europe originally were expected to enhance European innovation and contribute to European economic growth (Leminen & Westerlund, 2019; The Helsinki Manifesto, 2006). Nowadays, these expectations remain and have been further developed to fit with various European policies and objectives, which are reflected as a general aim or specific objectives in the majority of European Living Labs. For example, the majority of Living Lab projects have clearly stated that they have a focus on involving various partners working together to co-create towards innovation, thereby addressing a crucial EU objective for open innovation – “Open innovation, open science and open to the world are the three main policy goals for EU research and innovation” (European Union, 2016 Official Website). ENoLL has advocated this policy since its establishment (The Helsinki Manifesto, 2006), and over the years through deep collaboration with the European Commission, ENoLL has now guided and developed Living Labs towards a tool that breaks innovation barriers in the context of European innovation partnerships (Aversano, 2016). In addition, there are some EU-funded Living Lab projects that focus on how scientific results are communicated and perceived by citizens, which addresses other EU objectives such as “Taking stock and re-examining the role of science communication” (European Commission, 2017 Website). Aligning with EU policies or objectives is an important European dimension for a European-based project. Therefore, it is crucial that the selected European Living Labs projects should also have such European dimension so that they can be representative cases in the context of European Living Labs.

#### 3.4.2.4 Overview of the Data Collection Results

Overall, this research has collected data from 16 European Living Labs projects (4 in inception stage, 4 in middle stage, and 8 in completed stage) and 28 interviews with different types of stakeholders, based on the sample selection criteria. Table 3.1 shows the collected project information and data collection information.

Table 3.1 Collected Project and Data Information

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stage | ID | Project Topic | Project Category | Involved Organisation Types | Data Type |
| Inception Stage (A) | A1 | Transport ecosystem | Smart City | Research Institute; Government; Industrial Firms; Citizen Community | Interview, Website Info., Published Project Document |
| A2 | Digital technologies and agricultural transition | Agriculture | Research Institute; Government; Industrial Firms; Citizen Community | Interview, Website Info., Published Project Document |
| A3 | AI, Europe's cities, and Sustainability | Smart City | Research Institute; Government; Industrial Firms; Citizen Community | Interview, Website Info., Published Project Document, Internal Project Logs |
| A4 | Labour Market Professionals and Education | Education | EU; NPOs; Student Community; Industrial Professionals | Interview, Website Info., Published Project Document, Internal Project Logs |
| Middle Stage (B) | B1 | Air Quality and Battery | Air Quality | Public Event Organiser; Research Institute; Industrial Firms | Interview, Website Info., Published Project Document, |
| B2 | Jobs, Workspaces and Digital Platforms | Employment | Research Institute; Industrial Firms; Citizen Community | Interview, Website Info., Published Project Document, |
| B3 | Smart Mobility Solutions for Mobility Companies | Smart Mobility | Research Institute; Industrial Firms; Citizen Community; EU | Interview, Website Info., Published Project Document, Internal Project Logs |
| B4 | Smart solutions and carbon neutrality | Smart City | Research Institute; Industrial Firms; Government; Citizen Community | Interview, Website Info., Published Project Document, |
| Completed Stage (C) | C1 | Smoking Cessation | Healthcare | Policymaker; Hospitals; Research Institute; Citizen Community | Interview, Website Info., Published Project Document, |
| C2 | Unwanted sound and city noise | Environment | Research Institute; Industrial Firms; Citizen Community; EU | Interview, Website Info., Published Project Document, |
| C3 | Citizen awareness on the quality of the urban environment | Environment | Research Institute; Industrial Firms; Citizen Community; European Commission | Interview, Website Info., Published Project Document, |
| C4 | Innovative information system on air quality | Air Quality | Research Institute; Industrial Firms; Government; Citizen Community | Interview, Website Info. |
| C5 | Get home safely and Smart Lights | Smart City | Research Institute; Industrial Firms; Government; Citizen Community | Interview, Website Info., Published Project Document, |
| C6 | Urban commons to Counteract poverty | Smart City | Research Institute; Industrial Firms; Government; Citizen Community | Interview, Website Info., Published Project Document, |
| C7 | Smart advanced services and digital transformation | Service Transformation | Research Institute; Public Agency; Industrial Firms; Citizen Community | Interview, Website Info. |
| C8 | Collaborative Solutions for Urbanisation challenges | Smart Cities | Research Institute; Industrial Firms; Government; Citizen Community | Interview, Website Info., Published Project Document, |

### **3.4.3 Data Analysis**

As this research applies the Glaserian Grounded Theory strategy, the data analysis follows constant comparison analysis suggested by Glaser and Strauss (1967). Glaserian Grounded Theory suggests that the researcher collects and analyses data simultaneously, developing codes as data emerges and integrating this data into categories in order to generate a theory (Saunders et al., 2015). For data from interviews, analysis has started after the interview, whereas analysis on data from documents has begun immediately upon gaining access.

Coding is a process that subdivide raw data to codes and assign the codes into categories (Basit, 2003). This is an important process in data analysis, which needs the researcher to fracture data, conceptualise data and integrate them into a theory (Strauss & Corbin, 1998). Raw data in this way can be analysed, distilled and interpreted towards a standardised theory (Basit, 2003). This process allows the researcher to notice and analyse the phenomenon in order to provide an explanation (Seidel & Kelle, 1995). As indicated in previous sections, there are three coding procedures in Glaserian version of Grounded Theory: open coding, selective coding, and theoretical coding. Figure 3.1-3.2 shows a screenshot of how an interview transcript and a website document are coded in open codes with memos. Table 3.2 shows a scaling up process of analysis from open coding to theoretical coding: how codes are grouped into concepts and finally towards categories.

Application

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Figure 3. 1 Screenshot of an open coding process of an interview transcript

A picture containing text, screenshot, font, number

Description automatically generated

Figure 3. 2 Screenshot of an open coding process of document information (website)

Table 3. 2 Scaling up process of coding (Partial of inception stage analysis)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Sub-Category** | **Concepts** | **Open Codes** | **Analytical Summary (Memos)** |
| Conditional Knowledge-ability | Inter-connecting  People shapes inter-connections with each other by knowing how to cultivate different relationships with different people | Cultivating Partnership | Attract technical partners to get involved (A12) | * Stakeholders build initial network with each other to cultivate a potential partnership. * Establishing contacts is the condition for any project-based collaboration. * Establishing Initial contact require distributed use of ICT. |
| Use email to establish initial contact of partners (A13) |
| Establish and connect networks (A13) |
| … |
| Connecting | A LL platform gathering different stakeholders (A11) | * Stakeholders are gathered for internal team communication. * Connecting people together via tools is the condition for any project-based collaboration. * ICT has both enablement and constraints by mediating human interactions. |
| Wasting time on gathering people together due to ICT (A21) |
| Meeting stakeholders virtually at early project stage (A21) |
| … |
| Bridging | An individual as a bridge to connect different background of partners (A11) | … |
| … |

Constant comparison is the core method in CGT that underpins the coding process (Glaser & Strauss, 1967). This method suggests that the researcher compares data sets by constantly checking for commonalities and differences. When new codes generate, existing codes need to be reanalysed to promote consistency (Saunders et al., 2015). Memos related to all detailed coding processes are necessary to recorded during constant comparison, which can help to show how different ideas arrive in Grounded Theory. Furthermore, the researcher will purposively select the initial participant who is considered as the Living Lab project manager to collect initial data. After coding and analysing the initial data, theoretical sampling commences based on categories or concepts developed from the initial data set (Tie et al., 2019). During the constant comparison process, the emergent theory or category analysed from the earlier data can help the researcher to identify comparative groups or concepts that will guide the researcher to decide what is next (e.g., who is the next participant, what concepts need to be explored next or verified). Two approaches are followed sequentially in dealing with these comparative groups to decide what comes next: minimising the differences in comparative groups with the aim of establishing the basic categories and concepts for emergent theory, and then maximising the differences among comparative groups with the aim of densely developing categories and delimiting the scope of the emergent theory (Glaser & Strauss, 1967) The aim of each approach will guide the researcher towards a theoretically relevant data collection and help to decide where next, such as who is the next participant and in which departments or organisations.

Theoretical saturation provides a significant criterion to determine whether data collection can stop or not. Theoretical saturation is reached when no new codes can be integrated into categories, all categories are developed and all relationships among categories are verified (Strauss & Corbin, 1998). In this research, practically, this is a crucial signal for the researcher to decide if it is necessary to continue conducting interviews with next Living Lab stakeholders. Figure 3.3 shows a brief depiction of methodology adoption in this research.

Diagram

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Documents

Figure 3. 3 Research methodology depiction

## 3.5 Ethical Considerations

Bryman and Bell (2015) emphasise the significance of ethical considerations in the design of research and provide key principles that researchers should follow in order to avoid failure. Berg and Lune (2012) similarly argue that in qualitative studies, ethical considerations are especially important as qualitative research investigates phenomenon from the perspective of individuals’ experiences and perceptions, which may refer to sensitive or personal issues. Therefore, this research strictly follows research ethics principles. The researcher has applied for and attained the ethical approval (Appendix C) at the University of Sheffield along with information/consent forms that all potential participants came in contact with before making a decision on whether or not they intend to participate in the study. Some important processes concerning ethics are explained specifically below.

### **3.5.1 Recruiting Potential Participants**

Participants (such as Living Lab project manager as the initial participant) was initially contacted by email which are posted on the website: ENoLL. The ENoLL has been established and developed since 2006. Currently, there are 175 active Living Labs and over 400 Living Labs in total in the network (ENoLL, 2019), with project topics covering smart cities, health care, electronic games, education and so on. The website established by ENoLL has posted information about its following Living Labs regularly as well as contact information. This information (including email, phone number, personal website, etc.) can be used to contact the Living Labs and Living Lab project managers. All participants were initially contacted via email or by telephone in cases where the number is publicly available to obtain their agreement about further potential contacts. All participants were voluntarily involved in this research.

The researcher explained to the potential participants how their contact information was obtained and how the investigation was to be conducted, and they will be given a summary of the project aims and research methods. At this point, the research information sheet has been made available to participants. It was explained to the potential participants that they are invited to take part in a 90-minute interview. Before the investigation starts, all participants were given a detailed explanation of the objectives of the study and an informed consent via paper copy or email (depending on which they prefer or Covid-19 outbreak), and they have all indicated that they were willing to take part in this research after consideration.

### **3.5.2 Data Management**

All data has been named in a specific format based on different data types, and they will be managed and stored securely.

**Collecting Data:** All interview data were online interviews, and these data were collected after the participant provided a signed digital consent form, and the online interview took place online via digital tools on a day that was appropriate for both participant and the researcher. The personal data that was collected in interviews was the participants' names and surnames, institutional affiliation, positions in Living Lab project, and the audio recordings of the interviews themselves. Each participant's name was linked to an assigned code and then referred to this anonymised code henceforth. The researcher himself has conducted the transcription of audio files through listening and transcribing the recordings.

For documentary data, data was collected after the researcher gained access to the documents. For documents such as project log, the personal data that was collected is participants' names and surnames and meeting related information. Each participant's name was linked to an assigned code and then refer to this anonymised code henceforth. For documents such as public articles, data that was collected is publicly available. The form of all documentary data was collected and organised in the text files and saved in research storage (explained in the next storing data part).

**Storing Data:** All data was structured by specifying who create data, how and when data was created, tools are used, etc., and will be kept with an original copy, a second local copy and remote copy online. To achieve this, all the data was held on the University of Sheffield Standard Research Storage Drive. When that is temporarily not possible, for example, because of a computer failure, or immediately after an interview has taken place, the data was kept on an encrypted hard drive and transferred to the Standard Research Storage as soon as possible. Audio recordings on audio recorders were copied to the storage or an encrypted hard drive immediately after the interview, and the audio recorder will be safely wiped. All data was backed up regularly.

**Sharing Data:** Participants' names have been removed and stored separately from the transcribed data, which will be anonymised. Data was only shared to supervisors, and the University of Sheffield if necessary. After the project ends, the anonymised records will be kept indefinitely for subsequent publications and presentations.

# CHAPTER 4 RESEARCH FINDINGS

## 4.1 Introduction

### **4.1.1 Organisation of the Chapter**

This chapter presents the findings of this research. An overview of the findings is presented first, briefly illustrating a framework of ICT-based inter-organisational knowledge exchange practice (IOKE) as emerging from the data. Subsequently, the main categories and concepts of the framework are presented and discussed (Section 4.1.2). The following sections (Sections 4.2 - 4.4) present detailed findings of the multiple case study with regards to the emerging concepts and their relationships divided into the three project stages: inception stage; middle stage; and completed stage. Section 4.5 presents the cross-stage analysis across the three project stages in order to propose an integrated theoretical framework of ICT-based IOKE practice.

### **4.1.2 Overview of The Findings**

The overall findings are divided into four different sections based on analysis of the European Living Lab project lifecycle stages, i.e., inception stage (section 4.2), middle stage (section 4.3), and completed stage (section 4.4). This is followed by a cross stage analysis (4.5). Each of the first three sections discuss: 1) the different layers of context that underly ICT-based inter-organisational knowledge exchange practice; 2) what knowledgeability is recurrently constituted in inter organisational knowledge exchange practice; 3) the activities that facilitate knowledgeability; 4) how ICT mediate activities as part of each knowledgeability by affording or constraining actors’ distinct abilities; and 5) the relationships between these concepts that together shape an integrative ICT-based IOKE framework. The last section reveals similarities and differences across the various project stages and illustrates the reasons why these may arise.

ICT-based IOKE is a sociomaterial, activity-based knowing in practice, and takes place within an environment that draws from an inter-organisational, intra-organisational and wider environmental context across all project life cycle stages. IOKE is broadly characterised by three essential knowledgeabilities: core knowledgeabilities as the core abilities employed in the pursuit of project goals; conditional knowledgeability that is the condition to any core knowledgeabilities; and resulting knowledgeability that is as result of enactment of core knowledgeabilities. Specifically, for all three project stages, conditional and resulting knowledgeabilities are the same, namely, they are: inter-connecting knowledgeability and co-ordinating knowledgeability, respectively. Core knowledgeabilities vary across different project stages: during the inception stage, core knowledgeabilities are shared understanding and interactive commenting; during the middle stage, core knowledgeabilities are expertise accumulating and collaborative problem solving; and during the completed stage, core knowledgeabilities are insights spreading and co-constructing. From a whole project progress perspective, these core knowledgeabilities can be grouped together and broadly characterised as: inter-active learning; and co-creating. There are different activities through which actors may enact different types of knowledgeabilities. ICT can mediate the enactment of these diverse knowledgeabilities by either affording or constraining actors’ distinct abilities within those activities. As described in the literature review chapter (section 2.5.7), an affordance view has both enablement and constraint nature in mediating ICT-based IOKE practice. The present findings in the ensuing narratives will use terms such as “affordance”, “afforded abilities”, or “affording” to indicate the enablement nature of ICT that facilitates ICT-based IOKE practice; and use terms such as “constraints”, “constrained abilities”, or “constraining” to indicate the constraint nature of ICT that inhibit ICT-based IOKE practice. Table 4.1 summarises all knowledgeabilities with a brief description for each, and indicates the relevant activities for each, as well as the ways in which ICT facilitate or inhibit the enactment of these knowledgeabilities across different stages. Underlined concepts are those that vary across the three different stages. A detailed discussion is provided in the subsequent sections (Sections 4.2 - 4.5).

Table 4. 1 Overview of knowledgeabilities, activities and ICT that afford or constrain abilities across the three project stages.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Knowledgeabilities** | **Knowing in practice** | **Activities** | **ICT-Afforded Abilities** | **ICT-Constrained Abilities** |
| Inter-connecting | Knowing how to cultivate relationships | Cultivating Partnerships (In., Mi.)  Connecting  Bridging (In., Mi.)  Socialising  Embedding in Real life (Mi.) | Cross-distance Networking  Notifying  Informal Interacting (In.)  Context Familiarising (Mi.) | Appealing (In., Mi.)  Accessing (In.)  Stable Communicating (Mi.)  Informal Interacting (Mi.)  Stress Releasing (Co.) |
| Shared Understanding (In.) | Knowing how to align expertise | Onboarding  Sharing | Showcasing  Collective Storing | Public Codifying  Implicit Signalling |
| Interactive Commenting (In.) | Knowing how to assist peers | Collaborative Writing  Group Discussing | Flexibility  Instant Workaround | Concentrating |
| Expertise Accumulating (Mi) | Knowing how to develop capabilities | Guiding  Training  Sharing  Elaborating | Visualising  Ubiquitous  Learning Ahead  Customising | Immediate Transforming  In-person Demonstrating  Communication Continuity |
| Collaborative Problem Solving (Mi.) | Knowing how to innovate | Co-designing  Collaborative Writing  Group Discussing | Sticking  Instant Workaround  Cross-Referencing | Humour Ability |
| Insights Spreading (Co.) | Knowing how to disseminate impact | Publishing  Circulating  Sharing | Visualising  Flexibility |  |
| Co-constructing (Co.) | Knowing how to integrate efforts | Consolidating  Collective  Reflecting | Reviewing  Instant Workaround | Integrating |
| Co-ordinating | Knowing how to direct performance | Controlling  Staffing (In., Mi.)  Nudging (In.)  Adapting (Mi.)  Monitoring (Mi., Co.)  Sustaining (Co.) | Confirming (In.)  Collective Evaluating (In.)  Documenting (Mi.)  Assigning (Mi.)  Tracing (Mi.)  Tracking (Co.) | Instant Responsiveness (In.)  Localising (Co.) |
| \*Underlined concepts - ones that vary across different stages. In. - concepts that only occur in the inception stage. Mi. - concepts that only occur in the middle stage. Co. - concepts that only occur in the completed stage. | | | | |

## 4.2. Inception Stage Finding

This section presents a detailed discussion regarding the concepts that emerged in relation to the ICT-based inter-organisational knowledge exchange process for the project inception stage. Figure 4.1 presents a framework of ICT-based IOKE practice during the inception stage of Living Lab projects. Quotations are provided in the structure of: content of quotation; ID of project stage (A indicates the inception stage); ID of project number; ID of interviewee; and No. of paragraph in the specific interview transcript. For example, *“(Project A1, Participant 3, Para. 90)”* indicates the inception stage project, project No.1, interview participant No. 3, and paragraph No. 90 in the interview transcript.

Diagram, schematic

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Figure 4. 1 ICT-based Inter-organisational Knowledge Exchange Practice (Inception Stage)

The ICT-based IOKE is a sociomaterial, activity-based knowing in practice, and takes place within an environment that draws from the inter-organisational, intra-organisational and wider environmental contexts. Actors in a Living Lab project, during the inception stage, exchange their knowledge across organisational boundaries with the use of diverse ICT. The inter-organisational context reflects the Living Lab space, i.e. the space within which actors from different organisations interact with each other. As such, the inter-organisational context is the first contextual layer of ICT-based IOKE practice. As one interviewee described:

*“We set up an approach that we have a flat organisational structure so that* *we lead this process, but we are not the leaders. What I mean by that is that we are a very open and transparent in the way we coordinate this effort, this common effort… Being honest and transparent about what our common interests are* [is very important]*. And we are always transparent about the issues we may face. And what we consistently look at is that the commitment of our partners and the ways to collaborate as equals. So being honest and transparent the thing is a very important thing.” (Project A1, Participant 2, Para. 22, 55)*

The above quotation shows that during the inception stage, Living Lab projects follow the project structure as originally envisaged by the Living Lab project methodology (Malmberg et al., 2017). There is not a single person acting as leader in their inter-organisational collaboration in such a structure, but project members adopt a flat hierarchy; each actor is leading on some processes, but they are not considered as being the leaders, i.e. they steer others and coordinate without however instructing them. Such structure is developed originally as an inter-organisational context within which actors collaborate and steer their project activities through a decentralised decision-making process. As they interact, a transparent and honest workplace climate is developed. During this stage, actors manage to shape a context within which they can freely discuss their opinions and ideas as equals. Such a transparent inter-organisational climate and flat inter-organisational structure reflect an inter-organisational context as originally developed by actors during the inception stage of a Living Lab project.

The Intra-organisational context, in turn, reflects how the actors who engage in ICT-based IOKE practice are also influenced by their own organisation’s characteristics, such as organisational routines and culture. As such, the intra-organisational context is the second contextual layer of the ICT-based IOKE practice. As one interviewee described:

*“We have… a very well-established procedure to communicate all the projects we work on. We have, like, our monthly chat, email that is sent to all of my colleagues. We are 1,400 people here in* [our organisation] *so this is quite a big organisation. Yeah. So, we usually share with our department about the project that we are involved in. And then through social media, also, internally here, we have these internal meetings twice a year. Also, we have this kind of internal meeting where different working groups talk about the project experience. So, you usually talk about the more relevant project to get feedback from our colleagues.” (Project A1, Participant 3, Para. 90)*

Each involved organisation has their own tool set, such as email or social media to support their intra-organisational activities. By doing so, actors get valuable insights such as feedback for their project from their own organisations. These communications take place in the same way as intra-organisational communications, following established communication procedures, organisational structure, or meeting frequency. It thus follows that the intra-organisational context is important for actors’ ICT-based IOKE. While these intra-organisational activities cannot directly influence actors’ ICT-based IOKE practice, they may become valuable when actors bring them into the context of their inter-organisational collaborations. Therefore, the intra-organisational context is viewed as the second contextual layer of the ICT-based IOKE practice.

Finally, the environmental context reflects that those actors who engage in ICT-based IOKE practice are a part of the wider society, and that their inter-organisational collaboration is influenced by macro-level environmental characteristics such as global health or national policy. As one interviewee described:

*“In this year by, for example, it was foreseen because it was proposed, and the proposal was written before Covid-19. It was proposed to have a lot of face-to-face meetings and face-to-face workshops and so on. But then Covid-19 came, and we realised that we couldn’t carry out the project set out in our proposal. So, we had to re-adapt the methodology to carry out those sessions online on a virtual basis. We had to develop a specific tool for those types of activities and for the community to be engaged and for the community to be connected.” (Project A1, Participant 3, Para. 5)*

Due to the outbreak of the Covid-19 pandemic in Europe early 2020 (Goniewicz et al., 2020), actors had to avoid face-to-face meetings to slow the spread of the disease and keep healthy. Therefore, many inter-organisational collaboration projects could not be carried out as usual and actors had to adapt their collaboration approaches and knowledge exchange practice. New ICT had to be explored and considered so that actors could develop their projects in a virtual way during the global pandemic. These activities indicate the significant influence environmental changes have on actors’ ICT-based IOKE practice. Since this environmental context cannot be controlled by the project actors and because it usually generates impact on a macro-level, this context is viewed as the third contextual layer of the ICT-based IOKE practice.

The empirical data in this study suggests that knowledge in ICT-based IOKE should be viewed as a capability, or knowledgeability which is the resulting of human interactions, facilitated by human interactive activities, and mediated by ICT. Such knowledgeability is performed through practices, emergent from activities, embedded in context, and bound up in the technologies that mediate human interactions. On the basis of this, IOKE at the inception stage is characterised by four different knowledgeabilities, namely: inter-connecting; shared understanding; interactive commenting; and co-ordinating. Each of these knowledgeabilities are enacted through different activities and are mediated via ICT. Two of these knowledgeabilities, shared understanding and interactive commenting, i.e., knowing how to align expertise and knowing how to assist peers respectively, are viewed as core knowledgeabilities because they are recognised as core abilities in the pursuit of project goals during the inception stage. These core knowledgeabilities occur only when actors can connect with each other, i.e., inter-connecting is a condition for these knowledgeabilities, whereby knowing how to cultivate relationships with different actors is enacted. As a result of the enactment of shared understanding and interactive commenting, actors will co-ordinate their project activities moving forward, such as nudging collaborators to undertake and complete their work or evaluate the quality of performance. This in turn allows them to develop knowledge regarding how to direct the project moving forward. Therefore, co-ordinating is the resulting knowledgeability of these core knowledgeabilities. As part of the ICT-based interorganisational knowledge exchange practice, actors enact their different knowledgeabilities with the support of ICT to achieve their goals, and their knowledgeabilities are thereby (re)produced in recurrent inter-organisational knowledge exchange practices. As a result, ICT plays a significant role in these practices by promoting or constraining different action possibilities while actors engage in activities.

The above are summarised in Table 4.2. During the project inception stage, there are four different knowledgeabilities within the ICT-based IOKE practice, each of which is an expression of different knowledge in practice and is enacted or performed via different activities. The last column summarises how ICT mediates actions as part of each knowledgeability, affording or constraining actors’ distinct skills. These are discussed in detail in the ensuing sections.

Table 4. 2 Summary of knowledgeabilities in ICT-based IOKE practice, its relevant activities, performed knowledge and ICT affordance and ICT constraints at the project inception stage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Knowledgeabilities of ICT-based IOKE Practice** | **Knowing in practice** | **Activities** | **ICT-Afforded Abilities** | **ICT-Constrained Abilities** |
| Inter-connecting | Knowing how to cultivate relationship | Cultivating Partnership  Connecting  Bridging  Socialising | Cross-distance Networking  Notifying  Informal Interacting | Appealing  Accessing |
| Shared Understanding | Knowing how to align expertise | Onboarding  Sharing | Showcasing  Collective Storing | Public Codifying  Implicit Signalling |
| Interactive Commenting | Knowing how to assist peers | Collaborative Writing  Group Discussing | Flexibility  Instant Workaround | Concentrating |
| Co-ordinating | Knowing how to direct performance | Controlling  Staffing  Nudging | Confirming  Collective Evaluating | Instant Responsiveness |

### **4.2.1. Inter-connecting and ICT**

Inter-connecting refers to a knowledgeability by which actors get inter-connected with the help of ICT to establish a network among them. There are four types of activities involved in this: Cultivating Partnerships; Connecting; Bridging; and Socialising. During these activities, ICT facilitates inter-connecting by affording actors cross-distance networking, notifying, and informal interacting abilities, which together support the knowledge of how to cultivate relationships with others. At the same time, ICT may inhibit such enactment of knowledgeability by constraining their ability to make their work appealing to prospective collaborators and counteracting simplified accessing to the group interaction. Table 4.3 provides a summary of inter-connecting knowledgeability, its accomplished knowing in practice, activities that allow the enactment of such knowledgeability, and their explanations.

Table 4. 3 Summary of the inter-connecting knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Inter-connecting  Explanation: Knowing how to cultivate relationship | Cultivating Partnership | Actors build initial contacts so that they are inter-connected, through which they are developing a knowledge of how to cultivate an initial relationship and make decisions about whether they want to get involved or not. |
| Connecting | Actors approach each other and are connected to interact in order to achieve work-related goals. The connecting activity indicate how actors become inter-connected and develop their knowledge on how to cultivate a workplace goal-oriented relationship. |
| Bridging | One or more actors work with individuals and groups of actors to bridge their different backgrounds. With the support of these actors, actors of different backgrounds are able to understand each other and connect with each other more effectively. This, in turn, allows them to develop a knowledge of how to cultivate a relationship with the involvement and help of a third-party. |
| Socialising | Actors get together and chat informally for some social goals (i.e., non-work-related goals) and thus develop informal communication. This allows them to develop their knowledge on how to cultivate a social and informal relationship during the project. |

**Cultivating Partnership:**

Actors establish initial contacts to build up initial relationships such as project partnerships by cultivating activities such as approaching new partners. For example, Living Lab actors at the inception stage usually need to reach out to new partners and include them in the partnership, so that they can acquire new insights or resources from these new partners and their organisations. When actors engage in cultivating partnership activities they negotiate and exchange information in order to decide whether they want to build this new partnership or not. As two interviewees note:

*“What we do is like establishing and connecting the networks. And at the end, building a trusted community among the stakeholders…* *I think that is especially relevant now, because of Covid-19 in this and last year, it is like more important to have an information system to establish* [contacts] *with the stakeholders… We usually use e-mail to establish the first contact with the partners and the public service in each of the cities and so on, and therefore they appear in our network, and they’re stakeholders.” (Project A1, Participant 3, Para. 5)*

*“We try to find the right balance between involving technical partners and understanding how they could be interested in participating in this project through Technical Information and challenging questions on the technical side. So, we communicated a lot in emails when we start involving them into our partnership. We primarily use email as the official communication channel for approaching partners from other cities or places. And there has been some efforts in using, like, direct messaging but they didn’t provide successful communication. Because usually we need to provide a lot of substantial or background information to attract partners and pose our questions, but social media with its direct messaging services, I’m sure, are not strong enough in supporting that.” (Project A1, Participant 2, Para. 43)*

The above examples indicate how actors involved in inter-organisational collaboration at the inception stage strive to establish initial relationships with new partners via ICT. In the first example, actors from project A1 built new relationships with the goal to shape a trust-based community, which indicates that trust is an important component for the inter-organisational context. ICT, such as emails, are required to facilitate these cultivating activities, particularly when there is a crisis within the environmental context such as the constraints imposed by the Covid-19 pandemic, which entailed social distancing and inhibited face-to-face contact. Emails though may also be required because often actors are geographically distributed. These factors (inter-organisational trust, distance, environmental crisis) indicate how the inter-organisational and environmental contexts work together to shape and influence a mutual trust-based and cross-distance Living Lab context. ICT is employed here to bring actors together irrespective of their geographical distance and other constraints by affording them a cross-distance networking ability, so that actors can cultivate an initial relationship, such as a project partnership within Living Lab, regardless of constraints. Drawing from the second example, actors need to consider new collaborators’ (e.g., technical partners) intrinsic motivations for participating in the Living Lab project. They need to provide rich information (such as a detailed background to the project) so that the collaboration is appealing and that they can attract new collaborators. Emails are perceived to provide cross-distance networking abilities by helping actors reach out to new collaborators from other locations and cultivate new networks; as such they are extensively used. In addition to email, actors may use alternative means for communication, such as social media, and have made use of them for facilitating the cultivation of relationship activities, because social media are also perceived to provide cross-distance networking abilities. However, social media are not considered to be as effective at communicating information, which is why their use may be discontinued as shown in the example above. This shows that actors prefer to use technologies that afford them multiple activities instead of only a few in their ICT-based IOKE practice.

**Connecting:**

Connecting refers to the activities through which actors are assembled together to establish project-based and goal-oriented relationships with each other. For example, actors in a project usually need to meet up with each other to discuss project activities. In connecting activities, actors use ICT to contact each other for specific work-related purposes, thus allowing them to establish their workplace relationships. The use of ICT such as Google chat or calendar allow actors to inform each other about activities, i.e. ICT allows actors to notify each other. As two interviewees note:

*“We have used Google Chat that is part of the email. That can be informal and really useful if I need to ask something really quickly, something small. I can try if this person is available.… or like, if there’s something you need to ask really quickly, then just type a message to them, like “Hey, do you have this and this”. So, it’s quite fast. But before the Covid 19, we never used Google chat like that.” (Project A1, Participant 1, Para. 71)*

*“For the meetings, we are using a calendar. Just a simple calendar, send the invitation. So, when I schedule an email, send an invitation with the calendar, so everyone has the information, get informed on their own calendar, it is there automatically.” (Project A1, Participant 4, Para. 69)*

Actors in the inter-organisational collaboration workplace usually need to connect with others for goal-oriented discussions such as project work related discussions. These communications could take place as actors meet-up or engage in some quick catch-up way as in the incident described above, i.e., transient connections, which are accomplished with the use of ICT such as Google chat or calendar. Therefore, the use of these ICT can inform actors about the connection whereby actors get notified and decide if they can and want to get in touch or not. Thus, ICT provides actors with the notifying ability which helps to facilitate the enactment of inter-connecting knowledgeability during connecting activities. However, these activities usually entail some difficulty because actors have their own work patterns or personal circumstances; thus, they may not be available to connect as required. Actors involved in inter-organisational collaboration usually show respect to each other’s availability (check their available slots in advance) for these transient connections, which helps to shape a flexible and respectful IOKE. Environmental factors. such as Covid-19, force actors to explore new functions and uses of technologies to accomplish their connecting goals online and at the same time maintain social distancing as required.

Although actors can use ICT to enable their notifying ability, ICT may also inhibit inter-connecting by constraining them in how they make their work appealing to others. For example, with regards to connecting activities, one interviewee notes:

*“I think the online workshops are not attractive enough to participate, people maybe like a city’s stakeholders and the citizens, it’s impossible to bring them all. Like they are not interested in workshops, especially it’s hard to maybe participate in the Zoom meeting if they haven’t ever used it or they don’t know how to use a computer or they aren’t much interested or like after a long day on a computer, they don’t want to spend time on a computer anymore. At that time there is a need to try to find something new. (Project A1, Participant 2, Para. 75)”*

When actors try to connect with other partners or stakeholders, they seem to have to make the envisioned activities attractive to them. Those targeted partners may have different reasons for which they resist connecting with others, and sometimes virtual meetings seem unhelpful and occasionally the reason for said resistance. In the example above, tools that support online workshops may be too complex to be understood by new users or they may exacerbate their daily fatigue, which leads to unwillingness to attend the workshops. The failure of connecting collaborators due to the use of ICT results in difficulties regarding knowing how to cultivate relationships. As a result, the actors may have to seek other ways to do this, which may include finding new and more attractive tools to the target audience. This reflects a need for an attractive and friendly interface between users and virtual technologies in the context of inter-organisational collaboration to mitigate users’ resistance to technologies.

In addition, if actors change ICT, the materiality of new ICT may result in new constraints that inhibit actors to connect with each other. As one interviewee notes:

*“Today, for example, I have a new phone. I try to go for, first of all, for a small walk to listen to the meeting. But then because of the new school system and the Teams meeting, we have, like, two factor authentications. And if I didn’t memorise the key like the Microsoft key, like on the new phone, I can’t access the meeting. But when I got it, the meeting was already over, but it didn’t still work. And I feel very frustrating.” (Project A1, Participant 1, Para. 53)*

As shown, the change of smartphone in the above example can lead to changes in the materiality of the ICT, as the MS key was stored in the previous device and was not available when needed in the new phone. Therefore, ICT in this case has constrained the actor’s ability to make a connection with their colleagues.

**Bridging:**

Actors can also get inter-connected through bridging activities. In these activities, actors endeavour to establish relationships with others, but they are sometimes restricted by multiple factors such as the diverse culture and background of actors. In this case, one or more individuals may act as a bridge to establish a common ground and understanding between each other and therefore become inter-connected and develop the partnership. ICT is leveraged here to facilitate actors’ cross-distance networking abilities to build networks through which actors develop a knowing how to cultivate relationship with the involvement of a third party (i.e., the bridger or boundary spanner). As one interviewee notes:

*“*[I collaborate] *with a partner who’s from Italy, and we have some virtual meetings before, mainly for pilot cities in my cooperation. And he’s in between, like technical partners and with the pilot cities because I didn’t have a technical background but he’s there. With these technical partners from Slovenia, Germany, and also from Spain, I have some direct meetings with them but not that often.* [Because] *their languages are really hard to understand because i’’s so technical. They speak about the technical details all the time. I’’s hard to understand. So, we need someone* [such as our Italian partner] *working in between to explain me those technical things. I know that other pilot cities have similar problems.” (Project A1, Participant 1, Para. 18)*

The above example shows that actors Involved in inter-organisational collaborations get inter-connected by someone working as a boundary spanner between two groups (such as the project manager (participant 1) and technical partners) to link with each other. Living Lab projects take place within an inter-organisational context and require multiple resources and expertise from diverse organisations. Therefore, actors in Living Lab projects are usually from multiple types of organisations and experts in different fields, which collectively help them achieve project goals. Within their own respective organisation, they have their own culture, background or own specialised language to communicate (e.g. technical language from technical partner organisation in the example above), which may be difficult to be understood by actors from other organisations. Although in this instance virtual meeting technologies allow the project manager (participant 1) to directly connect and communicate with their technical partners, such connection is to some extent problematic due to the actors’ diverse background. Actors address these issues by involving in their meetings a third-party role as a boundary spanner (Lundberg, 2013) who is a master in both aspects of expertise (technical and non-technical expertise). Although actors may have different physical locations such as Italy, Slovenia or Germany, virtual meeting technologies become useful here because they allow the boundary spanner to connect regardless of location.

**Socialising:**

Socialising refers to the activities in which actors communicate informally with a social purpose, whereby they may discuss some personal or social topics that are less relevant to the project. ICT is used here to help actors connect for these informal situations and they provide actors informal interacting abilities to build such networks, through which they can develop their knowledge on how to cultivate informal or social relationships with each other. However, for this to be possible, actors will need to use ICT that are familiar to them, as potentially different functionalities and issues regarding familiarity may work counterintuitively and restrict such opportunities. As one interviewee notes:

*“**We can have some face-to-face communication, like, some informal discussions, like, corridor discussions, but they don’t exist when working from home… Like, in face-face meetings, we have coffee breaks. We used to have them every day. And actually, they went very popular. Now we have used something like Jitsi for* [informal chats]*. But actually, I don’t know why our ICT persons wanted us to use* [Jitsi]*. Because we are used to Google Meet. So, we take this* [Jitsi] *for use, probably just wanted to test it. But finally, we changed it to Google Meet because we use them in many ways. Yeah. Like coffee breaks there. Actually, they are quite funny.” (Project A1, Participant 1, Para. 69)*

Inter-organisational collaboration activities sometimes create pressure for involved actors, who sometimes may need a break, disengage from project activities and have fun with each other that is not related to work. These informal discussions create a comfortable climate within the inter-organisational context and seems to be welcomed by actors. Environmental changes such as those brought about by the Covid-19 pandemic, transformed such informal activities from offline to online, because actors may have to stay at home and are unable to physically get in touch. The frequency of these activities may also change because everyone has their own work schedules when working from home and thereby it is hard to simply find moments to have a corridor discussion or a real coffee break. ICT such as Jitsi and Google Meets allow actors to re-shape these informal activities and afford actors the ability to informal interact and develop a knowing how to cultivate social relationships. However, actors prefer those technologies that they are familiar with to indulge these informal activities, and resist the introduction and use of new ones, such as Jitsi. This may indicate that actors do not want to be forced anymore and desire to use tools they are familiar with in these social activities. In addition, these social activities show that an inter-organisational context is not one that requires intensive or high-pressure work all the time, but rather familiarity.

### **4.2.2. Shared Understanding and ICT**

Shared understanding refers to a knowledgeability enacted by actors who together develop their understanding and expertise towards a common level. At the inception stage, actors who are from different organisations may have diverse expertise. To bring these skills to the project, actors are required to build up a common understanding on any concepts that are related to the project. This requires actors to enact their shared understanding and knowledgeability such that they are able to develop a common understanding on how to align expertise towards a common level. Actors accomplish this knowledgeability through two primary activities: Onboarding; and Sharing. ICT can support such accomplishments by affording actors with the showcasing and storing ability while constraining an actors public codifying ability at the same time. Table 4.4 provides a summary of shared understanding knowledgeability, its accomplished knowing-in-practice activities that allow the enactment of such knowledgeability, and their explanations.

Table 4. 4 Summary of the shared understanding knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Shared Understanding  Explanation: Knowing how to Align Expertise | Onboarding | Actors get onboard in the project towards a shared knowledge level required by the project team. |
|  | Sharing | Actors share insights and expertise with each other towards a common understanding on specific topic |

**Onboarding**

Onboarding refers to an activity through which actors get onboard in the project towards providing the level of shared knowledge required by the project team. There are usually training courses or instructions organised by the project team to advance actors’ knowledge level. Actors who engage in onboarding activities are able to develop a common understanding towards project relevant concepts so that they know what the project is about, what expertise they have, and what they should do in this project. The use of ICT such as digital slides affords actors showcasing ability so that they can learn the project from each other. This allows actors to enact their shared understanding knowledgeability as they get onboard and develop an understanding on how to align expertise towards a common level. As one interviewee notes:

*“**We try to get all the participants on board on the same kind of knowledge level about the project and what is expected from them by presenting the project in some slides. These slides provide very rich information, and they could easily get to know what we are expecting from them and how they should be contributing.” (Project A1, Participant 2, Para. 39)*

Actors who are collaborating in the project may possess an insufficient level of knowledge and understanding to perform their tasks as required by the project. Therefore, actors will need to learn this information by engaging in onboarding activities. The use of ICT, such as digital slides, are usually prepared containing detailed information before their presentation. This shows that actors can use these slides to showcase their expertise and that they can learn from each other and develop and share their knowledge.

**Sharing**

Sharing refers to the activity through which actors share insights and expertise with each other towards a common understanding of a specific topic. At the inception stage, actors may explain their expertise by sharing information with regards to some specific concepts upon which they can develop a mutual understanding. In doing so, actors are able to improve their understanding of how to align diverse expertise through the enactment of shared understanding knowledgeability. ICT can facilitate the above by affording actors collective storing ability. As one interviewee notes:

*“We have to set up a kind of common understanding for all of them, not only in this project A, but in other projects, what we did is to have a wiki. So, with wiki what we did in our groups is to have a wiki where it demonstrates some key concepts that we identified. We all are in that way, we ensure that we all are understanding the same thing when we talk about some key concepts, right? Because we all can contribute to that concept, so it is a good way to have this common understanding and to have this common vision of the project for the next several years.”* *(Project A1, Participant 3, Para. 26)*

In the above instance, project partners use Wiki as a common repository to store key project concepts or ideas collectively. Due to the democratic nature of inter-organisational knowledge exchanges, all partners have access to the website and can view and learn about, and store new concepts on the Wiki. The digital repository as the material properties of the digital Wiki affords actors collective storing ability, which allows actors to develop a mutual understanding to any insights they put on the Wiki. During the inception stage, the Wiki can be used as a common basis for future activities, which indicates the significance of shared understanding knowledgeability as a core capability for the inception stage of the Living Lab project.

Although actors in the project usually have direct access to work on ICT for sharing expertise, there are scenarios where some specific ICT allows only a specific person to edit. In this case, ICT may constrain actor’s public codifying ability that may inhibit their enactment of shared understanding in sharing activities. As one interviewee notes:

*“Now we are getting those new companies in, I have planned that Slack will be the main communication because we have a challenge between us and the company website because the web page of me or my colleagues in front of business, we are not able to update the website. One of the principles in this project is that the information will not be just given to one company but should be available for all. So, in the first request for tender phase, we were having a question and answer section on the website. But it is not very easy because there wasn’t real-name email address but a desk-email box and so once I got questions, I have to say that this email address was mine. And then I reply on that question and then I will send the question and answer to the partner who was responsible for the website, and then they were adding it. And then me and my colleagues went to check how it looked like, because they were a little bit busy, maybe. And sometimes* [a lot of information] *was missing. And so with I think that in this phase, I need a service or solution, which I can update website by myself and immediately and instantly. So, I don’t need to ask anybody else to do something and then try to explain what I was wishing them to do.” (Project A1, Participant 3, Para. 70)*

In the above instance, at the initial stage, the project is in the process of involving new partners, which require the project partners to share project information with the new collaborators. However, in this case, although the communication platform, the website, has an interactive section that allows actors to share their expertise, actors cannot directly edit the website and share the insights. They have to ask specific individuals who are responsible for updating the website and sharing the relevant information. It is required that all information be shared for partners to shape a mutual understanding, which reflects the democratic nature of the inter-organisational context in the Living Lab project. However, this increases actors’ difficulties to capture all others’ insights for sharing. The materiality of such websites that only specific persons are able to update can thereby greatly inhibit actors sharing their expertise towards mutual understanding by constraining their public codifying ability.

In addition, as actors immerse themselves in sharing expertise, they can deliver their insights in explicit and implicit ways. However, although ICT allow actors to showcase their insights directly, at the same time, ICT may prohibit them from providing enough implicit meaning by constraining their implicit signalling ability. As one interviewee notes:

*“Face to face in a physical way, it’s very much needed, and you will never get the same outcomes from a virtual meeting. Because you miss a lot of things with having this kind of virtual meetings instead of walking in together and having face-to-face meetings, because the interaction is not the same. You may learn a lot of information from the slides and talk, but people’s body language also is important, you need some, I don’t know, some different nuances that maybe the body language can provide you to explain their work. And in the face-to-face meeting, you will get a lot of more information in that sense.” (Project A1, Participant 3, Para 37)*

As shown in the above example, actors could use ICT such as slides in a virtual meeting to showcase their expertise to others and enable them to learn. However, there is also a great deal of implicit information that can only be provided through non-verbal body language, and such information also seems to be significant in shaping shared understanding. Therefore, the use of ICT may constrain actors’ implicit signalling ability to communicate effectively with each other, which may thereby inhibit actors’ accomplishment of shared understanding knowledgeability.

### **4.2.3. Interactive Commenting and ICT**

Interactive commenting refers to a knowledgeability enacted by actors who give opinions or feedbacks on each other’s work so that they know how to assist their peers to improve their work. There are two types of activities that comprise such knowledgeability: Collaborative Writing; and Group Discussions. During these activities ICT can facilitate such enactment by providing actors an instant workaround and flexibility. At the same time, ICT may inhibit such enactment of knowledgeability by constraining their ability to signal implicit meanings and concentrate on their works. Table 4.5 provides a summary of interactive commenting knowledgeability, its accomplished knowing-in-practice, activities that allow the enactment of such knowledgeability, and their explanations.

Table 4. 5 Summary of the interactive commenting knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Interactive Commenting  Explanation: Knowing how to assist peers | Collaborative Writing | Actors get intensively engaged together to support each other in the achievement of writing tasks |
| Group Discussing | Actors provide opinions on each other’s thoughts to rich discussions about some concepts or topics during group meeting. |

**Collaborative Writing:**

Collaborative writing refers to the activities in which actors engage to support each other in writing tasks. At the inception stage of project, the main deliverables are usually text-based outputs that require actors to support each other in writing, i.e., collaborative writing. ICT allows actors the ability to directly comment on each other’s contributions by affording an instant workaround ability so that they can overcome geographical/temporal distance and improve their work timely. By working together in collaborative writing activities, actors may ask questions and give feedback to each other frequently encouraging new insights to be co-created, which allows actors to accomplishing their knowing how to assist their peers in the project. As one interviewee note:

*“At our project level we are using a common repository for documents that is a Fresco. But personally, one missing point is that the Fresco version we are using does not support the collaborative writing of documents [so we change to Google Docs] … I think that this kind of functionality (i.e., collaborative writing of documents) on Google Docs are very helpful to integrate our partners’ contributions instead of massive exchange of documents by email or through the full repository… Most new and useful solutions were actually learned from documents. So, the possibility to write the documents together would be very helpful, because we certainly can check what the other writing, we can immediately have a call or direct interaction with them and try to adjust and find the correct solution quickly.” (Project A1, Participant 4, Para. 15, 37)*

Actors sometimes seem to have a large volume of information to communicate or learn from each other during the collaboration. Technologies such as email or Fresco seems to constrain their exchanges because these tools complicate communication even more and perhaps are time-consuming to integrate due to massive documents exchanged. Google docs that support ‘collaborative writing functionality’ provides people with an instant workaround ability that allows immediate engagement in and interaction around what they just wrote, providing each other feedback, reflecting on their own work and accordingly producing immediate changes. By doing so, actors are able to synthesis their expertise so that they are able to learn from each other and co-create new insights. Actors thereby can enact their interactive commenting knowledgeabilities in their collaboration with each other when writing documents together, with the aid of ICT.

**Group Discussing**

Group Discussing refers to an activity through which actors provide opinions on each other’s thoughts to rich discussions had on concepts or topics during group meetings. During group discussions, actors actively engage in communication with each other, learn new knowledge and provide their own specific understandings to support their peers for idea stimulation. ICT can be used in these activities to allow actors to flexibly select their discussion environment, though it may constrain an actor’s ability to focus on the accomplishment of interactive commenting. As one interviewee notes:

*“**Our meetings usually have some presenter roles who are explaining their work or their knowledge* [to inform a rich discussion]*. If I have, like, a really small role in a meeting, it’s quite easy. Like, if it is a face-to-face meeting, it is really easy just to browse the internet, free news or required emails, and maybe not concentrate on the discussion so much. But now I usually, if I have this kind of virtual meeting* [with Zoom or Google Meets]*, I go for a walk. And then I can’t browse internet. And actually I’m listening more actively to these discussions. I ‘m already walking so I don’t need to do anything else. Like, it’s easier to concentrate, especially when the topic may be not that interesting or a bit difficult to understand. By this way, I found myself really starting to understand their work and able to say something to enrich their discussion.” (Project A1, Participant 1, Para. 63)*

Actors in the Living Lab project usually possess diverse expertise and some of this expertise is usually too complicated to be understood by others. Therefore, within the meetings or sessions organised by the project team, there are sometimes a presenter role, who explains their specific expertise to other members and inform group discussion. Actors can start learning by actively engaging in the presentation and group discussion. However, for those actors who are not in such specialised areas, this requires them to concentrate on the discussion more intently and engage in the discussion more actively through which they can learn from each other. In face-to-face situations, actors may not be able to immerse themselves into group discussion activities. ICT (e.g. Facebook) may provide too much information and thus are distractions that focus their attention elsewhere. However, with the use of Zoom or Google Meets, actors could select their preferable learning environment flexibly (e.g. go for a walk) so that they can stay at a comfortable place and thereby actively engage in the discussion. As actors are able to engage in group discussions with the aid of ICT, they can recurrently accomplish their knowing how to support their colleagues to improve their works for this project.

### **4.2.4. Co-ordinating and ICT**

Co-ordinating refers to a knowledgeability enacted by actors who generate reactions to the outputs of others’ work or themselves in order to move their work forward. As actors enact their different core knowledgeabilities in ICT-based IOKE practice, actors may deliver diverse achievements and outputs from their project activities, including documents, products, capabilities, and innovations. Based on the quality of these outputs, actors are able to subsequently unify their actions to pursue their project goals. Therefore, co-ordinating knowledgeability occurs only when actors have delivered some outputs having already accomplished their core knowledgeabilities so that they are better informed to direct project performance. There are three types of activities that comprise co-ordinating: Controlling; Staffing; and Nudging. ICT allows actors the ability to collectively evaluate and confirm, and thus be able to support actors’ ability to know how to direct their work performance as the project moves forward. ICT may also inhibit such knowledgeability by constraining an actors ability to instantly respond to the coordination. Table 4.6 provide a summary of the knowledge in practice, relevant activities and their explanations in co-ordinating knowledgeability.

Table 4. 6 Summary of the co-ordinating knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Co-ordinating  Explanation: Knowing how to direct performance | Controlling | Actors evaluate each other’s performance in order to control the quality of project performance and control the project moving on the correct direction. |
|  | Staffing | Actors (re-)arrange personnel, allocate them tasks and roles, and get them agreed to conduct next unity of actions as project moving forward based on their existing achievements. |
|  | Nudging | Actors push each other’s work performance gently as project moving forward |

**Controlling**

Controlling refers to activities in which actors evaluate each other’s performance in order to control the quality of project performance and ensure that the project is moving in the correct direction. ICT is leveraged here to provide collective evaluating abilities which enables actors to make evaluations together and recognise good or bad decision making. This allows actors to develop their knowledge on how to direct project performance in the project decision making process. As one interviewee notes:

*“**We have been selecting our buyer companies together, definitely. The selection has been done together, and it has been a mutual agreement and this doesn’t mean that big companies are safe because we have scored them. All the cities have got the scores for each application. And then that after the striking and scoring, we have been selecting companies. So, it has been very democratic… Quite often we have been using excel when we are doing this kind of evaluations or scorings… we got very good feedback on it because we were able to share the questions, the criteria and the documentation in one place. And then they were putting their scorings. There was possibility that multiple persons will evaluate the same document or the same tender and they will put the scores at the one place. And when you had submitted your own scores, you were able to see which ones has got what kind of scorings that others had given and commented.* *And based on those evaluations. We were making the ranking. And then the partners, the buyers group, they had a meeting where we go through this this list and these companies and decided which are good. And these companies will become ones that we like to continue in this project or select in this project”* *(Project A3, Participant 1, Para. 28-32)*

The above example shows that people make decisions together and determine their next stages’ collaborators (buyer companies). The way that actors evaluate each other and avoid any bias reflects a very democratic (as they indicated) context within which everyone is treated or wishes to be treated equally. With the aid of Excel, people are able to review and comment on each other’s performance and make judgements, which reflects a transparent environment where everyone can understand how such an evaluation is produced. The material properties of Excel such as the digital scores, provides actors with a collective evaluating capability that allows decisions to be made afterwards so to direct project performance. People evaluate others’ work and provide comments that promote their performance, and at the same time receive feedback from others so that they can reflect on what level of performance is required and what improvements could be made, through which they are developing knowledge of how to direct their future performance.

**Staffing:**

After accomplishing core knowledgeabilities in ICT-based inter-organisational knowledge exchange practice, actors may provide a response as a reaction to their achievements in the project. Staffing refers to activities in which actors (re-)arrange personnel, allocate them tasks and roles, and get them agreed to conduct next unity of actions as the project moves forward based on their existing achievements. ICT is leveraged here to provide actors with confirming abilities which enables them to evaluate the arrangement of their next unity of actions in the staffing activities. This allows actors to develop knowledge of how to direct project performance by allocating the right actors into right role as the project moves forward. As one interviewee notes:

*“**We are using the service called right signature* [to confirm our agreement to our allocated roles and responsibilities on the project contract]*. So rightsignature.com is a website and I’m uploading the pdf documents there. And then I will send the link to the people who are going to read and sign the contract on behalf of the companies and also to our CEO in FVH who is signing the form from our side. If they agree with those contracts, they will sign them on the right signature.” (Project A3, Participant 1, Para. 24)*

The project contract indicates an agreed role allocation for all project stakeholders, responsibilities, and their obligations to work in their collaboration. The failure of verifying such an agreement may have a significant impact on their participation in the next collaboration step. Such a contract can be viewed as an achievement resulting from their basic accomplishment of knowledgeabilities in ICT-based inter-organisational knowledge exchange practice. ICT, such as Rightsignature, allows people to evaluate and confirm the content of the project contract. The materiality of Rightsignature affords actors the ability to confirm and sign the contract collectively. The final signed contract indicates that all organisations are satisfied with the agreement’s content. These activities sometimes need to be done by the representative of the stakeholders’ own organisations (e.g. CEOs), so some internal organisational factors (such as an organisation’s own information system for partners to share information or links) may also take part in these activities. This reflects staffing activities that may take place within both the inter-organisational context and the intra-organisational context.

**Nudging:**

Nudging refers to the activity of actors gently pushing each other’s work performance to move the project’s progress forward. This activity may occur as a result of existing performance not reaching expectations or not matching requirements. ICT is leveraged here may constrain actors’ instant responsiveness ability and thereby inhibit actors to develop their knowledge on how to direct their performance as the project moves forward. As one interviewee notes:

*“**Some of our partners sounded like they can do almost everything. They’re super talented. And they probably are. But it has been a bit slow to work with these partners recently. They are nice people. But for some reason, their performance is quite behind our progress. And because I’'m working as a project manager, and both with my supervisor, he’s also part of the project, but he has really a smaller role in it. And he has technical background. And he’s like, “could these partners do something”" I had this question as well and I would send them emails and ask for reasons. But no one replies, I don’t know.” (Project A1, Participant 1, Para. 21)*

Actors usually have some expectations of the performance of others in collaboration tasks, especially those who sounded talented. However, it may not be possible for the real quality of a performance to align with these expectations. For example, in the above example, an actor (participant 1 in project A1) seems to have confused feelings about the existing performance of some of project partners and think their performance is delaying the progress of their project. This may because at the inception stage of inter-organisational collaboration, people may not be very familiar with each other and their general level of performance. Such a mismatch can lead to confused feelings that usually result in queries such as emails which enquire about the reasons and request improved performance for the future tasks. However, it is difficult to obtain a response from those with a low performance level from communication media such as emails, and therefore this prevents actors from developing their knowing how to direct their performance for the project.

## 4.3. Middle Stage Findings

Figure 4.2 presents a framework of ICT-based IOKE during the middle stage of Living Lab projects. This section presents a detailed discussion regarding the concepts that emerged in relation to an ICT-based IOKE process for the project middle stage. Quotations are provided in the following structure: content of quotation; ID of the project stage (B indicates the middle stage); ID of project number; ID of interviewee; and the paragraph number in specific interview transcripts. For example, *“(Project B2, Participant 1, Para. 60)”* indicates the middle stage project, project no.2, interview participant no. 1, and paragraph no. 60 in the interview transcript.

Diagram

Description automatically generated

Figure 4. 2 ICT-based Inter-organisational Knowledge Exchange Practice (Middle Stage)

At the project middle stage, inter-organisational knowledge exchange practice is continuously taking place in three layers: inter-organisational, intra-organisational, and environmental context; being influenced and influencing diverse embedded contextual characteristics; and mediated by ICT. Interorganisational knowledge exchange practice at the project middle stage is characterised by four different knowledgeabilities, namely: inter-connecting, expertise simulating, collaborative problem solving, and co-ordinating. Each of these knowledgeabilities are enacted through different activities and are mediated via ICT. Two of these knowledgeabilities: expertise simulating and collaborative problem solving (i.e. knowing how to develop skills, and knowing how to innovate) are viewed as core knowledgeabilities because they are recognised as core abilities in the pursuit of project goals at the project middle stage. These core knowledgeabilities occur only when actors can connect to each other, i.e., inter-connecting is a condition or antecedent for these knowledgeabilities, whereby knowing how to cultivate relationships with different actors is enacted. As a result of the enactment of expertise accumulating and collaborative problem solving, actors will co-ordinate their project activities moving forward, which allows them to develop knowledge regarding how to direct project performance to move forward. Therefore, co-ordinating becomes the resulting knowledgeability of these core knowledgeabilities. As part of the ICT-based interorganisational knowledge exchange practice, actors enact their different knowledgeabilities with the support of ICT to achieve their goals, and their knowledgeabilities are thereby (re)produced in recurrent inter-organisational knowledge exchange practices. As a result, ICT plays a significant role in these practices by affording or constraining different action possibilities while actors engage in activities.

The above are summarised in Table 4.7. In the project middle stage, there are four different knowledgeabilities within the ICT-based IOKE practice, each of which is an expression of different knowledge in practice and becomes enacted or performed via different activities. The final column indicates how ICT mediates actions as part of each knowledgeability, affording or constraining actors’ distinct skills. These are discussed in detail in the next sections.

Table 4. 7 Summary of knowledgeabilities in ICT-based IOKE practice, its relevant activities, performed knowledge and ICT affording and ICT constraints in the middle stage of the project.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Knowledgeabilities of ICT-based IOKE Practice** | **Knowing in practice** | **Activities** | **ICT-Afforded Abilities** | **ICT-Constrained Abilities** |
| Inter-connecting | Knowing how to cultivate relationships | Embedding in Real life  Cultivating Partnership  Connecting  Bridging  Socialising | Cross-distance Networking  Context Familiarising  Notifying | Stable Communicating  Appealing  Informal Interacting |
| Expertise Accumulating | Knowing how to develop capabilities | Guiding  Training  Sharing  Elaborating | Visualising  Ubiquitous  Learning Ahead  Customising | Immediate Transforming  In-person Demonstrating  Communication Continuity |
| Collaborative Problem Solving | Knowing how to innovate | Co-designing  Collaborative Writing  Group Discussing | Sticking  Instant Workaround  Cross-Referencing | Humour Ability |
| Co-ordinating | Knowing how to direct performance | Adapting  Staffing  Monitoring | Documenting  Assigning  Tracing |  |

### **4.3.1. Inter-connecting and ICT**

Inter-connecting refers to a knowledgeability by which actors become inter-connected with the help of ICT to establish a network among them. At the middle stage, there are four types of activities involved: Embedding in Context; Connecting; Bridging; and Socialising. During these activities ICT can facilitate such inter-connection by affording actors cross-distance networking, selective networking, context familiarising, and the ability to interact informally to develop their understanding of how to cultivate relationships with others. At the same time, ICT may inhibit such enactment of knowledgeability by constraining their ability to stably communicate with each other. Table 4.8 provides a summary of inter-connecting knowledgeability, its accomplished knowing-in-practice, activities that allow the enactment of such knowledgeability, and their explanations.

Table 4. 8 Summary of the inter-connecting knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Inter-connecting  Explanation: Knowing how to cultivate relationship | Embedding in Context | Actors embed themselves in each other’s context to deepen relationship with each other. |
| Connecting | Actors approach each other and interact in order to achieve work-related goals. The connecting activity indicates how actors get inter-connected to develop their knowing how to cultivate a workplace goal-oriented relationship. |
| Bridging | One or more actors work with individuals and groups of actors to bridge their different backgrounds. With the support of these actors, actors of different backgrounds are able to understand each other and connect with each other more effectively. This, in turn, allows them to develop an understanding of how to cultivate a relationship with the involvement and help of a third-party. |
| Socialising | Actors get together and chat informally for some social goals (i.e. non-work related goals) and thus develop informal communication. This allows them to develop their understanding of how to cultivate a social and informal relationship during the project. |

**Embedding in Context**

Embedding in context refers to activities in which actors immerse themselves in each other’s context to network with each other in order to deepen their relationships. In the middle stage project, actors start a process of familiarisation by embedding themselves in a real life context. The real life context is a special setting in Living Lab projects that offers real life characteristics to the inter-organisational context. For example, actors in a Living Lab project usually need to become familiar with their collaborators, such as the citizens/end users involved, by deeply exploring and understanding their real-life scenarios, including: their personal habits, workplace culture, and embedded wider environment, and the relevance of these to the project-goals. This also shows that ICT-based IOKE is embedded and influenced by diverse contextual factors. Actors visit their collaborators’ physical setting; they communicate with them and exchange information in order to deepen the relationship with each other. As such, ICT affords actors with the ability to become familiar with the real life context and the involved activities, whereby ICT such as social media and LinkedIn allows actors to learn more about the context of their collaborators, their work, their life, and their potential contributions to the project. This then facilitates the development of how to cultivate relationships with each other during these activities. As one interviewee notes:

*“**We embed ourselves very much into the particular context… we entered into the context, spoke to the municipalities and the artists and so on. And that’s how we get to know them. And we do a lot of pre study to be able to get their involvement not based on just looking from desktop research but based on actual stories and experiences. And the podcast was actually a tool to get to know this context and the artist and so on. Of course, I work for a lot of years already in Belgium. And so, I know a lot of artists, personally. But early in every project, you need to embed yourself very much by understanding their perspectives. That is very important aspect. And we bring the story about this perspective via different tools. So, in this case, they are the podcast, but also added with the posters such as pictures and stories.” (Project B2, Participant 1, Para. 60)*

As collaboration moves to the middle stage of the project, there will be some collaboration tasks that will have been completed, which can facilitate the cultivation of deeper collaborative relationships between actors. As the example described, stakeholders in project B2 have done many pre-studies to learn about their participants and involve them in the project. Actors’ previous experience can facilitate this involvement process, for example in the above quotation stakeholders may already know some suitable participants involved in their previous project experiences from their own organisation in Belgium. This shows that actors’ experience from intra-organisational contexts can facilitate inter-organisational collaboration. ICT can also facilitate such involvement since they allow people to familiarise with the context of their collaborators. For example, actors can use ICT such as podcasts and posters to learn about their collaborators’ real life experience when they try to network. Due to the nature of Living Lab project, such involvement focuses more on the consideration of the characteristics of real-life settings such as collaborators’ actual situations and perspectives in their daily life. This means that these collaborators’ intra-organisational and environmental contexts are deeply investigated as they are inter-connected into inter-organisational collaboration, which facilitate actors to recurrently accomplish inter-connecting knowledgeability facilitated by ICT.

**Cultivating Partnership**

Actors establish initial contacts to build up and cultivate initial relationship such as project partnerships by cultivating activities such as approaching new partners. Actors in the Living Lab project at the middle stage seems to require continued reaching out to new partners to get them into the partnership, which may be due to the nature of the Living lab project that requires wider perspectives for co-creation. In doing so, actors may need to manifest themselves in an attractive way to facilitate the involvement and inter-connection, while the use of ICT here may inhibit such an accomplishment by constraining actors to make their works appealing to new participants. As one interviewee notes:

*“What the main thing we noticed is that most of the time we use LinkedIn, ’it’s the main way that works the best. But our reach is in a very small way. And you see that the problem is to get contact with a lot of attention from a lot of people, that’s the difficulty we are facing. Because’ it’s not interesting enough I think for people to get to read it or to get in contact with us.”* *(Project B1, Participant 1, Para. 64)*

Actors from project B1 are trying to use LinkedIn to inter-connect with new collaborators. However, the use of ICT does not allow actors to display their works in an attractive way or be seen by a large number of people, which results in a failure to cultivate new partnerships to accomplish inter-connecting actor knowledgeability.

**Connecting**

Connecting refers to the activities through which actors become assembled together to establish workplace goal-oriented relationship with each other. For example, actors in a project usually need to meet up with each other to discuss project activities. In connecting activities, actors use ICT to contact each other for some specific work-related purposes, which allows them to understand how to establish their workplace relationships. ICT facilitates actors notifying abilities that allow them to inter-connect with each other in the workplace and develop such understanding in practice. As one interviewee notes:

*“Communication is important all the time. So, within our group, we had many communications through email and also Microsoft team meetings with our colleagues to discuss our some project activities. Once we receive these meeting invitations, we know what we are going to talk about. For example, what do we do with the themes in our next workshops? What cases do we take? Which are the three cases that we’re going to use, etc.” (Project B2, Participant 3, Para. 60)*

Actors may need to meet up with their collaborators to discuss diverse workplace goal-oriented topics, such as the themes for workshops and cases to be discussed. These communications can only take place when they know how to become inter-connected. ICT, such as email and Microsoft teams with invitation notifications, are frequently used to provide/afford actors with notifying capabilities so that they can be informed about meeting topics as they develop interconnecting knowledgeability before they start communicating in a meeting.

In addition, the use of ICT may also promote actors networking ability, because sometimes actors may become connected from geographically distributed locations whereby the use of ICT allows actors cross-distance networking ability. As one interviewee note:

*“As you see in the project, the farthest distance is almost 100 kilometres. So, in this project, I think distance is not the biggest issue. I noticed that in other European projects, when you have a partner in the south of England, then the distance is an obstacle, of course. Then when you have to meet each other, that will take you two days or 1 day to go to there, and the other day to get back. So that are the biggest problems, I think, within the European project. But in this project, that was not a big problem’ It’s more flexible in choosing digital or physical cooperations in this project. And now you see in this time of Covid-19’ it’s easier to meet each other on a digital platform and we do that. So ’hat’s advantage when you compare it to a physical meeting” (**Project B1, Participant 1, Para. 90)*

Actors in the middle stage of a Living Lab project can continue their work either remotely or face-to-face working. This depends on the distance among project stakeholders. In project B1, the distance among stakeholders is not that great, which allows actors to flexibly choose their way to get connected. Due to environmental crisis, i.e., Covid-19 pandemic, actors may not be able to conduct face-to-face connection, so the use of ICT with digital meeting platforms allows them to continue getting together regardless of constraints caused by distance and so provide actors with cross-distance networking capabilities.

However, remote working with ICT may not always be successful since actors may not always have access to a stable connection as they use ICT. Due to unstable wi-fi or internet connections, ICT may constrain stable communication between actors, which may inhibit actors enact inter-connecting knowledgeability during the project’s middle stage. As one interviewee notes:

*“The challenge with technologies is usually getting everyone to connect smoothly. Yeah, so due to the danger of technical problems, such as unstable digital connections, Wi-Fi connections, sometimes during our meeting, suddenly someone drops out, and our connection is interrupted.” (Project B2, Participant 2, Para. 78)*

**Socialising**

Socialising refers to activities in which actors communicate informally for social purposes. As the project moves to the middle stage, actors may become more familiar with each other, so more informal communication is expected to take place among them, further developing their informal relationships. However, remote working with ICT may constrain on actors’ informal interaction. As one interviewee notes:

*“I think that face-to-face meetings we have experienced have the advantage that we are talking to each other between the meeting break and we have lunch together and we meet each other, we chat to each other to familiar with each other in an informal way. And on a digital platform, you miss that kind of informal contacts, which I think is the main problem when we only have digital meetings.” (Project B1, Participant 1, Para. 86)*

In face-to-face meetings, there seems to be breaks during which actors can develop informal relationships. These breaks give actors space to network with each other usually in an informal way, such as having lunch together, which allow actors to cultivate an informal relationship. However, these types of relationships seem to be constrained by the use of digital meeting tools. The use of digital platform seem to only allow actors to have digital meetings that are related to their project work. They don’t have breaks during digital meeting that allow them to cultivate informal relationship when they use digital platform. Therefore, such digital platform poses a constraint on limiting actors’ ability to perform informal interacting, which inhibit actors to enact their inter-connecting knowledgeability and barricading their knowing-how to cultivate informal relationship.

### **4.3.2.** **Expertise Accumulating and ICT**

Expertise accumulating refers to a knowledgeability enacted in which actors learn from each other’s expertise and thereby accumulate further skills. At the middle stage, with project collaboration becoming more intensive, the enactment of expertise accumulating entails that actors actively engage in learning-by-doing to develop their knowledge of how to develop their capabilities. Actors acquire this knowledgeability through four primary activities: Guiding; Training; Elaborating; and Sharing. ICT can support such accomplishment by affording actors with visualising, ubiquitous, learning ahead, and customising abilities, whilst at the same time, constraining actors in immediate transforming, communication continuity and in-person demonstrating abilities. Table 4.9 provides a summary of expertise accumulating knowledgeability, its accomplished knowing-in-practice and activities that allow the enactment of such knowledgeability, and their explanations.

Table 4. 9 Summary of activities and explanation in expertise accumulating knowledgeability.

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Expertise Accumulating  Explanation: Knowing how to develop capabilities | Guiding | Actors develop their behaviours under guidance of experts. |
|  | Training | Actors engage in an intensive skill development process under training of experts. |
|  | Elaborating | Actors learn from each other under a detailed explanation to their works. |
|  | Sharing | Actors learn from each other as they share their insights and expertise. |

**Guiding**

Guiding refers to an activity through which actors develop their behaviours under guidance of experts. When engaging in guiding activities, actors actively learn and improve their skills and level of knowledge under guidance provided by experts or experienced people. In the middle stage of a project, since there are still new participants or partners involved into the project, guiding activities provide and opportunity for new actors to develop their understanding of how to develop skills under the guidance of project relevant experts. ICT may be useful to support such accomplishments by allowing actors to learn ahead so that they can accumulate expertise under experts’ guidance in advance. As one interviewee notes:

*“This website was prepared as a sort way to communicate about all this later on, but it was also a sort of website for people who would participate in the workshops. They got the link and they also got the links to the website. And there were even small broadcasts made. You can see them in the menu, there’s also a broadcast. And then in the when just about 2 days or a week before a workshop, on the broadcasts, more film about the theme would be put on the website. So everyone, before they participated in the workshop, could go to the website, browse it, and look at the small outcast, which is a small film explaining thing and a very briefly introducing the three cases. They are related to the theme as a sort of an intro that people could do at home, preparing a bit for the workshop. And so we’don’t lose time for that. I think ’hat’s also very efficient way to have participants organise their own leisure timing, and they just go to the website, browse, look at the field at the broadcast in advance.”* *(Project B2, Participant 2, Para. 47)*

In the middle stage of the project, more typical Living Lab activities, such as workshops for co-creation, are being organised. This requires project members to recruit new participants such as end users or citizens into the workshop for inter-organisational collaboration. As new participants become involved in the project, they may need some guidance on what the workshop is about and what tasks they need to perform. At this stage, the guidance is usually very detailed information, which is usually time-consuming to deliver during a short period of time such as a workshop. Therefore, the project team in the above example use websites as a means to provide guidance. The websites afford participants learning ahead ability, so that they can develop their skills ahead of the workshop communication. This facilitates actors to enact their expertise accumulating knowledgeability in guiding activities.

Although guiding activities organised for a group of actors are usually rich enough to support actors to accumulate expertise, there are also other guiding activities taking place interpersonally. The use of ICT thereby may not allow actors to demonstrate full insights or expertise for their collaborators to learn, by constraining their in-person demonstrating ability (ability to demonstrate expertise inter-personally in a face-to-face way). As one interviewee notes:

*“If they have trouble with the technical side, they ask me,* *as far as I know I will guide them to solve the issue, of course, because I have a technical background. But sometimes I will say, yeah, I can make it but I cannot tell you right now what’s going on in a virtual meeting, because it is too complex to explain verbally.” (Project B2, Participant 3, Para. 60)*

Living Lab project partners have diverse backgrounds and a diverse portfolio of expertise, there are occasions when partners can rely on each other’s distinct expertise to deal with a problem. In the above example, partners may sometimes also need guidance from technical experts to deal with problems. Sometimes this technical expertise may be too hard to explain verbally and require in-person demonstrating. However, due to the materiality of virtual meeting tools, that only allow virtual interacting in a digital way, an actor’s ability to demonstrate results and engage in-person is constrained, which inhibits actors’ enactment of expertise accumulating knowledgeability.

**Training**

Training refers to an activity through which actors engage in a skill development process under the guidance of experts. As actors are trained, they learn new skills and acquire a better understanding of how to develop their abilities. ICT may be useful in supporting such accomplishments by providing actors with ubiquitous ability so that actors can acquire more detailed guidance to facilitate learning. As one interviewee notes:

*“We at first really need to know how UIA platform works and how it can be used. So at the start of the project, two of my colleagues were going to Brussels. They received some lectures in college about how UIA works and what you have to do and what you have to sign in so that. So, they give you information and also the access to UIA website. And now we are using this website very frequently at this stage because you can find all the information that is necessary to fill in all the requirements of the UIA, so you can directly learn them on website anywhere and anytime when you need. Third, we have one contact person within the UIA and you can call him or email him or meet him virtually about questions anytime and he will help us how to work and how to cooperate.” (Project B1, Participant 1, Para. 34)*

Actors in the project sometimes need to learn how to use resources that support their collaboration and help achieve project objectives. This requires actors’ to repeatedly practice their learning under guiding knowledgeabilities as provided in their training activities. In training activities, actors may seek internal or external expert guidance to guide them to learn complex resources, which allows actors to recurrently develop their understanding of how to develop their aptitude on using the resources. Thanks to the website of UIA that displays all relevant expertise online, project members can enact their expertise when accumulating knowledgeability, which allows them to develop their skills anywhere and anytime. Also, the use of phone calls, email and virtual meetings allows actors to easily communicate with experts from the UIA community whenever needed. This shows how technologies enable people to develop knowledge and understanding and how to develop skills in training activities, by providing people ubiquitous ability so that actors can be trained at anytime and anywhere.

As another interviewee also spoke about such training activity:

*“We used the Miro to do the works... we have adapted our tools based on this new situation since working online. So, Mirro is certainly one that we changed. If you look at the general website, also the podcast, so we asked people who participated each time before the session to listen to the pod cast, because the pod cast told the story of the three projects that will be discussed during the sessions. And you didn’t want to do that again, like the online lecture where you have to follow all the time. Now with a podcast. You can do that while you’re running or doing your exercise. It’s a nice way to engage with the project, but it doesn’t require you again to sit at the screen. And so, you can listen to it, which was nice.”* *(Project B2, Participant 1, Para. 26)*

Diverse expertise in inter-organisational collaboration increases complexity within the inter-organisational context and thereby the practice of learning and accumulating expertise becomes time-consuming. Therefore, actors may use technologies to increase the effectiveness of their learning process. For example, actors may use Miro podcast to learn tasks or project information before each discussion session, such as workshop sessions. In this way, actors can be trained to be aware of all information and expertise that they need about the session in advance, so that they can effectively join the discussion session afterwards. Actors can use Miro podcast whenever they need, since this podcast allows them to participate in training anywhere (i.e. running or doing exercise) and anytime (i.e. do not have to learn within a fixed time period). Therefore, ICT such as the Miro podcast provide actors ubiquitous ability so that they have access to such training activities and develop their knowledge and understanding of how to develop skills anytime and anywhere they need.

**Elaborating**

Elaborating refers to activities in which actors learn from each other and offer a detailed explanation of their works. In the middle stage of the project, actors may have produced some unique work that may indicate complex insights that is hard for others to understand. By explaining these project works, other actors are given the information to help understand these insights and the expertise needed to produce them. This in turn helps with expertise accumulation, thereby helping to enact their knowledge and how to develop these skills. ICT may enable such enactment of knowledge by providing actors with the tools to visualise their insights in a digital form that is easier to understand. As one interviewee notes:

*“I created* [this website] *because the university asked me to, and more specifically, the university asked me to show all pieces of information about the project in an article structure. And the main important thing is, how are they connected to each other. Because it’s a woven structure in a kind of network. And the challenges to create this is in the beginning, there are only small, connected groups and projects. And then we used a force field, implementation. So, in every dot we have power and will push all this away. But when it starts becoming a lot of notes, it was not clear anymore or everything is not clearly connected. So, then we evolved this structure to more coloured dots where the yellow, the green, and the black ones, the initiatives, the events, and the tools have a fixed place, and the others are in power. The main goal that it was created for is to provide the information and overview visualization to the researchers.” (Project B2, Participant 3, Para. 28)*

Actors in the project have their own allocated tasks, which in this case is to create a website as a means to demonstrate project information for some target audience (e.g., researchers in this case). Such a website affords actors to be able to visualise project concepts, ideas, or activities with distinct colours or icons, which greatly facilitates the audiences’ understandings. Via this medium, actors are able to share their insights accumulating knowledgeability from this project. The website is also developing as the project progresses. In the project’s middle stage, the visualised information becomes much more detailed on the website and the structure is evolving to facilitate the dissemination of information. This indicates the use of ICT are also evolving in ICT-based IOKE practice.

However, ICT may not always be suitable in supporting actors to conduct elaborating activity, and the different uses of ICT may also constrain actors’ communication continuity ability as actors enact their expertise accumulating knowledgeability. As one interviewee note’:

*“**It’s easier to understand what people say in the real setting... because people usually have video off in online meetings when they talk, so there are usually someone interrupting, and internet connection* [may interrupt] *as well, and this leads to confusion sometimes. So, it’s easier to let each other speak their whole sentence without interruptions in real meeting.” (Project B2, Participant 3, Para. 78)*

Technological infrastructure may be not stable all the time and different people may use the technology differently. These environmental factors and personal preferences may lead to interruptions when actors are explaining their project work, as indicated by participant 3 from project B2. As a result, any explanation be given of the project may be interrupted, and actors would be unable to maintain learning in this situation.

**Sharing**

Sharing refers to the activity through which actors learn from each other as they share their insights and expertise. At the middle project’s stage, sharing activities entail actors sharing information or expertise with each other and so accumulation of expertise for the project. With the enactment of expertise accumulating knowledgeability, actors are able to translate each other’s insights, and increase their own understanding and develop their own skills. ICT can facilitate in this by providing actors customising ability. As one interviewee notes:

*“**We knew that it was a bit risky to work with a kind of Miro board in this case, because often artists are quite allergic to like this kind of workshop setups. They want to operate very autonomously and so on. So forcing them in a structure is not always working. Well, we try to pay very much attention to that. So that’s why we always ask them to use the pod cast. So actually, they could tell and share their story in their own ways, in their own contexts as so they could share their stories about their artwork.”* *(Project B2, Participant 2, Para. 20)*

In the above example, actors, for example artists may have diverse stories which are recognised as valuable expertise for the project. However, actors may have their own concerns that can inhibit their intentions to share their insights. Actors are not forced to provide expertise through a structured procedure which reveals a respectful and flexible workplace climate. This indicates a great strength of inter-organisational contextual factors on ICT-based IOKE practice. Instead of using structured ICT tools such as Miro that may cause stress, actors instead use podcasts to share their expertise. Podcast in the above example allow actors to customise their insights in a form that they feel comfortable with, which mitigates their concerns on sharing and allows the project team to develop their understanding towards these insights. Accordingly, their understanding of how to develop skills is accomplished in these sharing activities.

However, ICT sometimes do not allow sharing of distinct types of content such as a specific apps due to the fixed nature of its materiality. This may constrain actors’ immediate transforming ability in sharing activities. As one interviewee notes:

*“We’re trying to share as much as possible, mainly the documents on SharePoint when we have intensive discussion in our virtual meetings such as the main appointments we make in the meetings, and we also share photos online. In addition, we share documents, for example, the application form… However, as we share too many types of documents, they cannot be transformed for sharing immediately. What you see is that, for example, we are developing an Ap’. You can’t share it on SharePoint. That’s difficult to share itself. There are two partners working on that App. And they are working together so they can share their information between them on the app but not by the other partners nor by SharePoint. Although they would like to respond to our questions, but it’s hard, because we don’t know what they are referring to when they discuss about that app. So, we are just disengage and wait for them there.” (Project B1, Participant 1, Para. 96)*

The use of SharePoint allows actors to share a diverse range of work materials with each other. However, since actors in the project possess different expertise, sometimes there are distinct forms of materials that require immediate transformation into an understandable form that every actor can use. The use of SharePoint seems to constrain actors immediate transforming ability when sharing activities preventing actors from understanding the shared information, so actors may have to disengage in from sharing activities.

### **4.3.3. Collaborative Problem Solving and ICT**

Collaborative problem solving refers to a knowledgeability through which actors support each other with new ideas to solve emerging problems and propose better solutions. In doing so, actors are better able to develop understanding of how to innovate collectively. There are two primary activities that comprise collaborative problem solving in the middle stages of projects: Co-designing; and Group Discussing. ICT facilitate such collaborative problem-solving by affording actors sticking, cross-referencing, and instant workaround abilities, however, it may also constrain actors’ ability to be humorous when performing collaborative problem-solving knowledgeability. Table 4.10 provide a summary of knowing in practice, relevant activities and their explanations in co-creating knowledgeability.

Table 4. 10 Summary of activities and explanations in co-creating knowledgeability.

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Collaborative Problem Solving  Explanation: Knowing how to innovate | Co-designing | Actors encourage each other to generate new ideas that can inform new product or service design. |
| Collaborative Writing | Actors get intensively engaged together to support each other in the achievement of writing tasks. |
|  | Group Discussing | Actors provide opinions on each other’s thoughts to rich discussion about some concepts or topics during group meeting. In the middle stage, the aims of group discussion is that the opinions provided by actors encourage each other to generate new insights or ideas during group discussion. |

**Co-designing**

Co-designing refers to activities in which actors encourage each other to generate new ideas that can inform new products or service design. In the middle stage of the Living Lab project, the team has usually started involving public or end users into their co-design process where many workshops labelled as co-creation sessions are conducted and co-design tools are adopted. In co-designing activities, diverse actors work around specific concepts, improve and develop these concepts by stimulating each other’s ideas. ICT used in these activities usually allow actors sticking ability so that they can always work on specific concepts together. As one interviewee notes:

*“Now we have these Miro boards for our co-designing. In this case it was about the theme of production and economy. We started always with a mapping of the project, so you see a map in more detail. My colleagues can follow me by if clicking on my little circle, then they can see where I am. So here and we start with a map, then some pictures of the projects that are discussed, such as its interesting aspects, confusions, etc. Many innovations related to these pictures comes out from such discussion.” (Project B2, Participant 1, Para. 23)*

For each workshop there are specific themes such as ‘production and economy’. In the above example, indicates a strong focus on their co-design process. In the project middle stage, there should be some concepts or pictures already worked out and where a focused interaction around these pictures informs new ideas that are generated as innovation outputs. The use of Miro boards can facilitate stimulation of such ideas by affording actors sticking function that allows them to always stay with their collaborators and work around specific concepts or pictures together.

**Collaborative Writing:**

Collaborative writing refers to the activity in which actors are intensively engaged together to support each other in the achievement of writing tasks. In the project’s middle stage, collaborative writing entails that actors encourage each other to revise and improve writing outputs. ICT allow actors to directly comment on each other’s thoughts by offering instant workarounds so that they can improve their work continually. By working together in collaborative writing, actors may ask questions and give feedbacks to each other frequently helping to generate new insights, which allow actors to increase their understanding of how to innovate in the project. As one interviewee note:

*“The most important is MS Teams, and the channels in MS teams, because we have shared the documents in those channels so we can comment on each other's documents at it through those channels. In this way, we can produce a better version together, so the channels are most important… Although it's still important for every developer to see all the documents, but mostly, there are no changes made in the documents [but mainly comments]. For example, they are mostly commented like ‘I hate this, or I should make something like that’. Then our colleagues* [will respond like]*, ‘can you look into this and see if you can find the right information you need’. They may change or may not change these writings based on the comment, it depends on themselves, but everyone respects each other’s primary work. In this way, we collaborate together and make innovations in our documents.” (Project B2, Participant 3, Para. 90)*

In the above example, actors use MS teams to support their collaborative writing of project documents. As they write together, actors may raise problems or seek help from their collaborators, and MS teams allows them to post their thoughts on the documents. Other collaborators may get notifications and respond to these questions. By doing so, they do not change each other’s work directly but only provide comments for others to consider potential improvement, which again shows the respectful nature of inter-organisational knowledge exchange. Actors also have their own preference to accept or not accept others’ comments based on their own expertise. The use of MS teams provides actors with the tools to interact together in collaborative activities and be inspired by others feedback and effectively improve their work. This shows how collaborating activities help actors to develop their knowledge of how to innovate and recurrently accomplish their collaborative problem-solving knowledgeability as they collaborate together.

**Group Discussing**

Group discussing refers to the activities in which actors provide opinions on each other’s thoughts to enrich discussion about some concepts or topics during group meeting. In the middle stage, group discussions entail that the opinions provided by actors are used to encourage each other and generate new insights or ideas. Actors in such an activity engage in an idea exploration process by stimulating each other’s thoughts and inspiring new ideas. Through group discussions, actors recurrently accomplish their collaborative problem solving knowledgeability, and develop their knowing how to innovate for the project. ICT in these activities provides actors with cross-referencing tools so that they can use a variety of sources together to stimulate idea generation. As one interviewee notes:

*“I think it helps another thing, for example, it is also an advantage of doing this digitally and having these discussions in Miro because you are using your computer, something that I did a lot when you have a discussion and someone mentions another artwork or mention something else, I can immediately google it and find some information about it to resolve any confusion. So the fact that I just have, I’m using my computer and having this workshop on my computer and I just open another window and I can check something or I can check a website, or I just put the URL website in the chat. That's okay. Everyone can click on it. And they all see the same website and you can continue the conversation and you talk about what they see on the website or et cetera. So’ yeah, it's fantastic that you have all those references available by clicking them when you're discussing things.” (Project B2, Participant 1, Para. 76)*

Actors during group discussions may propose new ideas that, however, may be confusing for others. With the aid of ICT, actors could work around those ideas immediately to resolve the confusion. ICT such as Google provide actors with the option of cross-referencing which allows them to refer to more detailed information from other sources and work around and discuss the same thing more deeply with gaining richer information. Miro board has the chatbot function that allows actors to copy and paste URLs, enabling everyone to stick with each other to discuss the same thing topic during group discussions.

There are also other ways to inspire new ideas during group discussion activities, such as joking with each other. However, the use of ICT may constrain this. As one interviewee notes:

*“New ideas are usually coming from meeting with random people and with random talking and humour, especially humour because many good things come up from humour. But ’hat doesn't exist in online events. For example, in this project we had an activity to measure steady tires. It was before the covid times and in one workshop, there were people who needed to just be on the street side and listen to the cars if they have steady tires or not. So, people were just standing on the road listening, and then talking and reflecting together about what they have heard. There are usually some jokes coming out as they talk, and from that kind of joking, joking about real things, which came into the innovation. This I think cannot come from technology, but exactly it's a good example that some innovative things don't happen in MS Team meetings. So, people don't joke about things in MS Team meetings and then get new ideas from that* [when online]*.” (Project B3, Participant 1, Para. 80)*

Living Lab projects usually require actors to co-create in their real-life experiences. In the above example, actors stay together and reflect on what they have learnt in the real-life settings and interaction with each other. The context of real-life seems to provide actors a relaxed environment that allow them to comfortably interact with each other face-to-face. Such context and the way actors interact face-to-face enables them to develop a sense of humour, so they are able to joke as they reflect. This seems to greatly enhance the process of exploring ideas and stimulating innovation. However, ICT seems to constrain an actor’s ability to be humorous in developing their knowledge about how to innovate, and thereby inhibiting an actor from using their co-creating knowledgeability.

### **4.3.4. Co-ordinating and ICT**

Co-ordinating refers to knowledgeability enacted by actors which helps generate reactions to the outputs of others’ work or themselves in order to move their work forward. At the project’s middle stage, this entails how actors coordinate their works based on their previous achievement. This usually leads to changes in their existing organising practices. There are three types of activities that comprise co-ordinating: Adapting; Monitoring; and Staffing. ICT can help actors by affording them documenting, tracing, and assigning ability to support actors in their understanding of how to direct their work performance as the project moves forward. Table 4.11 provide a summary of knowing in practice, relevant activities and their explanations in co-ordinating knowledgeability at the project’s middle stage.

Table 4. 11 Summary of the co-ordinating knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Co-ordinating  Explanation: Knowing how to direct performance | Adapting | Actors change their behaviours regarding existing organising practices in order to make them suitable for new situations |
|  | Monitoring | Actors keep checking the projects performance closely as the project is progressing in order to monitor how work develops so that actors can make any necessary changes |
|  | Staffing | Actors (re-)arrange personnel, allocate them tasks and roles, and get them agreed to conduct next unity of actions as project moving forward based on their existing achievements. |

**Adapting**

Adapting refers to activities in which actors change behaviours and existing practices in order to make them more suitable for new situations. At the project’s middle stage, actors may have completely organised some project activities, while the quality of the performance of these activities may vary informing actors to adapt their organising behaviours for new situations. ICT can provide actors documenting software tools to record existing behaviours in project activities which can inform new requirements or change to fit into the new situations. As one interviewee notes:

*“So actually, the tool is used for documenting. So, each person that we interview and any of our project activities is then documented in the project... So we are quite, we try to be very thorough on that. Actually, we redevelop our activities based on new needs identified from the documentation of every progress. For instance, the concept of “Leash” was added to this project because we saw that the conceptual layer is so important to understand how these commissions work but are under-developed as documented on DAM tool. Thereby we need DAM tool to document more about those layers. I work very closely with the developers, and actually the tool is adapted to the documentation needs. It’s used in two ways one as a communication tool, but also second as a documentation tool” (Project B2, Participant 1, Para. 35)*

As the project moves forwards, actors may be aware of some important concepts that are under-developed based on the records of their existing project activities. Actors in above instance use DAM tool, a digital platform called De Andere Markt, to document any of their project activities. Based on the documentation of project activities, some issues are identified which can inform changes, such as adding new concepts to the project. Such a tool is also adapted and redeveloped to document more activities as the project moves forward. As actors adapt project activities and tools, they are able to understand better how to direct the project performance on the right way.

**Monitoring**

Monitoring refers to activities in which actors keep checking the projects performance closely as it is progressing in order to monitor how it develops so that actors can make any necessary changes. At the project’s middle stage, as more project activities start developing, actors need to closely monitor how these activities are developing such that actors are able to know how to direct the project overall performance. ICT can provide actors with tracing tools which allows them to closely monitor the developing trajectory of these activities. As one interviewee notes:

*“We use a lot of videos. And so, in this case, the audio and the podcasts were a way of recording and at the end bringing it to the public. We had intended at some point to also do recordings of the workshops themselves and to make a kind of documentary afterwards. But to be honest, actually, there was not the money to do this kind of stuff. Production wise, it takes a lot of effort. So, we did record the sessions, but it will be more processed in a kind of policy advisory that are documented afterwards so that we can know how the sessions are developed, but the podcasts of the context and the projects themselves play that role very much” (Project B2, Participant 1, Para. 78)*

In the above example, actors use videos and podcasts to record their workshop activities for monitoring purposes and to check how workshop activities are developing. These videos are also available to the public, revealing the transparent nature of the Living Lab project. Although there seems to be better ways to monitor these activities, the financial situation of the project may become a constraint inhibiting such changes to take place.

**Staffing**

Staffing refers to activities in which actors (re-)arrange personnel, allocate them tasks and roles, and get them agreed to conduct next unity of actions as the project moves forward based on their existing achievements. At the project’s middle stage, there are continually new tasks to be allocated to different project members. ICT provide actors with tools that help with assigning staff, allowing actors to clearly indicate the roles and responsibilities for each other. This facilitates actors to better understand how to direct the projects performance in a better way. As one interviewee notes:

*“We also use Trello. It’s like a digital board where you can put sticking notes on and assign tasks to people. So it’s a common matter for programming companies to divide the project and tasks and assignments to people” (Project B2, Participant 3, Para. 13)*

In the above example, actors use Trello for staffing activities. This is a tool used commonly organisations to allocate their tasks, which shows an industrial pattern of ICT selection as an environmental factor that may affect ICT-based IOKE practice. Trollo allows actors to demonstrate their roles and tasks clearly with the use of sticking notes, allowing actors assigning ability in staffing activities.

## 4.4. Completed Stage Finding

Figure 4.3 presents a framework of ICT-based IOKE during the completed stage of Living Lab projects. This section presents a detailed discussion regarding the concepts that emerged in relation to the ICT-based IOKE process for the project completed stage. Quotations are provided in the structure of: content of quotation; ID of project stage (C indicates completed stage); ID of project number; ID of interviewee; and No. of paragraph in specific interview transcripts. For example, *‘(Project C3, Participant 2, Para. 20)’* indicates completed stage project, project No.3, interview participant No. 2, and paragraph No. 20 in the interview transcript.

Diagram

Description automatically generated

Figure 4. 3 ICT-based Inter-organisational Knowledge Exchange Practice (Completed Stage)

During the project completion stage, IOKE is continuously taking place under three contextual layers: inter-organisational context, intra-organisational context, and environmental context, these being influenced and influencing diverse embedded contextual characteristics and mediated by ICT. IOKE at the project completed stage is characterised by four different knowledgeabilities, namely: inter-connecting; insights spreading; co-constructing; and co-ordinating. Each of these knowledgeabilities are enacted through different activities and are mediated via ICT. Two of these knowledgeabilities: insights spreading and co-constructing (i.e., knowing how to disseminate impact, and knowing how to integrate efforts) are viewed as core knowledgeabilities because they are recognised as core abilities in pursuits of project goals at the project completed stage. These core knowledgeabilities occur only when actors can connect to each other, i.e. inter-connecting is a condition for these knowledgeabilities, whereby knowing how to cultivate relationships with different actors is enacted. As a result of the enactment of insights spreading and co-constructing, actors are able to co-ordinate their project activities moving forward, which allows them to develop a understanding regarding how to direct project performance to move forward. Therefore, co-ordinating becomes the resulting knowledgeability of these core knowledgeabilities. Although the core knowledgeabilities and the role of ICT are different here compared to other stages, the finding shows a similar implication on the nature of ICT-based IOKE practice across all stages; that is, as part of the ICT-based IOKE actors enact their different knowledgeabilities with the support of ICT to achieve their goals, and their knowledgeabilities are thereby (re)produced in recurrent IOKEs. As a result, ICT plays a significant role in these practices by affording or constraining different action possibilities while actors engage in activities.

The above are summarised in Table 4.12. In the project completed stage, there are four different knowledgeabilities within the ICT-based IOKE practice, each of which is an expression of different types of knowing in practice and is enacted or performed via different activities. Finally, the last column indicates how ICTs mediate actions as part of each knowledgeability, affording or constraining actors’ distinct capabilities. These are discussed in detail in the ensuing sections.

Table 4. 12 Summary of knowledgeabilities in ICT-based IOKE practice, its relevant activities, performed knowledge and ICT affording and ICT constraints in the project completion stage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Knowledgeabilities of ICT-based IOKE Practice** | **Knowing in practice** | **Activities** | **ICT-Afforded Abilities** | **ICT-Constrained Abilities** |
| Inter-connecting | Knowing how to cultivate relationship | Connecting  Socialising | Grouping  Cross-distance Networking  Notifying | Stress Releasing |
| Insights Spreading | Knowing how to disseminate impact | Publishing  Circulating  Sharing | Visualising  Flexibility |  |
| Co-constructing | Knowing how to integrate efforts | Consolidating  Collective Reflecting | Reviewing  Instant Workaround | Integrating |
| Co-ordinating | Knowing how to direct performance | Controlling  Monitoring  Sustaining | Documenting  Tracking | Localising |

### **4.4.1. Inter-connecting and ICT**

Inter-connecting refers to a knowledgeability by which actors are inter-connected with the help of ICT to establish a network among them. At the completed stage, there are two types of activities involved in this: Connecting and Socialising. During these activities ICT can facilitate such inter-connection by providing actors cross-distance networking, networking maintaining, and a notifying ability to develop their understanding and expertise in how to cultivate relationships with others, while this may also inhibit their inter-connection by constrain actors’ stress releasing ability. Table 4.13 provides a summary of inter-connecting knowledgeability, its accomplished knowing-in-practice, activities that allow the enactment of such knowledgeability, and their explanations.

Table 4. 13 Summary of the inter-connecting knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Inter-connecting  Explanation: Knowing how to cultivate relationship | Connecting | Actors approach each other and are connected for interaction in order to achieve work-related goals. The connecting activity indicates how actors are inter-connected to develop their knowing how to cultivate a workplace goal-oriented relationship. |
| Socialising | Actors communicate informally with social purpose |

**Connecting**

Connecting refers to the activities through which actors are assembled together to establish workplace goal-oriented relationships with each other. At the completed stage, actors continue engaging in activities to reach out to each other with a focus on maintaining communications with their collaborators. As one interviewee notes:

*“**In the end, it’s surprising that some of the oldest technology is the one that works best. Sometimes. So, for example, for many stakeholders that were older, the most effective thing to reach out to them was just taking the phone and calling them, to maintain more regular contact between the workshops that we were doing. And with younger people, we just used a lot of Telegram. We have a Telegram group where all volunteers are there. With this tool, it was like a really easy way to get in touch with them. I mean for all these projects, it’s very important that you maintain this rapport with the volunteers all the time.” (Project C2, Participant 1, Para. 47)*

Different age groups may have different preference on the use of ICT for connecting. Therefore, using suitable ICT for connecting can greatly enhance the effectiveness of maintaining communication. Regular contacts between actors reveals a formal structure of inter-organisational context. The grouping affordance of Telegram that allows actors to be grouped together can significantly facilitate such a connection among multiple actors.

In addition, as during the previous two stages, ICT may afford actors cross-distance abilities that allow them to inter-connect with others regardless of distance, and notifying ability that allows them to be informed by events at the completed stage such that actors are able to develop inter-connecting knowing in practice. As one interviewee notes:

*“We are in Sicily. That is a very nice place to live. It’s very far from everything. It’s pretty cool, but our consortium was made up as I told you of 13 other partners from five different countries. So for sure, we used Skype, we used Google Meet, we use Zoom, all the possible tools to get in contact with these people. We took a lot of planes, and this is allowed by polices now permitting face-to-face meetings, but the technologies are mainly of course the video calling technologies.” (Project C3, Participant 2, Para. 20)*

*“So we as a leader of the consortium, we use this* [Slack]*. Other partners use Email more often than Slack, because they were used to use EMAIL in that way. We tried to discourage this, because then you have a lot of emails. Of course, it’s sort of life span like if you leave. And then maybe some important communication is just there with label like ‘Move’, and you don’t read it. It’s the matter, I think also, of your research is not only in the Information, but also getting the attention on the Information. This is the game that project managers or project leaders I think had to deal with. For example, on Slack, if you, if I mention you, I put the @, you might also receive an EMAIL automatically if you don’t react in 24 hours. So, Slack send you an EMAIL of my message, and then you will react as its more formal. I think Slack was really good for remote working.” (Project C3, Participant 2, Para. 17)*

In the first instance, actors may continue working from widely spaced locations at the completed stage. However, face-to-face meetings seem to be also required at this stage, but this only takes place under the permission of national health policy. There are diverse tools in the market such as Skype, Google meet, or Zoom that can be selected for connecting actors, while the most significant requirement for these ICTs is that they support video calling. This reflects that different ICT may have similar fixed materiality, which may determine actors’ selection in the support of connecting activities. The second instance reveals that different actors may have different preferences in the selection of ICT for inter-connecting. However, at the ending stage, there is too much information to be exchanged, and thereby a tool that can facilitate organising this information is very much need. Compared to Email, Slack affords actors notifying ability through which actors can inform each other about specific information in a more effective way.

**Socialising**

Socialising refers to the activities in which actors communicate informally with a social purpose. They may discuss personal or social topics that are less about their project work. ICT seems to constrain actors to explore enjoyable activities to develop their knowing how to cultivate their social relationships. As one interviewee notes:

*“And we were sometimes having lunch together or going out together to get closer. So to have this close interaction, I didn’t use tools, because we could do more interesting things face-to-face to release stress” (Project C3, Participant 3, Para. 80)*

In the completed stage, actors may have more workplace stress, compared to other stages. This usually requires actors to develop some social activities with each other to release this stress. Usually, actors prefer to have face-to-face contacts in this which seems to provide more diverse activities for actors to enjoy social purposes. ICT is not used because ICT cannot afford enough enjoyable activities for actors to engage themselves in to develop social relationships.

### **4.4.2 Insights Spreading and ICT**

Insights spreading is a knowledgeability enacted by actors who seek to spread their insights or expertise to others and through which they can develop an understanding of how to extend their insights’ impact. In project end stage, actors may have achieved many tasks which results in diverse insights and expertise. Actors engage in insights spreading since they may expect to leverage these insights to help others and extend the impact of these achievements into other contexts. Actors accomplish this through three primary activities: Publishing; Circulating; and Sharing. ICT can support such accomplishment by affording actors with visualising and flexibility tools whilst they may constrain an actors humanistic communicating ability. Table 4.14 provide a summary of these activities and their explanations in insights spreading knowledgeability.

Table 4. 14 Summary of activities and an explanation of insights spreading knowledgeability

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Impact Spreading  Explanation: Knowing how to Disseminate Impact | Disseminating | Actors share their expertise or insights into a form that supports dissemination to the public and allow public to learn |
| Circulating | Actors engage in circulating insights or information among multiple audiences to enable a collective learning process |

**Disseminating**

Disseminating refers to an activity through which actors share their expertise or insights into a form that supports dissemination to the public and allows the public to learn about the project. At the completed stage, as the project is going to end, actors have delivered most of their achievements in the results of the project. Therefore, actors in Living Lab project seem to expect their achievements to be published outwards so that their project can generate wider influence in a wider context. ICT allows actors visualising tools so that allows them to explain their insights to the public in a clear way. As one interviewee notes:

*“We plan to have a final conference or a big event with many hosts. We switched them to a little booklet that was a special part of the magazine, the local magazine. We use pictures and diagrams inside to show the results. So everybody can have a general view of the results of the projects. And so we have to change all these strategies, just the last month of the project, but before covid, everything was going as planned, quite good and without difficulties.” (Project C3, Participant 3, Para. 56)*

Due to the Covid-19 pandemic, actors were not allowed to organise/attend face-to-face conferences and publish their results. As an alternative, actors used booklets as a means to publish their results. Booklets with its picture or diagrams inside afford actors visualising ability so that they can share their insights publicly. By doing so, actors are able to develop their knowing how to extend the impact of their insights to a wider audience.

**Circulating**

Circulating refers to an activity through which actors engage in the circulation of insights or information among multiple audience to enable a collective learning process. Typical circulation approaches include messaging, emailing, or document posting. As actors actively learn in circulating activities, they are able to enact their impact spreading knowledgeability and develop understanding of how to extend the impact of their insights to a large audience. ICT may be useful to support such accomplishments by providing actors flexibility to deal with diverse information as they circulate. As two interviewees note:

*“At the end stage, a lot of messages were exchanged. We need the contribution into that package and with the contribution into that deliverable. Please send us the information by that day, etc… For the ending [completed] stage as I said it was mostly quick package messages about required things to be done in the specific deliverable in completing the tasks and organizing the final project, the workshop etc.” (Project C1, Participant 1, Para. 68)*

*“Slack is a chat system where you can create, where you can have different teams, and you can have different channels. So we had like the communication channel. And so you can be just in that channel and not in others, but you can still be informed. The big issue in doing this project is that information has to circulate, and everyone has to be informed. Probably then the problem is that at the ending stage people are overwhelmed by emails, messages, whatever it is. That’s why Slack work a little bit better, because you can be able to have access, just in a few channels, but still have access to the others if you want to be informed.”* *(Project C3, Participant 2, Para. 35)*

At the completed stage, there is too much information to be circulated around actors. Therefore, Slack is used as a means to circulate information that allows actors flexibility to deal with the most important information while at the same time preventing them from becoming overwhelmed by unexpected information.

### **4.4.3. Co-constructing and ICT**

Co-constructing refers to a knowledgeability by which actors work together to produce new insights based on each other’s ideas. At the completed stage, the enactment of co-constructing knowledgeability entails a more intensive and mature innovation stimulation process based on the combination of diverse expertise, in which actors are developing their knowledge on how to integrate the diverse efforts of other actors. There are two primary activities that allow actors to enact co-constructing knowledgeability: consolidating, and collective reflecting. Table 4.15 provide a summary of knowing in practice, relevant activities and their explanations in co-constructing knowledgeability.

Table 4. 15 Summary of the co-constructing knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Co-constructing  Explanation: Knowing how to integrate efforts | Consolidating | Actors combine diverse insights into a more solid form |
| Collective Reflecting | Actors stay together to reflect new insights from what they have learnt |

**Consolidating**

Consolidating refers to the activities in which actors combine diverse insights into a more solid form through which they then develop a better understanding of how to integrate the diverse efforts of actors. At the completed stage, different actors may have delivered different outputs which are sometimes required to be consolidated together into a more insightful and coherent whole. ICT allows actors to interact timely with each other by affording them instant workaround ability so that they can overcome problems timely and improve their co-constructed work effectively. As one interviewee note:

*“Also, the writing of the documents that we led, again, was on Google Docs. Even if then we made the final editing, I think it was in design or whatever. But all the contents were on a shared Google Doc where everyone was aware, informed and could add changes in any way making comments in order to produce a better version.” (Project C3, Participant 3, Para. 20)*

In the above example, actors use ICT to collaborate on writing the project documents. At the completion stage, actors still need to iteratively make sense of their work, interact with each other, and give feedback on each other’s drafts in order to produce a better final version. This is to enable further innovations and reflects a co-construction process among partners. That everyone is able to contribute to the shared Google document entails a consolidation process through which actors combine different contributions, allowing them to develop a better understanding of how to integrate efforts among multiple collaborators.

However, ICT may also inhibit the co-construction of insights in consolidating activities by constraining an actor’s integrating ability. This take place especially when a large number of insights are documented into too distributed locations. As one interviewee notes:

*“For Trello, we had tons of boards that were really filled with contents, but we cannot integrate them together. And so at the end’ we just didn’t use it anymore. We still use it for our internal purposes, but not with the consortium.” (Project C3, Participant 2, Para. 37)*

In the above example, as the project is nearing completion, there are many ideas being delivered and visualised on Trello boards. However, the use of Trello does not allow actors to combine these distributed ideas together. Although such a tool is still used within the intra-organisational context, its inherent constraints inhibit actors from integrating insights, and emphasising the enactment of co-constructing knowledgeability, resulting in the discontinuation of its use in inter-organisational context.

**Collective Reflecting**

Collective reflecting refers to the activities in which actors stay together to reflect on new insights what they have learnt. Actors in such an activity engage in an insights co-construction process by stimulating each other’s thoughts and inspiring new ideas. Through collective reflecting, actors recurrently accomplish their co-constructing knowledgeability, and develop a better understanding of how to integrate each other’s ideas towards more coherent insightful outputs for the project. The use of ICT can provide actors with reviewing tools which allows them to review their previous experience upon which they can then develop their collective reflection. As one interviewee notes:

*“We were all there together. So, in the end, exactly, we were all there together, exactly. We were working together on it. What we did was at the end of the project, what we really took a lot of effort in doing not just to discuss the results, but then also to discuss the methodology by which we had obtained results... So, we always had a video that is still not published, but we have a short video about our experience. This is where specific communication outcomes of the project come out and is the basis that we could review together for our reflection.” (Project C2, Participant 1, Para. 60)*

The above instance shows that actors at the project completed stage not only develop reflections on the project results, but also the trajectory that they to reach such results. Actors always work together throughout the project collaboration, which indicates the collaborative and co-creation nature of Living Lab project. The use of videos allows actors to review their experience upon which they are able to discuss together and create new insights collaboratively.

### **4.4.4. Co-ordinating and ICT**

Co-ordinating refers to a knowledgeability enacted by actors who generate reactions to the outputs of others’ work, or themselves, in order to move their work forward. At the completed stage, co-ordinating entails that actor’s co-ordinate project activities with a focus on project closure and its sustainability. There are three types of activities that comprise co-ordinating: Controlling; Monitoring; and Sustaining. ICT affords actors tracking and documenting ability which increase their understanding of how to direct their work performance as the project is moving to the end. ICT may also inhibit such knowledgeability by constraining actors’ ability to locate important materials and so on. Table 4.16 provides a summary of knowing in practice, relevant activities and their explanations in co-ordinating knowledgeability.

Table 4. 16 Summary of the co-ordinating knowledgeability and its relevant elements

|  |  |  |
| --- | --- | --- |
| **Knowledgeability** | **Activities** | **Explanations** |
| Co-ordinating  Explanation: Knowing how to direct performance | Controlling | Actors evaluate each other’s performance in order to control the quality of project performance and control the direction of the project |
|  | Monitoring | Actors change their behaviours from existing organising practices in order to make them suitable for new situations |
|  | Sustaining | Actors engage in developing project values continually when the project is nearly or fully completed |

**Controlling**

Controlling refers to activities in which actors evaluate each other’s performance in order to control the quality of the projects performance and control the direction of the project. At the completed stage, controlling activity entails that actors are focus on the control of overall project performance to achieve the projects overall goals. ICT can facilitate controlling by providing actors with documenting tools while they may also inhibit controlling by constraining actors’ ability to locate important project related materials. As one interviewee notes:

*“We use software to document all activities, experiences, plus the deliverables that we have produced, the times of the different tasks in the black packages, messages, etc. So everything was there that was a sort of project management, and the software we used specifically and this thing was called Teamwork… This platform is used during the whole duration of the project because it’s just for project management. It’s useless now because now the project is completed, you can only download the documents, but nothing else. During the particular time, you can exploit its effectiveness, for example it allows you to send messages, to control the activities, to call for a project and teleconference.” (Project C1, Participant 1, Para’ 58-62)*

*“Why I’m unhappy is because if you mix too many projects at the same platform, there will be many different log-in, and they might mix up, and my account get mixed up. And occasionally I find myself not being able to locate the document” (Project C1, participant 1, Para. 86)*

In the first instance, actors use Teamwork as a means to control the project activities by documenting all relevant activities and experiences throughout all stage of the project. At the completed stage, this tool is perceived useless but still available to use with the purpose of some possible downloads. This indicates that ICT may have sustainable values in the support of future project related works. In the second instance, actors may try to organise too many projects on the platform which leads to problems locating specific documents. There are multiple actors in the Living Lab project, which serves to increases the level of complexity when managing multiple projects and locating specific documents.

**Monitoring**

Monitoring refers to activities in which actors keep checking the project’s performance and progress closely, in order to see how it develops such that actors can make any necessary changes. At the project completed stage, as more project activities are completed and more outputs are delivered, actors need to closely monitor how these outputs are delivered to ensure that project tasks are achieved. This provides information to actors on how to direct the project’s overall performance and complete the overall project goals. ICT is used here to afford actors tracking abilities, enabling actors to track each other’s work in a shared space. This monitoring activity allows actors to develop a better understanding of how to direct the project’s performance in. As one interviewee notes’

*“I think that’s Google Drive is very useful. Yes. Otherwise, it would be quite difficult to serve all the documents where it records our completed tasks and relevant experiences. For example, if you compare that sending all these documents by email and that would be difficult to keep on track, which is the latest version of the documents. So that is very crucial to have one common place. You don’t have to keep them all of them in your own or holders or your own computer. It doesn’t matter if it’s Google or Microsoft Teams because they have a similar idea. That’s a similar way of doing. I just ’refer Google, it’s easier to use.” (Project C3, Participant 1, Para. 115-117)*

As projects move to the completed stage, a large amount of documents are being generated. Actors in Project C3 use Google Drives as a common shared space to store these documents and as a way to integrate multiple actors’ work. The use of Google Drives affords actors a tracking ability that helps discover the latest version of documents or specific one’s in an effective way so that they can be reviewed and learned afterwards. The shared space also allows actors to avoid putting extra efforts in documenting their experience, such as using their own PCs. With the use of ICT for monitoring, actors can organise their work in a more systematic way so that they always know that their existing performance is up to date. This allows actors to enact their co-ordinating knowledgeability and develop their knowledge on how to direct work performance collaboratively. Actors may have their personal preference in the selection of ICT, but it seems that they do not bother too much as long as the ICT supports their monitoring activities.

**Sustaining**

Sustaining refers to the activities in which actors engage in continually developing project values as the project is nearly or fully completed. At the completed stage, actors may seek new opportunities to find other project values in Living Lab to achieve sustainability. As actors sustaining their project value in the completed stage, they are developing a better understanding of how to direct project performance in a sustainable way. As one interviewee notes:

*“We plant this project as a proof of concept. The idea was, okay, it’s a small pilot that will allow us to validate the whole technology. Before that, we had a plan, we had an idea, we had a blueprint. Now we have a very deep prototype. So with this validated prototype, we’re still doing on this. Now, this project is ’completed, but we’re trying to find other ways, other areas, to deploy it.” (Project C3, Participant 3, Para. 40)*

As the Living Lab project progresses, ideas may be developed deeply, and more valuable project outputs are delivered at the completed stage. To extend the value of the project’s outputs, actors seek new ways to re-develop the project’s ideas as a sustainable value. This indicates the sustainability is an important characteristic of the European Living Lab context.

## 4.5 Cross Stage Analysis

As explained in the previous sections, ICT-based IOKE is characterised by three broad knowledgeabilities: conditional knowledgeability, core knowledgeabilities, and resulting knowledgeability, which exist across all three project stages. Conditional knowledgeability (inter-connecting) and resulting knowledgeability (co-ordinating) remain the same across all three stages, while specific core knowledgeabilities vary as the project progresses. This may be due to the shifting focus of actors as they engage in different stages of project activities when they enact core abilities in pursuit of project goals. This indicates that different project stage activities require different core abilities to achieve project tasks. Although these core knowledgeabilities vary, the condition to which these core knowledgeabilities can be enacted remains the same due to the nature of ICT-based IOKE as an interactive practice. In other words, actors must be inter-connected to enable any form of interactions. Regarding the resulting knowledgeability, it remains the same and is may be enacted across all three stages due to the project-nature of European Living Lab context. There is usually one or more project co-ordinator roles who lead the progress of the whole project and direct project performance in the correct way in order to complete project tasks within the estimated or funded project duration. Therefore, any activities organised in the project should somehow contribute to the project goal and provide implications on progress to move the project forward, which may help to explain why any enactment of core knowledgeabilities will result in the enactment of co-ordinating knowledgeability. More specific explanations for each knowledgeability across different project stages are provided in the ensuing subsections in order to inform an integrated framework for ICT-based IOKE practice.

### **4.5.1 Inter-connecting as a conditional knowledgeability**

As the empirical data shows, inter-connecting is a conditional knowledgeability across all stages. Although such knowledgeability (inter-connecting) remains the same across all stages, the elements that comprise inter-connecting (i.e., activities and ICT afforded/constrained abilities) vary and provide different outcomes for each stage.

For all stages, connecting and socialising appear as the activities allowing actors to enact their interconnecting knowledgeability. This indicates two primary relationships for which actors become inter-connected throughout the project: formal workplace relationship; and informal relationship. Formal workplace relationship allows actors to achieve their tasks in pursuit of project overall goals, which is the basis to complete any project tasks for each project stage. Informal relationship allows actors to release project stress and familiarise themselves with each other in a more comfortable way, which also takes place throughout the project. Therefore, knowing how to cultivate these two different types of relationships becomes an important accomplishment throughout the project, and is thereby commonly shared across different stages.

In the inception stage, cultivating partnerships appear since this is the initial stage where actors are actively seeking their appropriate collaborators as their partners to shape the project team. This activity takes place in the middle stage as well, while targeted collaborators are usually citizens or end users since in the middle stage, actors are in need of crowd (general public) perspectives and start to involve citizens or end users into the project by inviting them into co-creation workshops. Such activity disappears in the completed stage, perhaps because the project team is already stabilised, and they also do not need any further insights from the crowd as co-creation workshops are going to be completed. Bridging activities are also only present at both the inception stage and the middle stage, while being absent from the completed stage. This may be due to the familiarity level among actors being increased as the project moves forward. Actors at the inception and middle stages are usually not very familiar with each other, neither with their expertise nor their communication styles. Therefore, they may need boundary spanners who help to mediate the communication between actors with diverse backgrounds. As the collaboration becomes deeper and matures at the completed stage, actors become more familiar with each other, and everyone’s expertise has continually developed into deliverables or outputs. Therefore, they do not need any boundary spanners to work in between different collaborators and start to know how to cultivate relationship with each other themselves as the project is going to end. Embedding in real life activity seems to only occur at the middle stage, this may because it is the stage when co-creation intensively take place. Due to the nature of the Living Lab project, the real life setting becomes a significant characteristic that helps actors learn from each other and co-create as they reflect on their work within this setting. Such co-creation is organised intensively during the middle stage of the project, thereby embedding actors themselves in a real life setting, and the need to know how to cultivate relationship in real life is significantly in need compared to other stages.

Across all stages, ICT can afford actors diverse abilities to accomplish their development of knowledgeability, including: cross-distance networking; notifying; informal interacting; context familiarising; and grouping. However, these may also constrain actors’ appealing, accessing, stable connecting, informal interacting and stress releasing ability. Among these, cross-distance networking and notifying become core ICT affordances that facilitates the enactment of inter-connecting knowledgeability across different stages. This indicates the core functionality which actors perceive ICT to bring are to allow them to collaborate remotely regardless of distance and receive information timely and effectively. An interesting observation is that the informal interacting ability is afforded by ICT at the inception stage but constrained in the middle stage. This may be because actors’ requirements for quality informal relationships increase as actors become more familiar with each other gradually as the project moves forward.

### **4.5.2 Core knowledgeability across Different Stages**

**Interactive Learning: Knowing how to deepen understanding of each other’s expertise.**

Although core knowledgeabilities are different for each stage, there are some broadly shared insights for some distinct concepts. The knowledgeabilities of shared understanding, expertise accumulating and insights spreading, are all focused on the development of understanding the insights that actors acquire from each other. Activities such as sharing appears in all stages, which indicates an insights-sharing process through learning from each other. Activities such as onboarding, guiding, training appear across the inception and middle stages, but both indicate a learning by doing process to deepen their understanding of new expertise. Activities such as elaborating and publishing appear across the middle and completed stages, but both indicate a demonstration of expertise through which actors can learn from each other in order to deepen their understanding and demonstrate expertise. Therefore, the knowledgeabilities of shared understanding in the inception stage, expertise accumulating in the middle stage, and insights spreading in the completed stage, have a broadly shared implication in terms that they all indicate; a collective learning process and actors’ enactment of interactive learning knowledgeability through which they develop knowledge of how to deepen their understanding of insights as they learn from each other.

However, specifically, these knowledgeabilities that comprise interactive learning evolve as the project progresses, mainly because the activities that actors actively engage in are somehow different for each stage. For example, the sharing activity appear in all three stages (inception stage where actors enact shared understanding, middle stage where actors enact expertise accumulating and completed stage where actors enact insights spreading), but what is notable is actors’ focus as they share. In the inception stage, the focus in sharing activities is to build up a common understanding, this is because at this stage actors are still in the process of becoming familiar with different collaborators’ expertise. As the project moves to the middle stage, actors have become more familiarised with each other while the focus is now on sharing activities that turn shared experience practice, so it is necessary for actors to develop a knowing-how to develop capabilities in order to achieve project tasks. As the project moves to the completed stage, actors have completed most of their project tasks, and thereby the focus is shifted towards the impact of their shared expertise in sharing activity. Therefore, the shifting focus of actors on the project leads to the enactment of distinct knowledgeability' required for different stages.

Across all stages, ICT can afford actors diverse abilities to accomplish their development of knowledgeability, including showcasing; visualising; collective storing; customising; ubiquitous; flexibility; and learning ahead. However, they may also constrain an actors’ public codifying, implicit signalling, immediate transforming, in-person demonstrating and communication continuity ability. Although the use of ICT to mediate the enactment of these interactive learning related knowledgeabilities vary across different project stages, they indicate some core functions afforded by ICT. The shifting of abilities afforded by ICT from the inception stage to the completed stage appears to indicate an increased need for intensity of displaying and flexibility for learning in ICT-based IOKE practice. For example, ICT-afforded showcasing ability are required in the project inception stage, while visualising function is required in the middle and completed stages. This is perhaps because an increased and intensive level of displaying skills is required as actors deepen their understanding as project moves forward. Such a change may be due to a need for an actor's knowledge to be presented in a more understandable form for each other’s to learn. In addition, ICT-afforded collective storing are required in the inception stage, which changes to ubiquitous and customising ability in the middle stage and further flexibility in the completed stage. This is perhaps because the actors require more flexible ways to support their learning from the diverse range of expertise as the project moving forward. Therefore, displaying ability and flexibility for learning seem to be two core affordances provided by ICT and perceived by actors as essential ICT-afforded abilities in facilitating the enactment of interactive learning knowledgeability.

**Co-creating: Knowing how to stimulate creativity.**

The knowledgeabilities of interactive commenting, collaborative problem solving, and co-constructing all focus on the development of creativity and innovation based on the insights of other actors. Activities such as collaborative writing and group discussion appear in both the inception and middle stages, which indicates an idea stimulation process as feedback and comments are shared. Co-designing activity in the middle stage indicates an intensive co-creation process, especially characterised by Living Lab co-creation workshops where many interactional practices take place to stimulate innovation. Consolidating and collective reflecting in the completed stage also indicates a reinforcement of creativity and innovation. Therefore, interactive commenting in the inception stage, collaborative problem solving in the middle stage, and co-constructing in in the completed stage have a broadly shared implication in terms of that they all indicate a co-creation process and actor’s enactment of co-creating knowledgeability through which they are developing knowledge and understanding on how to stimulate creativity as they support each other.

Specifically, the knowledgeabilities that comprise co-creating also evolve as the project progresses. For example, group discussions appear in both the inception stage (where actors enact interactive commenting) and the middle stage (where actors enact collaborative problem solving), but what is notable is the intensity of creativity that is being stimulated. In the inception stage, group discussions are usually informed by someone’s presentation. The intensity of creativity is not that robust since at the inception stage actors are still in the process of familiarising themselves with each other’s work or expertise, while the constructive feedback that stimulates innovation may not be given that much. As the project moves to the middle stage, the innovation is co-created intensively as actors have become more familiar with each other and are able to solve problems together. There are also specific co-creation workshops being organised with a focus on stimulating creativity. In the completed stage, although most innovative outcomes are delivered, actors are now focusing on the reinforcement of these outcomes through consolidating and collective reflecting, which further advance the stimulation of creativity. Accordingly, as the intensity of creativity evolves throughout the project, actors’ enactment of knowledgeability for stimulating creativity also evolves across different project stages.

Across all stages, ICT can afford actors diverse abilities to accomplish their development of knowledgeability, including flexibility, instant workaround, sticking, cross-referencing and reviewing, while may also constrain actors’ concentrating, humour ability and integrating ability. Although the use of ICT to mediate the enactment of these co-creating related knowledgeabilities vary across different project stages, they indicate some core abilities afforded by ICT. ICT-afforded instant workaround ability appears across all stages, which indicates that instant workaround is a core ICT affordance required for the enactment of co-creating knowledgeability. This may be because to co-create new insights, the ability to work together on the refinement and improvement of specific concepts or topics is perceived as a core affordance that can be provided by ICT to facilitate actors’ enactment of co-creating knowledgeability throughout the project.

### **4.5.3 Resulting Knowledgeability across Different Stages**

Resulting knowledgeability (co-ordinating) remains the same across all stages, but the elements that comprise co-ordinating (i.e., activities and ICT-afforded/constrained abilities) vary and have different implications for each stage.

Controlling is an activity that appear in all project stages, which indicates controlling is an essential activity that allows actors to know how to direct project performance. This may because the outcomes of each project activities always need to be controlled in terms of their quality and being fit for purpose across all the different project stages. Staffing appears only at the inception and middle stages, perhaps because compared to the completed stage, there are more project tasks that are still waiting completion. Therefore, there is a great need to allocate roles and responsibilities to undertake different tasks in these two stages. Monitoring appears only at the middle and completed stages, because there are more formal project activities to be organised at these stages requiring monitoring, while in the inception stage actors are more engaged in initiating project ideas. Adapting activity becomes essential in the middle stage, perhaps because actors have accumulated more project collaboration experiences that can inform changes compared to the inception stage. Furthermore, there is more room to allow the project to be refined compared to the completed stage. Sustaining activity appears only at the completed stage, perhaps because there are more project outcomes to be evaluated in terms of its sustainable value, and actors have more time to explore the sustainability related opportunities at this stage.

Across all stages, ICT can afford actors diverse abilities to develop their co-ordinating knowledgeability, including confirming, collective evaluating, documenting, tracking, tracing and assigning, whilst this software may also constrain actors’ instant responsiveness and localising. Although the use of ICT to mediate the enactment of the co-ordinating knowledgeability vary across different project stages, they indicate some core affordances provided by ICT. Among them, ICT-afforded confirming ability at the inception stage, tracing in the middle stage, and tracking in the completed stage seem to have a broader implication where they all indicate a reviewability provided by ICT through which actors are able to confirm, trace or track the project activities. This is perhaps because actors always rely on the reviewable project experience to make evaluations or judgements to help them direct the projects performance. The ICT facilitated documenting ability also seems to be essential across all stages, although it is only perceived at the middle stage. This may because any evaluation or judgement that allows actors to know how to direct the projects performance is built on the basis of documentation to relevant project experience or activities. Therefore, documenting and reviewability are two core affordances provided by ICT that facilitate the enactment of co-ordinating knowledgeability across all project stages.

### **4.5.4 Integrated framework of ICT-based IOKE practice**

Based on an analysis of the above sections, it is seen that although ICT-based IOKE practices at different project stages may have different characteristics, they share a common meaning when these are considered in relation to project progress. ICT-based IOKE takes place within multi-layer contexts: inter-organisational; intra-organisational; and environmental. From the overall project progress perspective, ICT-based IOKE can be characterised by four knowledgeabilities: inter-connecting; interactive learning; co-creating; and co-ordinating. Inter-connecting is the conditional knowledgeability to any core knowledgeabilities, through which actors develop an understanding of how to cultivate diverse relationships in the project. ICT facilitates the enactment of inter-connecting by affording actors cross-distance networking and notifying ability. Interactive Learning and Co-creating are two core knowledgeabilities in pursuit of project goals, through which actors are developing knowledge of how to deepen their understanding of insights as they learn from each other and an understanding of how to stimulate creativity as they support each other respectively. ICT facilitates the enactment of interactive learning by affording actors displaying and flexibility ability. ICT facilitates the enactment of co-creating by affording actors with instant workaround ability. Co-ordinating is the resulting knowledgeability from any core knowledgeabilities, through which actors are developing knowledge and understanding of how to direct project performance. ICT facilitates the enactment of co-ordinating by affording actors reviewability and documenting ability. Figure 4.4 presents an integrated framework of ICT-based IOKE across all project stages of Living Lab projects.

Diagram, schematic

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Figure 4. 4 An Integrated Framework of ICT-based IOKE

# CHAPTER 5 DISCUSSION

## 5.1 Introduction

This chapter discusses the findings of this research in the context of the relevant literature in order to position implications of the findings within a broader context of this research and sharpen its contributions to the relevant field. The structure of this chapter is developed as follows: Section 5.1 introduces the discussion chapter; Section 5.2 discusses the frameworks of ICT-based IOKE practice across different stages; Section 5.3 discusses the main contribution of this study.

## 5.2 Theoretical Implications: The Stage-based Frameworks

This study purposefully sampled the data based on three different stages of Living Lab projects and has iteratively compared the data and existing theories to explore and explain the research phenomena, following the Glaserian Grounded Theory (Glaser & Strauss, 1967). Three theories are found appropriate and highly relevant for this research phenomena – Practice Theory, Sociomateriality Theory, and Affordance Theory – which are employed at different level of analysis. More specifically, Practice Theory helps to understand what stakeholders do in their ICT-based IOKE practice, which leads to the use of *knowledgeability* to demonstrate stakeholders’ different practice-based knowing in knowledge exchange. Sociomateriality Theory helps to understand how stakeholders achieve their knowledge works by enacting distinct knowledgeability and ICT together in their sociomaterial practices, which leads to a relational understanding on the enactment of ICT and knowledgeability in practice. Affordance Theory helps to understand the *enablement or constraint* effects of ICT on enacting stakeholders’ knowledgeability - how knowledgeability and ICT are related in stakeholders’ ICT-based IOKE practice. As a result of analysis, the present study proposes a conceptual framework of ICT-based IOKE practice for the project’s lifecycle – a single integrated framework and its three variations, taking into account differences across the three project stages (inception, middle and completed stage).

The proposed framework as presented in Chapter 4 contains three distinct categories: conditional/core/resulting knowledgeabilities, ICT afforded/constrained abilities, and embedded contexts. These categories are inter-related and shape the ICT-based IOKE practice together. It appears from the stage specific frameworks that conditional and resulting knowledgeability remain the same across all project stages – inter-connecting and co-ordinating respectively, while core knowledgeabilities vary across different stages. ICT has a great impact on the enactment of these knowledgeabilities by affording or constraining actors’ different abilities in their inter-actions and thus mediates (facilitates or inhibits) actors’ ICT-based IOKE practice in different stages. As described in the literature review chapter (section 2.5.7), an affordance view has both enablement and constraint nature. The present discussion in the ensuing narratives will use terms such as “affordance”, “afforded abilities”, or “affording” to indicate the enablement nature of ICT that facilitates ICT-based IOKE practice; and use terms such as “constraints”, “constrained abilities”, or “constraining” to indicate the constraint nature of ICT that inhibit ICT-based IOKE practice. The findings also demonstrate that ICT-based IOKE practice is embedded in a three-layer context – inter-organisational, intra-organisational, and environmental contexts across the whole project. This section begins with a discussion on the integrated framework from the perspective of the whole project progression and its implications for the existing literature, which is followed by a discussion of theoretical implications of other frameworks.

### **5.2.1 The Integrated Framework**

The integrated framework demonstrates three essential elements that shape ICT-based IOKE practice: knowledgeability, ICT affordance/constraints, and their embedded context for inter-organisational collaboration. These elements are enacted through actors’ interactions with and use of technologies as they engage in the ICT-based IOKE practice. These elements are also intrinsically dynamic in nature, each shaping the other in practice (Bunge, 2004). The accomplished or unaccomplished knowledge work as immediate concrete outcomes that connect organisations’ knowledgeabilities, the ICT affordances/constraints, and the multi-layer contexts provided by organisations in practice, and accordingly makes the ICT-based IOKE practice what it is. The depicted figure for integrated framework has been placed below as well (Figure 5.1), for signposting the relevant concepts and categories. The ensuing narratives discusses in more detail how these elements are shaped in ICT-based IOKE practice in relation to existing studies.

Diagram, schematic

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Figure 5. 1 A Copy of Figure 4.4 An Integrated Framework of ICT-based IOKE

**Knowledgeabilities for the Overall Project**

From the whole project perspective, the findings of this study show that Living Lab projects require four essential knowledgeabilities (inter-connecting, interactive learning, co-creating, and coordinating) to accomplish actors’ ICT-based IOKE practice. The enactment of inter-connecting allows actors to cultivate relationship with each other. The enactment of interactive learning knowledgeability allows actors to familiarise and understand each other’s existing expertise and accordingly refine and improve their own workplace effectiveness. The enactment of co-creating knowledgeability allows actors to stimulate innovation among them and develop new ideas together. The enactment of coordinating allows actors to direct work performance and thus promote the collaboration progress.

Specifically, the findings of this study shows that core knowledgeabilities among all identified knowledgeabilities consist of interactive learning and co-creating, which shows actors’ key capabilities to develop their organisational learning and promote their inter-organisational collaboration progress. Such findings bear resemblance with March’s (1991, p. 71) seminal work that argues knowledge exploitation and exploration are two main types of organisational learning in organisational collaboration: knowledge exploitation refers to “such things as refinement, choice, production, efficiency, selection, implementation, execution”, while knowledge exploration refers to “things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation”. Specifically, interactive learning depicts how actors develop their organisational learning through exploring new insights as they understand each other’s work, which implies the process of knowledge exploration (Luo et al., 2018; Vermeulen & Barkema, 2001); co-creating depicts how actors develop their organisational learning through intensively exploiting new insights together, which implies the process of collaboration for knowledge exploitation (Dzhengiz, 2020; Kim, 2020).

Recent research indicated that knowledge management has a dynamic nature for the project lifecycle overall (Piraquive et al., 2015; Ranf & Herman, 2018). For example, Ranf and Herman (2018)’s work proposes a knowledge management cycle throughout the project: identifying knowledge in projects, knowledge sharing with stakeholders, applying knowledge through project activities, and learning from mistakes. These concepts have been articulated by the proposed integrated framework of this study that deals with the whole project lifecycle, e.g., interactive learning demonstrates the practice that actors are actively identifying knowledge in the project. This shows a generic and broader understanding to the development of knowledge in project management.

Further, the present findings show a more specific changes across different project stages. For example, the findings of the present study show that developing shared understanding knowledgeability to identify new knowledge for actors seems more important at the project inception stage where the focus here is to develop understanding towards a similar level of expertise and getting partners onboard. As the project moves forward and the collaboration becomes more involved developing expertise in accumulating knowledgeability to identify new knowledge becomes more essential at project middle stage where the focus is to know how to develop actors’ capabilities through learning by doing. As the project moves to the end, actors identify new knowledge by developing insights spreadingknowledgeability whereby the focus is to disseminate insights to a wider audience. Such shifting patterns demonstrate that actors’ knowledgeabilities can evolve in practice across different project stages, which should be managed accordingly in regards of project lifecycle. This echoes earlier studies that indicate a co-evolution of knowledge management and project management (Li, 2018).

**Relationships among Knowledgeabilities**

The present study theorises the relationships among different knowledgeabilities by identifying two core knowledgeabilities: one conditional knowledgeability that informs the enactment of core ones, and one resulting knowledgeability as a result of the enactment of core ones.

The present study finds that the enactment of inter-connecting knowledgeability is a condition to the enactment of core knowledgeabilities. Inter-connecting allows actors to establish networks with each other in inter-organisational collaborations in order to acquire and utilise external knowledge. This echoes existing studies that argue the shaping of inter-organisational networks and relationships is significant and can inform organisational learning and knowledge management (Agostini et al., 2020; Ahmad & Daghfous, 2010). Furthermore, the findings of this study shows that actors may need to build up different relationships (e.g., partnership, workplace goal-oriented relationship, cross-disciplinary relationship, informal relationship) to enact their core knowledgeabilities.

This study finds that inter-connecting knowledgeability reflects the actors’ network diversity, density, or connectivity through direct or indirect ties (i.e., role of boundary spanner) and can have a great impact on the enactment of core knowledgeabilities. Such findings respond to recent research that calls into question the value of dynamics of inter-organisational networks on knowledge management (Ahuja et al., 2012; Clegg et al., 2016). For example, McEvily et al. (2012) argue that bridging ties exhibit both accumulating and imprinting effects on knowledge accumulation with long-lasting benefits. This study confirms this which shows that the enactment of interactive learning may require actors’ bridging activities, which afford inter-connecting knowledgeability, to enable them to understand each other’s expertise effectively. By signalling the inter-connecting knowledgeability as an important condition for the development of actors’ core knowledgeabilities, the present study further emphasises the value of studying the inter-organisational network dynamics and their effects for knowledge management and organisation studies.

The co-ordinating knowledgeability is the result of the enactment of core knowledgeabilities. Co-ordinating knowledgeability reflects how actors employ their knowledge in how to influence project performance. The way actor’s co-ordinate project activities and direct their performance reflects the process of organising knowledge management activities. We find that such knowledgeability is the result of the enactment of core knowledgeabilities. This implies that the enactment of core knowledgeabilities has a significant consequence upon which coordinating is enacted to direct future project development. This is in line with earlier findings whereby Blecker and Neumann (2000) argue that the organisation of a knowledge intensive process allows actors to reflect upon their previous experiences and evolve new patterns of knowledge exchange activities. Therefore, how knowledge management activities are organised plays an important normative role in inter-organisational knowledge management and learning. This normative role of the organisation process is informed and a result of the identification process (this has a strategic role in inter-organisational knowledge management) where the existing knowledge is diagnosed and new knowledge is identified (Blecker & Neumann, 2000).

**Role of ICT in the Overall Project**

Through the lens of ICT affordances and constraints, the findings indicate that the changes of ICT use with different purposes are crucial in enabling or inhibiting the enactment of knowledgeabilities in ICT-based IOKE practices. As a relational construct, ICT affordance and constraint are developed as actors engage in project knowledgeable activities with particular purposes and how they use ICT to achieve these purposes (Leonardi, 2011; Majchrzak & Markus, 2012). The findings suggest that as inter-organisational collaboration is developed, the purposes of the interactions for knowledge exchange evolve with the use of ICT, which demonstrates a co-evolution of knowledgeabilities and ICT affordance/constraints. It is found that actors are continually adjusting their use of ICT as they perceive their abilities being afforded or constrained, to meet the needs for the development of project activities where knowledge emerges.

The findings suggest that the use of ICT afford actors displaying, flexibility, and learning ahead abilities, which facilitate the enactment of interactive learning knowledgeability. This resembles findings in the extant literature that depicts the enabling role of ICT in the enactment of interactive learning knowledgeability but may provide different implications. For example, Gibson et al. (2021) identifies three technology affordances that are essential for project works: collective attention focusing, collective sense making, and public collective codification, which are adopted by project stakeholders to enable their knowledge accumulation, integration, and implementation respectively. According to their work, the use of power point slides visualises rich information that keep actors focused on the content such that actors are able to accumulate their knowledge, which is described as ICT afforded attention focusing ability. However, in the present study, the findings suggest that this is identified as ICT afforded displaying ability, as actors demonstrate rich information with ICT for others to view in order to guide them to learn and absorb new expertise. In this case the present study reconceptualises the effects of ICT in facilitating learning in knowledge exchange practice through affording displaying ability, which contributes to the ICT-enabled knowledge management studies. In addition, this study also bears resemblance with their findings, such as instant workaround ability afforded by ICT corresponding to collective sense making technology affordance in facilitating the exploitation of collective insights.

The findings also suggest that the use of ICT afford actors instant workaround, sticking, flexibility, cross-referencing and reviewing abilities, which facilitate the enactment of co-creating knowledgeability. This echoes studies in the extant literature focusing on the positive impact of ICT on ICT-based IOKE practice. For example, Majchrzak et al. (2013) introduce the meta voicing affordance of social media that allow actors to react on each other’s presence and activities and thus develop innovations. This bears resemblance with the proposed notion of instant workaround and sticking abilities which facilitate actors’ enactment of co-creating knowledgeability, while the proposed notion of instant workaround puts more emphasis on the timely responses that can further enhance the effectiveness of innovation. Extant literature also suggests that the use of ICT, such as YouTube, allow actors to rewatch videos several times over so that they are able to explore new insights and stimulate innovation (Saide & Sheng, 2021). Such a positive impact of ICT is confirmed by the reviewing abilities afforded by ICT identified in the present study which allow actors’ enactment of co-creating knowledgeability.

Furthermore, the present study also suggests that the effects of ICT in the enactment of knowledgeabilities can change across different project stages. This bears resemblance with prior studies that suggest an evolution view of affordance (Gibson et al., 2021; Groshek & Tandoc, 2016; Humphreys et al., 2013).

**The Complexity of the Context for Overall Project**

The findings indicate that the context for ICT-based IOKE practice is shaped by three different contextual layers: inter-organisational, intra-organisational, and wider environmental context. Although how these contexts are shaped by/shape ICT-based IOKE practice is not the focus of this study, the findings suggest that the relationship between these contexts and ICT-based IOKE practice are interactive rather than linear. That is, the shaping of the contextual characteristics such as norms, roles, structures and workplace climate are not immutable or rigid, but very much depend on actions taken by different organisations or the involved actors. For example, the manner of communication between actors in the project can be either flexible or regulated, formal or informal, depending on the specific situations: their working patterns, responding speed, or effectiveness of negotiation. This bears resemblance with the notion of structuration (Giddens, 1984) which suggest the structure themselves are interdependent from the actions taken by individuals within the structure – individuals produce and reproduce social structures as they undertake activities, but also are confined and restricted by these structures.

The present findings suggest that the context of ICT-based IOKE practice has diverse patterns such as structures, roles, routines, culture, workplace climate, and focus. However, different stages may have different patterns. The different stage-based frameworks show that these patterns can also evolve as the project moves forward. For example, at inception stage, the context is rather chaotic and fussy where the focus is more about putting on familiarisation with involved actors and cultivating an equal relationship among actors. As the project moves to the middle stage, more intensive collaboration is conducted where a more inclusive and reciprocal environment is created for enabling co-creating activities. For the completed stage, the focus shifts to the sustainability of project values to support further potential collaboration. Such shifting patterns reveals an evolution of context of ICT-based IOKE practice over time.

### **5.2.2 Inception Stage Framework**

The present findings show that shared understanding and interactive commenting are two core knowledgeabilities during the inception stage, conditioned by actors’ inter-connecting knowledgeability and resulting in co-ordinating knowledgeability. The enactment of these knowledgeabilities is mediated by thirteen ICT affordances, seven constraints, and three different contextual layers. Compared to the integrated framework, core knowledgeabilities (interactive learning and co-creating) have two variations (shared understanding and interactive commenting), while conditional (inter-connecting) and resulting knowledgeabilities (co-ordinating) remain the same. The depicted figure for inception stage framework has been placed below as well (Figure 5.2), for signposting the relevant concepts and categories.

Diagram, schematic

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Figure 5. 2 A Copy of Figure 4.1 ICT-based Inter-organisational Knowledge Exchange Practice (Inception Stage)

**Knowledgeabilities in Inception Stage**

At inception stage, actors focus more on establishing and enacting a shared understanding as a variation of interactive learning. This is because at the inception stage, actors from multiple organisations can bring diverse expertise into an inter-organisational collaboration, but the utilisation of this expertise requires actors to establish an initial understanding of their collaborators’ skills and expertise (Meer, 2014). Given the nature of the diversity and equivocality during the inception stage, the present findings show that actors are necessarily for conducting activities such as onboarding and sharing to acquire new knowledge from each other in order to become familiarised with the divergent level of thinking in inter-organisational collaboration and form a mutual understanding of every actor’s expertise. As existing research indicates, cultivating a mutual understanding with project collaborators such as users or technical partners could inform their new methods of working and overcome uncertainty of fussiness created by cultural differences or interdisciplinary backgrounds in the inception stage (Herstatt, 2003; Larsen et al., 2021). Such enactment of shared understanding knowledgeability allows actors to iteratively make sense of each other’s work and thereby explore new expertise in their inter-organisational collaborations towards a mutual understood level. The development of knowing how to align expertise in such knowledgeability thus creates symmetry of expertise for project collaborators, which is crucial and the building blocks to the accomplishment of successful collaborative practice (Bruns, 2013).

At inception stage, actors emphasise more on enacting interactive commenting as a variation to co-creating from the integrated framework. The theorisation of interactive commenting demonstrates what activities afford actors the ability to stimulate co-creation at the inception stage and how ICT may enable or inhibit the enactment of relevant knowledgeability. The present findings shows that interactive commenting demonstrates the capability that actors enact to stimulate innovation through responding to each other’s work. During the inception stage, project activities are carried out mainly to determine and clarify the project’s scope and plan future work, which requires actors to actively negotiate and discuss with each other to explore potential opportunities for innovations (Chappin et al., 2019). The present findings show that the enactment of interactive commenting knowledgeability allows actors to provide feedbacks to each other’s existing solutions so that actors are able to evaluate and promote their ideas towards new solutions. The activities that afford such knowledgeability, such as collaborative writing demonstrates iterative and interactive feedback loops and leads to the inspiration of new knowledge and nurtures creativity. This emphasises a trial-and-error learning process at an early stage due to the complexity and fussiness nature of the context and that collaborators promote their actions as they receive feedback to their prior outcomes (Evans et al., 2018; Chappin et al., 2019; Van De Ven & Polley, 1992). As Chappin et al. (2019) state, actors can generate new knowledge as they receive positive or negative feedback that leads them to modify or preserve their actions. The core role of such enactment of interactive commenting in ICT-based IOKE practice identified in the present study also corresponds to existing understanding of the key components of IOKE and collaboration, such as presented in Bruns’ (2013) work, that indicates the joint assessment and consultation as essential for stimulating innovation and promoting collaboration.

To enable the accomplishment of the above core knowledgeabilities at inception stage, it is also necessary to enact inter-connecting knowledgeability as a condition through which actors establish networks with each other and cultivate diverse relationships. The enacted conditional knowledgeability remains the same to the integrated framework, but its comprising activities have changed. At inception stage, actors are in the process of recruiting and involving new collaborators into the project (Obstfeld et al., 2020), and thereby activities such as cultivating partnerships are essential to develop knowledge of how to cultivate initial relationships. The present findings also emphasise the role of intermediaries in this stage which mainly manifest themselves in the enactment of inter-connecting knowledgeability. At inception stage, actors with diverse backgrounds or differing cultures cannot usually exchange their knowledge easily, which requires intermediaries to play a bridging role that introduces different parties or mediates their interactions (Colombo et al., 2015; Howells, 2006; Kim & Wilemon, 2002). The present findings further denotes that the role of intermediaries may vary and shifts as the project moves forward, since at inception stage the role of intermediaries is mainly to introduce different parties for establishing initial networks, while its mediating role becomes more explicit in subsequent stages.

The enacted resulting knowledgeability remains the same to the integrated framework, but its comprising activities have changed. The resulting knowledgeability of co-ordinating at inception stage demonstrates actors’ capability to organise project activities and move project forwards as actors accomplish their core knowledgeabilities. The present study finds that as actors initiate the project, the main activities required to direct actors’ next unity of actions and move the project forward, is to awaken collaborators to their roles and responsibilities through staffing and keep their performance on track through controlling and nudging. This helps to reduce the fussiness and ambiguity of their collaboration and contributes to organising their overall learning and knowledge management at an early stage (Blecker & Neumann, 2000; Stevens, 2014).

**ICT Affordances and Constraints during Inception Stage**

The findings here identified nine ICT-afforded abilities and six ICT-constrained abilities that mediate the enactment of knowledgeabilities of ICT-based IOKE practice, which bears resemblances with prior studies for the inception stage. For example, Gibson et al. (2021) argue that at the projects initial stage, stakeholders focus on knowledge accumulation activities and the main ICT affordance is collective attention focusing. In addition, Erhardt et al. (2016) have suggested three email affordances for project team learning: seeking-giving affordance for knowledge sharing, requesting-expanding for co-construction, conflicting-confirming for constructive conflict. Some of these are articulated by the present study’s inception stage findings. For example, showcasing ability in the present study corresponding to giving affordance in Erhardt et al.’s work that enable a shared understanding of each other’s work, and confirming ability afforded by ICT in the present study corresponding to confirming affordance in Erhardt et al.’s work that demonstrates how actors resolve conflicts towards mutual agreement so that the project can move forward. However, their study does not investigated how email may inhibit the project team learning and where the development of knowledge may be constrained. Prior studies have shown that IOKE can be enabled by ICT affordances, while there also exist creating barriers for IOKE practices such as: geographic distance (Cramton, 2001), existence of subgroups (Yilmaz & Peña, 2014), or cultural differences (Bayer & Maier, 2022; Sapuarachchi, 2021) all of which are under investigated by existing studies that have examined the role of ICT at inception project stage. The present study accordingly provides implications regarding this by demonstrating diverse ICT-constrained abilities (e.g., appealing, implicit signalling) in the accomplishment of knowledgeable works in ICT-based IOKE practice during inception stage.

**Complexity of the Context for Inception Stage**

At the inception stage of Living Lab projects, activities in ICT-based IOKE practice are situated in an early initiation process where actors strive for knowledge to probe new possibilities and nurture initial creativity (Juujärvi & Lund, 2016). Compared to the whole *project* perspective, this stage is viewed as *preject* or *front-end* stage where prolonged goal seeking and emergence of open thinking is crucial for radical innovations at the level of knowledge exchange and interactions (Colombo et al., 2015; Darsø, 2003).This stage of the project lifecycle usually implies an early stage of learning and innovating, and is usually featured as fussiness or chaotic (Kim & Wilemon, 2002; Chappin et al., 2019). The present findings conform to these arguments by uncovering the characteristics of inter-organisational context of ICT-based IOKE practice where actors at inception stage usually commence with unclear goals of the project, less knowledge about their partners and relationships, and divergent levels of expertise. The findings of this study further indicates that intra-organisational and wider environmental contexts can also have an impact on actors’ knowledge exchange. This is because actors are also situated in their own organisations and wider society thereby being affected by intra-organisational and societal rules and routines, where the equivocality and uncertainty of the front-end surroundings intensifies during inception stage.

### **5.2.3 Middle Stage Framework**

The present findings show that a shared understanding and interactive commenting are two core knowledgeabilities characteristic of middle stage, conditioned by actors’ inter-connecting knowledgeability and resulting in co-ordinating knowledgeability. The enactment of these knowledgeabilities is mediated by thirteen ICT affordances, seven constraints, and three different contextual layers. Compared to the integrated framework, core knowledgeabilities (interactive learning and co-creating) have two variations (expertise accumulating and collaborative problem solving), while conditional (inter-connecting) and resulting knowledgeabilities (co-ordinating) remain the same. The depicted figure for middle stage framework has been placed below as well (Figure 5.3), just for signposting the relevant concepts and categories.

Diagram

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Figure 5. 3 A Copy of Figure 4.2 ICT-based Inter-organisational Knowledge Exchange Practice (Middle Stage)

**Essential Knowledgeabilities in Middle Stage**

As the project moves to the middle stage, ICT-based IOKE practice is about to move to a more mature stage. The present findings suggests that at the middle stage, actors’ ICT-based knowledge exchange practice emphasis the development of their project collaboration where core knowledgeabilities enacted by actors are thereby changed to expertise accumulating and collaborative problem solving. This is the stage where actors intensively develop their project activities in pursuit of their project goals which has been defined during inception stage. This echoes Calamel et al.’s (2012) findings that the learning process of inter-organisational collaboration moves from an exploratory-oriented to development-oriented process as the project collaboration progresses over time.

The enactment of *expertise accumulating* demonstrates the capabilities of actors who learn and understand each other’s work through which actors explore and internalise each other’s expertise towards new knowledge acquisition and accumulation. Through activities such as training and sharing, actors can acquire new insights and skills and accordingly understand how they could contribute to the project goals. This bears resemblance with Gibson et al.’s (2021) findings that actors iteratively accumulate their knowledge as they acquire new insights. The present findings suggests that actors can develop their knowing on how to develop capabilities such as skills and expertise as they enact expertise accumulating knowledgeability through guiding and training, which corresponds to Orlikowski’s (2002) work. Through investigating a project’s internal collaboration, Orlikowski (2002) develops the notion of, and identifies a type of knowing in practice labelled as *learning by doing* through which actors develop their knowing of how to develop capabilities as they conduct activities such as mentoring and training, which leads to actors’ accumulation of new knowledge and skills. Drawing on the practice perspective, the present findings suggest that such accumulation of inter-organisational knowledge only takes place as actors immerse themselves into the interactions with each other over time. This also echoes existing studies on inter-organisational learning and knowledge accumulation that suggests prolonged learning by doing in inter-organisational collaboration is crucial for the acquisition and accumulation of tacit knowledge (Avadikyan et al., 2001; Battistella et al., 2016; Mokhtarzadeh & Faghei, 2019).

The enactment of collaborative problem solving is another vital component important for actors to perform ICT-based IOKE practice in the middle stage. Compared to the inception stage, the middle stage covers more Living Lab approach informed activities, such as co-creation workshops or real-life experiencing (Gascó, 2017; Malmberg et al., 2017). Actors in this stage may encounter diverse problems in pursuit of their project objectives, while thanks to the divergent and interdisciplinary expertise in inter-organisational collaboration, actors can solve these problems together through the enactment of collaborative problem solving. As Nickerson and Zenger (2004) state, due to the complex nature of problems, actors are able to generate knowledge as they strive for solutions in dealing with diverse problems. The present findings acknowledge such a problem-solving perspective to knowledge creation, while emphasising the collaborative interactions in inter-organisational settings and contends that collaborative problem solving could lead to knowledge co-creation and stimulate open innovation. As actors solve problems together through activities such as co-designing and collaborative writing, they can inspire each other’s ideas timely and co-create value for the project. These findings conform to existing knowledge of open innovation where increased linkages and access to cross-boundary support supports problem solving that can largely improve innovation outcomes (Felin & Zenger, 2014; Leckel et al., 2020; Lee et al., 2012). This study finds that the characteristics of the Living Lab approach, such as co-designing or real-life experiencing enable actors to conduct timely collaboration or reflection, and thereby allows effective problem solving. This corresponds to existing studies that emphasise the role of synchronisation in inter-organisational collaboration and knowledge co-creation (Hilbolling et al., 2022; Sharma & Bansal, 2020; Shi et al., 2012).

**ICT Affordances and Constraints during Middle Stage**

The proposed theorisation of the role of ICT in IOKE practice during the middle stage contributes to the existing literature by specifying diverse ICT affordances and constraints in the mediation of the enactment of diverse knowledgeabilities. Prior studies have identified essential knowledge and knowledge exchange practices for the middle project stage. For example, drawing on a knowledge management perspective, Haass and Azizi (2019) identifies four knowledge sharing practices as essential knowledge management activities for the middle stage of projects (identified as executive phase) including: communities of practice, learned lesson, after action review, and mentoring. These activities can be supported by the use of ICT, such as convenience and flexibility affordance granted by ICT for online mentoring (Pollard & Kumar, 2021; Schichtel, 2010); and connectivity, multiplicity, codifiability and programmability affordance granted by ICT for online community of practice (Gammelgaard, 2010; Jung, 2009; Kietzmann et al., 2013; Nithithanatchinnapat et al., 2016). In addition, Beiryaei and Vaghefi (2010) argue that at this stage, acquisition, refinement and storage are essential knowledge management activities where ICT may play a role such as affording guiding and promoting discussions for knowledge acquisition (Laurillard et al., 2000); and social mobilisation, pervasive sharing and browsing afforded by ICT for knowledge storage (Nelson et al., 2017; Wang & Lim, 2021). Many of these affordances have been articulated by the present study, such as ubiquitous ability, similar to pervasive sharing, that allows actors to develop expertise anywhere and anytime.

**Complexity of the Context for Middle Stage**

The findings indicate an intensive real-life based practice that shapes the context of ICT-based IOKE practice in the middle stage (activities such as embedding in a real-life context and real-life group discussion). This shows real-life experience as an important characteristic in Living Lab methodology (Hawk et al., 2012). Co-creation appears more explicitly and intensively in a context where there are many co-creation sessions organised at this stage. As one of significant procedure in Living Lab methodology (Hagy et al., 2017), co-creation in our findings demonstrates an open, reciprocal, and inclusive environment for actors’ inter-organisational collaborations. This bears resemblance with open innovation studies that suggest the significance of open and respective relationship for cultivating creativity and innovation (Elmquist et al., 2016; Gascó, 2017).

### **5.2.4 Completed Stage Framework**

The present findings show that shared understanding and interactive commenting are two core knowledgeabilities found during the completed stage, conditioned by actors’ inter-connecting knowledgeability and resulting in co-ordinating knowledgeability. The enactment of these knowledgeabilities is mediated by nine ICT affordances, three constraints, and three different contextual layers. Compared to the integrated framework, core knowledgeabilities (interactive learning and co-creating) have two variations (Insights Spreading and Co-constructing), while conditional (inter-connecting) and resulting knowledgeabilities (co-ordinating) remain the same. The depicted figure for completed stage framework has been placed below as well (Figure 5.4), just for signposting the relevant concepts and categories.

Diagram

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Figure 5. 4 A Copy of Figure 4.3 ICT-based Inter-organisational Knowledge Exchange Practice (Completed Stage)

**Knowledgeabilities during Completed Stage**

The present findings suggests that at the completed stage, actors’ ICT-based knowledge exchange practice tends to become publication-oriented and focuses on the integration and propagation of their project achievements where core knowledgeabilities enacted by actors are insights spreading and co-constructing. Since actors have nearly achieved most of their project objectives and are delivering the outcome at this stage, the publication and spreading of their achievements becomes prominent to their ICT-based knowledge exchange practice in order to sustain their projects value as a result of their inter-organisational collaboration (Mirzabeiki et al., 2022).

The enactment of insights spreading demonstrates the capability of actors extend the impact of their project achievements. As the project moves to the completed stage, an actor’s achievement is communicated widely with not only internal collaborators, but also external audiences such as the public. Through disseminating and circulating activities at this stage, actors are able to exchange their knowledge with each other to scale up the impact of their expertise and spread their insights across different contexts to inform larger audiences about their insights, which entails a publication-informed learning process as the project value is sustained. The present findings thus advocates the significant role of sustainability in the ICT-based IOKE practice at the project completion stage, which conforms to existing literature that suggests incorporating sustainability into project management to sustain innovation and knowledge management (Achterkamp & Vos, 2006; Khalifeh et al., 2020; Martins et al., 2019). The wider audiences at this stage are not seen as irrelevant stakeholders to the project, rather they are viewed as potential actors or potential collaborators who take part in the publication-oriented phase of their ICT-based IOKE practice at completed stage and have the potentials to further sustain the value of the project. Therefore, contrary to prior studies that hold a closed-ended view to study inter-organisational collaboration (Kubler et al., 2016; Le Pennec & Raufflet, 2018; Tidström & Åhman, 2006), the present findings suggests an open-ended view on inter-organisational collaboration and knowledge management, and highlights the role of potential collaborators in the sustainability of the ICT-based IOKE practice at this stage.

The other core knowledgeability at completed stage, co-constructing, demonstrates the capability that actors construct new insights together towards a combined form. At this stage, since actors may have accomplished achievements which may exist in diverse forms, combining and integrating this distributed knowledge allows actors to explore in greater depth their lessons learnt and explore the hidden value of the project. This thus can inform the co-creation of new knowledge as actors enact co-creating knowledgeability at this stage. Gibson et al. (2021) claims that iterative integration of knowledge leads to the synthesis of team capability’s variety, which allows actors to collaborate in a way that accounts for team respects and incorporates diversity into the team (Harvey, 2014). Engaging in such an integration process ensures every actor’s voice is heard and leads to further exploration of new insights, which creates more opportunities for co-creation of meanings (Cronin & Weingart, 2007; Harvey, 2014). The present study thus contends that the co-constructing is an important knowledgeability to stimulate creativity in ICT-based IOKE practice for sustaining the value of inter-organisational collaboration at project completed stage.

**ICT Affordances and Constraints during Completed Stage**

The proposed theorisation of the role of ICT in ICT-based IOKE practice during the completion stage contributes to the existing literature by specifying diverse ICT affordances and constraints in the mediation of the enactment of diverse knowledgeabilities. Prior studies have identified essential knowledge and knowledge exchange practices for the completed project stage. For example, Beiryaei and Vaghefi (2010) argue that at this stage, utilisation and organisation performance are essential knowledge management activities where ICT may play a role such as, embedding knowledge into organisational routines (Beiryaei & Vaghef, 2010; Brainin & Arazy, 2016; Leonardi, 2011) and collective public codification affordance (Gibson et al., 2021) for knowledge utilisation. The present study drawing on a practice perspective argues that even in the projects ending stage, actors are developing a diverse range of knowledgeable practices and knowledge utilisation is integrated with these practices as knowledge is always in use. The present findings suggest nine ICT afforded abilities and three ICT constrained abilities that enable or inhibit actors to accomplish their diverse knowing in practice (inter-connecting, impact spreading, co-constructing, and co-ordinating) in inter-organisational projects completed stage. This combines insights of knowledge management, ICT, and project management into an integrated framework, and delineates the effects of ICT on knowledgeable works at project completion stage.

**Complexity of the Context for Completed Stage**

As a project moves to the completed stage, the findings here emphases the role of sustainability and how sustainability is developed as actors use ICT for their knowledgeable works. This indicates that the sustainability of the project is becoming significant for the context of inter-organisational collaboration and project innovation (Bendix et al., 2017; Hansen & Klewitz, 2012; Mirzabeiki et al., 2022). In addition, due to the increased maturity of collaboration, actors are enacting regulated routines and structures for their ICT-based IOKE practice. This echoes with the findings of previous studies that indicate regulatory norms for inter-organisational relations (Lie, 2011; Marchington & Vincent, 2004). Environmental forces continually affect actors’ knowledge exchange practices, such as the pandemic inhibiting actors physical spreading of their insights. However, actors at completion stage demonstrate their ability to identify alternative approaches against environmental barriers, such as using digital books to spread their works. This bears resemblance with previous studies that indicate the ongoing environmental forces in the shaping inter-organisational knowledgeable practices (Bdeir et al., 2013; Dooley & Gubbins, 2019).

## 5.3 Re-conceptualisation of ICT-based IOKE Practice

In light of the present findings (the proposed stage-based frameworks), the present study is able to reconceptualise ICT-based IOKE practice. The key contributions of the proposed re-conceptualisation to earlier works are: 1) ICT-based IOKE practice is a dynamic co-evolutionary process in its nature, and 2) Human knowledgeabilities are sociomaterial and can be enacted by ICT affordances/constraints in ICT-based IOKE practice; and 3) The context underlying ICT-based IOKE is a multi-layer context, constituting in practice and can evolve over time. These contributions are extensively discussed in related to extant literature in ensuing subsections.

### **5.3.1 The Evolving Dynamic Nature of ICT-based IOKE Practice**

Previous studies have indicated that understanding the process of knowledge exchange and how ICT plays a role in the process is significant for organising and management in a collaboration context (Bouncken & Aslam, 2019; Davenport, 2018; Hislop et al., 2018). However, prior research has often studied knowledge exchange throughout the whole collaboration progress, and with less emphasis on its interaction with the dynamic nature of ICT. There is also limited research that investigates ICT, knowledge, and context in conjunction to show their dynamic relations throughout the lifecycle of inter-organisations. To address the gap, the present study demonstrates a novel finding that ICT-based IOKE practice has a dynamic interactive nature in which ICT, human knowledgeability, and context co-evolve as the project moves forward. More specifically, the present study demonstrates diverse and evolving patterns that shape ICT-based IOKE practice across the inter-organisational lifecycle and uncovers how they co-evolve as the inter-organisational collaboration is moving forward. The ensuing narratives will discuss these patterns more specifically compared with relevant literature and show how the proposed co-evolutionary nature of ICT-based IOKE practice across the inter-organisational lifecycle can contribute to existing knowledge, particularly in the area of technology affordance studies.

**Diverse and Evolving Patterns of Knowledgeability**

The present study identified diverse knowledgeabilities important in the context of European Living Labs which are not as yet the focus of existing research. For example, for the overall project, the present study extends March’s (1991) work by identifying new knowledgeabilities in the support of organisational learning: a conditional knowledgeability (inter-connecting) and a resulting knowledgeability (coordinating) to the core knowledgeabilities. This means that the process of knowledge exploration and exploitation cannot be enabled if actors do not know how to cultivate relationship with each other (inter-connecting), and such a process cannot be promoted if actors do not know how to direct their work performance (coordinating).

The proposed conceptualisation of diverse knowledgeabilities for the inception stage in this study also extends current models of knowledgeable practices at the initial stage of the project. Existing research has indicated that the ICT-based IOKE practice at the initial project stage is usually embedded in a context with a high level of ambiguity and thus requires more comprehensive understandings on its nature (Oliveira et al., 2015; Chappin et al., 2019). The present findings contribute to this body of research by encapsulating ICT-based IOKE practice and proposing diverse knowledgeabilities at the inception stage, which is afforded by a large range of activities and mediated through ICT affordances and constraints. Prior studies have indicated that it is important to understand how actors embark towards mutually understood level of expertise from each other at the project’s initial stage (Fagerholm et al., 2014; Karambelkar & Bhattacharya, 2017). However, these studies do not demonstrate how knowledge emerges from relevant activities in the initial project environment and how ICT mediates such knowing in practice, which is significant for managing knowledge in initial project works. Accordingly, the theorisation of shared understanding knowledgeability contributes to the current literature by uncovering what project activities comprise such knowledgeability and how the enactment of shared understanding is mediated by ICT. In addition, the theorisation of co-ordinating knowledgeability also contributes to existing studies by uncovering how a project is progressing through the enactment of co-ordinating knowledgeability, which has not yet been the focus of existing KM studies. This provides an integral insight into project management and knowledge management, while prior studies are usually concerned with knowledge and project management as separate managerial practices while neglecting how a project is progressing with the development of knowledge. Regarding the middle stage, the present study also contributes to an understanding of the diversity of knowing in practice by identifying more comprising activities such as guiding, elaborating and sharing that can also enable actors to learn new insights from each other and accordingly know how to develop their capabilities.

Our theorising about the shifting patterns of knowledgeabilities across different project stages contributes to current models of knowledge management that have not yet specified the evolution of knowledgeabilities over time in project environments. Prior studies show that knowledge is developed throughout a projects lifecycle and embedded into project methodology in the project environment (Emiliano de Souza et al., 2022; Owen, 2006; Yeong & Lim, 2010). However, these studies focus more on the exploration of the tacit or explicit nature of knowledge and how this supports project success, while less attention has been given to the development of knowledge across different project stages. In the present study, we found that core knowledgeabilities shift as a project moves forward: shared understanding and interactive commenting at inception stage; expertise accumulating and collaborative problem solving at middle stage; and insights spreading and co-constructing at completed stage. In light of these findings, the present work thus argues that core knowledgeabilities can shift as the project is progressing. Such findings extend existing works by suggesting a more dynamic nature of knowledge in ICT-based IOKE practice. For example, this study develops March’s (1991) seminal work by suggesting that the nature of knowledge exploration and exploitation is also dynamic and can be updated in the context of temporal inter-organisations such as Living Lab projects. The shifting patterns of knowledge with project progression also indicates a co-evolution of knowledge management and project management, which calls for more future research.

As recent scholarly work suggests, a practice perspective allows unsung knowledge to be explicit and discloses the existence of the relationship between knowers and known (Nicolini, 2011, 2016; Schatzki et al., 2005). Thereby, a practice perspective provides a promising way to understand social phenomena in relation to knowledgeable works. However, there are currently limited studies that investigate the development of knowledge from a practice perspective and provide implications on how a practice-based approach enables ICT-based knowledge management for project management. For example, Orlikowski’s (2002) work identified several important knowledgeabilities such as, sharing identify, interacting face-to-face, aligning effort, supporting participation and learning by doing. This work provides a starting point to understand different enactments of knowledge from a practice perspective, however, it does not show how these knowing in practices develop as actors continue their works overtime. Furthermore, practice-based studies have argued that knowledge is an ongoing accomplishment and are recurrently emerging in practice (Nicolini, 2011, 2016; Orlikowski, 2006). However, the underlying generative mechanism through which knowledge emerges has not yet been articulated. With the body of evidence, the present study argues that knowledge is not merely emerging from the practice but is also developed as activities change and continually evolve in the practice. The findings of the present study thus contribute to existing practice-based literature by uncovering how knowing in practice is developed throughout project lifecycle from a practice-based perspective. Practice itself is renewing accomplishment and the renewal of practices are achieved through interactions (Nicolini, 2013). The present study thus argues that it is the evolvement of knowledgeabilities that facilitate the renewal of ICT-based IOKE practice. Such evolvement, with the use of ICT, represents the sustaining and perpetuation of ICT-based IOKE practice, and accordingly the present findings contribute to the field by illuminating a way to understand how agents perpetuate the conditions of their agency (Giddens, 1984; Nicolini, 2016) as they participate in ICT-based IOKE practice.

**Diverse and Evolving Patterns of ICT Affordance/Constraints**

The present study’s theorising about the ICT-based IOKE practice shows a diverse bundle of affordances/constraints for the enactment of knowledgeabilities. This enriches current understanding on the roles of ICT affordance and constraints in mediating the enactment of knowledgeabilities. For example, some studies have broadly summarised essential ICT affordances for knowledgeable work (Gibson et al., 2021; Sun et al., 2019), while they may lose the speciality of ICT affordances if the situated use of ICT are taken into account. Some studies are more concerning with the ICT affordances in enabling knowledge exchange related activities (Erhardt et al., 2016; Gott & Schaefer, 2020), while there are limited studies specifying which ICT constraints may inhibit the enactment of knowledgeabilities. The present study thus contributes to this body of research by identifying more ICT affordances and constraints in mediating ICT-based IOKE practices and specifying which affordances/constraints are mediating which specific knowledgeabilities.

The present study also illuminates existing research on understanding how the effects of ICT in the enactment of knowledgeabilities evolve across different project stages. Prior studies mostly place the focus on investigating the effects of ICT on knowledgeable works for overall project. However, recent studies have indicated that knowledgeable practices can change as a project moves forward whereby ICT may play different roles across different project stages (Gibson et al., 2021; Haass & Azizi, 2019; Ranf & Herman, 2018). Therefore, the present study provides contributions on this body of research by demonstrating how ICT affordances and constraints change and evolve with knowledgeabilities as a project moves forward. This also provides an integral insights of knowledge management, ICT, and project management. This prompts future research on how ICT and knowledge are to be managed and developed together in the context of inter-organisational project lifecycle management.

Prior studies have indicated that the effects of ICT affordances or constraints are determined in specific situations and thus there is no universal set of affordances that fit into all contexts (Majchrzak & Markus, 2012; Treem & Leonardi, 2013). This indicates that ICT affordances/constraints may evolve as situations change, such as the shifts of knowledge management activities (Gibson et al., 2021). However, there is currently less evidence to show how ICT affordances/constraints evolve as the patterns of knowledge exchange shifts across specific stages. The present study demonstrates a bundle of affordances/constraints for each knowledgeability and how these change as a project moves forward. Compared to Gibson et al.’s (2021) conceptualisation of co-evolution of affordance and knowledge management activities, the present study emphasis that ICT affordance does not merely co-evolve with knowledge, but also co-evolves with the project. Such findings thus contribute to the current understanding of the relationship between ICT affordance and social practices by arguing that the shaping of ICT affordance/constraints and knowledge (knowledgeability) are interdependent and can mutually co-evolve over time. This implies a far more dynamic nature of ICT-based IOKE practice in inter-organisational settings than the findings of previous studies. Moutinho and Silva’s (2022) work show that current studies on the theorisation of knowledge transfer in projects call for a greater understandings on how specific project knowledge is being created and communicated effectively over time. Our findings accordingly extend this body of research by specifying how a bundle of different ICT affordances/constraints are actualised for the enactment of different knowledgeabilities across different project stages.

**Evolving Patterns of Inter-Organisational Collaboration Contexts**

The findings here uncovered diverse patterns across three contextual layers in the context of ICT-based IOKE practice, which provides existing studies an integral perspective on contextual characteristics of ICT-based IOKE practice. Existing research often approaches the study of IOKE by merely being concerned with inter-organisational patterns (Al-Busaidi & Olfman, 2017; Blecker & Neumann, 2000; Easterby‐Smith et al., 2008). However, the present study shows that ICT-based IOKE practice is embedded in triple contextual layers that also include an intra-organisational and wider environmental context. As Holmqvist (2003) argues, there is a dynamic relationship between intra and inter-organisational learning: they interactively support an actor’s learning process through knowledge exploration and exploitation. However, these studies have not yet specified how different contexts can be integrated into knowledgeable practices. The present study thus enriches this body of research by identifying how different ICT-mediated knowledgeabilities are enacted resulting from the effect of multiple contextual layers.

The findings suggest an evolution of context for ICT-based IOKE practice, which contributes to existing research on understanding the dynamic contextual nature of knowledge exchange. Prior studies have shown that the context of ICT-mediated knowledgeable works are not immutable or rigid, but recurrently produced and reproduced in ongoing sociomaterial practices (Gao, 2007; Giddens, 1984; Nicolini, 2016; Orlikowski, 2007). This indicates a potential evolution of context as people develop their practices over time. However, these aforementioned studies have not yet delineated how these contexts may change or evolve. The present study identifies that the patterns of ICT-based IOKE practice contexts co-evolve with actors’ knowledgeabilities and their actualised ICT affordances/constraints, which provide significant implications on understanding the dynamic contextual nature of ICT-based IOKE practice. Thereby, such findings illuminate a salient area which calls for future research to investigate on such an evolution of ICT-based IOKE practice contexts.

Furthermore, prior studies often focused on co-creation as a context or event (e.g., a project phase, a workshop, or a session) within which actors exchange knowledge. This views advocates that scholars can assess the performance of the co-creation event in order to evaluate the success of knowledge management or innovation (Carlsen et al., 2014; Cunliffe & Scaratti, 2017), especially in Living Lab contexts (Hagy et al., 2017). However, this focus risks emphasising such events as the sole knowledge co-creation activities and neglecting other project events as valuable knowledge co-creation activities. Contrary to that, Sharma and Bansal (2020, p. 401) adopt a process ontology perspective and describe co-creation as “a continuous process that is always becoming” throughout the project. Indeed, the practice perspective adopted in this study indicates that knowledge co-creation as a co-creating knowledgeability can be enacted across all stages of the project, allowing actors to develop their knowing on how to stimulate creativity. Therefore, this study contributes to the co-creation studies by capturing the full picture of knowledge co-creation process and shows that such co-creating is always accomplished in practice and thus can take place at any stage of the project. This is possible despite its patterns varying across different project stages according to the actors’ intentions and interactions as the project progresses.

This study also contends that there is a temporal dimension that is rooted in the context of ICT-based IOKE practice. The fact that organisations jointly engage in ICT-based IOKE practice usually takes place within a fixed time frame (Iacono et al., 2012; Jones & Lichtenstein, 2008). In the present study, the practice can usually only be identified in project-based settings where a fixed duration of the project is determined at the beginning. Such a dimension is essential for understanding the dynamic nature of ICT-based IOKE practice, because as much as actors know their stage across the fixed temporal duration, they also know how to manage their ICT-based IOKE practice for different stage. The proposed frameworks also only make sense when such a temporal dimension has been taken into account such that different project stages across its lifecycle can provide different contexts and enact different knowledgeabilities. Such findings contribute to existing research by identifying a temporal dimension as another potentially important contextual factor that affects ICT-based IOKE practice and thus raise future research attention.

**A Co-evolutionary Nature of ICT-based IOKE: Towards an Evolving Dynamics**

As discussed above, the diverse and evolving patterns of knowledgeability, ICT affordance and constraints, and the context have constituted a dynamic nature of ICT-based IOKE practice. More importantly, these elements do not change solely; rather, they co-evolve together over time as inter-organisational collaboration is moving forward. For example, the present study shows that core knowledgeabilities for pursuing project goals evolve across different collaboration stages. At the same time, the bundle of ICT affordances/constraints that facilitates or inhibits each core knowledgeability and the contexts that underpin the constitution of knowledgeability and ICT also evolve as core knowledgeabilities change. Such co-evolution among knowledgeability, ICT affordances and constraints, contexts, and project progress reflects the dynamic co-evolutionary nature of ICT-based IOKE practice in temporal inter-organisational collaboration settings. This provides a novel finding for the research field on the dynamic interactions within ICT-based IOKE practice. Currently, most of the existing studies show a focus on the constitutive dynamics of ICT and knowledge – how stakeholders’ knowledge is dynamically constituted through diverse practices such as sharing or creation where ICT is considered as a contextual and influential factor (Choi et al., 2008; Ward et al., 2012; Wu et al., 2010; Francisco & Klein, 2018), or how ICT are dynamically constituted through diverse affordances and constraints in stakeholders’ workplace practices to support their knowledge exchange (Sun et al., 2019; Wagner et al., 2014; Rice et al., 2017). These studies neglect how ICT and knowledge management are dynamic in nature of themselves and such dynamics may influence each other over time in temporal IOKE practice, which leads to the research gap of the present study. By delineating a co-evolutionary nature of ICT-based knowledge exchange, the present study argues that ICT and knowledge are not only dynamically constituted in practice (i.e., constitutive dynamics), but they are also evolving together with their embedded contexts over time, which shows a further evolving dynamic interaction of in ICT-based IOKE practice – a “dynamic of dynamics”. Such evolving dynamic is an emerging field in studying dynamic interactions between ICT and knowledge. For example, Gibson et al. (2022) has identified that ICT affordances can evolve as project knowledge management activities evolve, which determines the project success of virtual teams. By providing a theoretical explanation on how ICT affordances/constraints, knowledgeability, and contextual factors co-evolve over time across project lifecycles, the present study argues that the dynamics of co-evolution is a significant and emerging field to understand dynamic interactions of ICT-based knowledge work. Therefore, the present study orients future research away from constitutive dynamics towards an evolving dynamic on researching ICT-based IOKE practice so that scholars can develop a deeper understanding on not only how ICT and knowledge influence each other in situated practice but also how such influence may change over time. More research questions in this area could be posed such as what factors are driving, enabling, or inhibiting the changes in the evolving dynamics? Which elements are changing during the shifts, and which are not? And how is the temporal context playing a role in the evolving dynamic? How to understand the concept of “temporality” in the evolving ICT-based knowledge work?

Such a co-evolutionary nature of ICT-based IOKE practice has also largely enriched technology affordance studies in the knowledge work settings. For example, the present study has identified different bundles of ICT affordances and constraints that are connected for different knowledgeabilities in ICT-based IOKE practice. Existing literature indicates that ICT artefacts can provide multiple affordances (i.e., bundle of affordance) and these affordances are interrelated and interdependent (Volkoff & Strong, 2017; Wang et al., 2018). Studying the relationships between diverse affordances is significant to understand how and when action possibilities emerge (Bloomfield et al., 2010; Strong et al., 2014). The present findings suggest that actors need to actualise a bundle of affordances or constraints of ICT so that they can enact their corresponding knowledgeability. This means that ICT affordances and constraints are bundled in a way that serve a distinct knowing-oriented goal, and as the goal changes the bundle of affordances and constraints also change. Therefore, the present study extends current understanding on the relationship among ICT affordances by identifying what affordances/constraints are bundled for which knowledgeability and how they co-evolve over different project life stages towards an evolving dynamic of ICT-based IOKE practice.

In addition, the present study has explored various ICT afforded/constrained abilities that allow humans to accomplish their knowledge work. These afforded/constrained abilities demonstrate an actualisation process of ICT affordance – how ICT affordances/constraints are actualised by actors as they engage with different ICT artefacts. As Strong et al. (2014, p. 70) defined, affordance actualisation is “the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals”. In the context of the present study, these immediate concrete outcomes are the accomplishment of know-how, and the afforded/constrained abilities show the actions taken by actors as they utilise ICT affordances in support of their knowledge work. By identifying various ICT afforded/constrained abilities, the present study therefore contributes to affordance actualisation theory by connecting ICT affordances/constraints to associated knowing-oriented goals (i.e., human intentionality of know-how). This can inform the design of ICT artefacts that are easier to use in the context of human knowledge work. Existing applications of affordance theory in the IS discipline show that there may be missteps or obstacles when actors actualise affordances in the real domain (Strong et al., 2014; Volkoff & Strong, 2017). Therefore, researchers should pay more attention on the process of affordance actualisation to demonstrate enabled or limited abilities that actors encounter during their organisation work (Wang et al., 2018). The present study thus responds to such calls by demonstrating various evolving ICT afforded/constrained abilities in order to extend understanding of the ease or difficulties that humans encounter as they actualise ICT affordances or constraints in knowledge work overtime.

### **5.3.2 New Characteristics of Knowledgeabilities**

As discussed in the literature review chapter, existing research has conceptualised knowledge in ICT-based IOKE practices mainly in two streams – objective perspective and practice-based perspective. As data in the present study informs, the present study purposefully employs a practice perspective to understand ICT-based IOKE practice and the findings show that such practice can be characterised by different knowledgeabilities. Knowledge in this study thus is understood as an ongoing and enacted capability (Orlikowski, 2002) which emerges from human interactions, and thus is described as knowledgeabilities that represent people’s knowing how to effectively accomplish their work. ICT-based IOKE practice is viewed as the site of such knowing, which affords the enactment of diverse knowledgeabilities (Nicolini, 2011). By studying the role of ICT in ICT-based IOKE practice, the present findings reconceptualise knowledgeabilities with the following characteristics: 1) knowledgeabilities emerge as situated and recurrent accomplishments, enacted through human interactions; 2) knowledgeability is sociomaterial; and 3) knowledgeabilities are inter-related. This study illustrates how the findings of these characteristics contribute to the existing literature in the ensuing discussion.

Knowledgeabilities emerge as situated and recurrent accomplishments from human interactions. Such situated and ongoing accomplishments are confirmed by existing understanding regarding practice-based knowing. For example, as Nicolini (2011, 2016) argues, knowledgeability is highly sticky to the situated practice, which thus is less about being or having but more about becoming or turning through human actions in their everyday life. Similarly, Orlikowski (2002, 2006) argues that knowing in practice is an ongoing accomplishment through human actions, and the enactment of knowledgeability reflects the performativity of knowledge instead of a representational or static substance. However, these studies tend to imply how unidirectional actions afford the enactment of human knowledgeability. The present study adds a more nuanced understanding on these studies, helping to reveal how the enactment of human knowledgeability is a result of human collective interactions where the role of collective participation and engagements should be taken into account. This is a more meso-perspective to view the performativity of knowledge – knowledge is enacted in joint participation in collaborative activities. As Lave and Wanger (1991) suggest in their notion of legitimate peripheral participation, situated learning always takes place since people actively interact with each other. It is thus essential to understand the significance of the network of multiple actors and how they build relations to develop communities of practices (Pan et al., 2015; Wenger, 2011). Such emphasis on interactions takes into account the distinctiveness of different actors who get involved in the practice and enact their knowledgeabilities. This accordingly contributes to existing studies on: collaborative knowing, open innovation, and collaborative learning. For example, Hsiao et al. (2012), drawing on a practice lens, investigate how an interactive expert system generates collaborative knowing through three boundary-spanning practices: identifying problem boundaries, orchestrating collective responsibilities, and developing a systemic understanding. The present study contributes to this by uncovering how different domain experts engage in interactive conduct in cross-disciplinary inter-organisational Living Lab projects and accomplish cross-boundary collaboration where more diverse collaborative knowing is produced.

Knowledgeability is sociomaterial. Such characteristic bears in mind that knowledgeability is both social and material – the duality of knowledge. Knowledgeability is social since it reflects the social structural properties (Gao, 2007); it is embedded and embodied in, and emerges from social practices (Gherardi & Miele, 2018); and is socially constructed (Koch, 2005; McAdam & McCreedy, 2000). Knowledgeability is also material since it is always bound up with the situated practices that are imbricated in materiality (Gherardi & Miele, 2018; Leonardi et al., 2012). Similarly, As Orlikowski (2006) argues, it is the artefacts’ materiality that scaffolds human knowledgeability. These studies have provided significant implications for the understanding of sociomateriality of knowledgeability. However, the issue neglected in extant practice-based studies of knowledge is how the enactment of knowledgeability takes place as a result of social and material interactions. Studies such as Østerlie et al (2012)’s work emphasise the sociomaterial nature of knowing and suggests three modes of sociomaterial knowing: interpretation, implementation, and learning, while their focus is to refine the idea of materiality in sociomaterial knowing practice instead of how materiality mediates the enactment of sociomaterial knowing. Gherardi and Miele (2018) suggest three ways of managing sociomaterial knowing, but do not show how materiality mediates the enactment of knowing in practice that informs the knowledge managing practice. The present findings thus contribute to this gap by studying knowledge and ICT together in practice and arguing that knowledge and ICT are shaped through the synergistic generation of knowledgeability and ICT afforded/constrained abilities in ICT-based IOKE practice as a way of managing knowledge for knowledge management.

The present study argues that knowledgeabilities are inter-related with each other based on the findings that the enactment of a certain knowledgeability may be conditional or consequential to others. Prior research has indicated that different knowledgeabilities are not independent but inter-related and interact with each other (Le-Nguyen et al., 2018; Orlikowski, 2002). However, these studies did not focus on the relationships among different knowledgeabilities (how they are inter-related and interact), which is a grey area of study as their relationship implies a new variable in determining the enactment of human knowledgeabilities in practice. For example, existing studies often suggest that knowledgeabilities, albeit different in its constituting activities or the accomplished knowing how, are usually overlapping in terms of their operation i.e., knowledgeabilities are usually operated interdependently of each other (Orlikowski, 2002). However, the present findings show that different knowledgeabilities may have inter-relations such as one becomes the others’ condition or result. For example, stakeholders must develop their knowing how to cultivate relationships with other partners (condition knowledgeability: inter-connecting) so that they can develop their knowing how to learn from each other (core knowledgeability: interactive learning). As Gibson et al. (2021) identified, human knowledgeable activities may evolve as change cues are recognised. For example, when people recognise a lack of shared understanding or global applicability (realisation of knowledgeable characteristics), people’s knowledgeable activities may shift from idea accumulating to synthesising. This indicates that under certain circumstances one knowledgeability emerging from activities may change to another. The findings in the present study suggest three types of knowledgeabilities – conditional, core, and resulting, which extends the current understanding on how different knowledgeabilities are connected to support the evolution of human knowledgeable activities.

### **5.3.3 The Evolving Multi-Layer Context**

The present findings suggest a multi-layer context - inter-organisational, intra-organisational and wider environmental context, which extends current work around contextual understanding of ICT-based inter-organisational knowledge work. Extant work studying ICT-based knowledge work in inter-organisational settings tends to position inter-organisational context as their primary focus. For example, Fu et al. (2019) have demonstrated a wide range of ICT tools to be used in different types of inter-organisational partnerships and identified affordances for inter-organisational collaboration teams. Gibson et al. (2021) have explored diverse ICT affordances for knowledge management activities in global teams with an emphasis on ICT use and effects across team collaboration. There are also many other studies that investigate cross-boundary collaboration emphasising the use and effects of ICT as boundary objects in inter-organisational knowledge work (Carlile, 2002; Cronemberger et al., 2017; Kimble et al., 2010). These studies tend to focus on ICTs that are used only between members from inter-organisational collaboration teams. However, the routinised work regulated by their organisation’s leaders (i.e., the rules and routines in the intra-organisational context) or emerging ICT introduced by the market (i.e., market-available ICT from wider environmental contexts) can also affect stakeholders’ perception and use of ICT in their inter-organisational work. By demonstrating various intra-organisational and wider environmental contextual conditions that can also influence ICT-based IOKE practice, the present study suggests a more complex environment surrounding ICT-based knowledge work in inter-organisational settings. Therefore, the present research informs future studies that look beyond the inter-organisational context as the primary focus in investigating inter-organisational collaborations and explore different implications from multiple layers of context on ICT-based inter-organisational knowledge work.

Albeit this study has put these contextual layers in the background of the present framework, contextual conditions such as project team structure, powers, rules, routines, roles, culture, and climate are all considered as open-ended, recurrently shaped, and time-bounded characteristics of human interactions, and they are both the medium and outcome of ICT-based IOKE practice. The rationale that has led them to become the background of the present framework is that the focus of this study is to uncover the role of ICT in ICT-based IOKE practice rather than to demonstrate in detail how these conditions are determined in practice. However, these contextual conditions together with knowledgeabilities and ICT co-shape the ICT-based IOKE practice – the ICT-based IOKE practice is context-shaped and context-dependent. This bears a resemblance with practice-based theories that understand context as emergent and recurrently renewed accomplishments of the practice (Engeström et al., 1999; Lave & Wenger, 1991; Nicolini, 2013; Schatzki et al., 2005).

Drawing on this view, extant literature has shown various contextual factors that are influencing the ICT-based IOKE practice. For example, Mueller (2015) argues that organisational culture is an accomplishment of social practices and explores five different cultural characteristics that are enacted in cross-boundary knowledge sharing practices. Organisational routines have been studied not simply as things (Feldman et al., 2016) but rather a dynamic accomplishment enacted in the practice (Bertels et al., 2016; Cohendet & Simon, 2016). However, these studies have not yet depicted how these contextual conditions may vary and evolve over time and across different progress lifecycle stages in inter-organisational collaboration. The present findings thus contribute to these studies by exploring what contextual conditions emerge at the wider environmental and inter and intra-organisational levels for each specific project stage, and that they change across stages. For example, at inception stage, the context is rather chaotic and fuzzy while the focus is to familiarise actors to the project; at middle stage, the context tends to be mature and thus more intensive, surrounded by an inclusive and reciprocal work environment; at the completed stage, there is a degree of maturity and thus the focus is to extend and sustain project value. Such changes are informed by diverse and evolving contextual factors at multi-layers over multi-stages, which underpins the evolving dynamics of ICT-based IOKE practice. It is thus suggested that future studies can investigate how particular contextual conditions vary across different stages, how this informs the change of a particular contextual layer/multi-layers, and further how this change provides implications for the evolving dynamics of ICT-based IOKE practice.

### **5.3.4 Knowledge and Project Coordination: Towards an Integration**

Further to the context, the present study has found that core knowledgeabilities in the pursuit of project goals can also lead to the know-how of project management as well (coordinating - the resulting knowledgeability). This is an interesting finding that project-oriented practices (project coordination practices in particular) can also be shaped by knowledge-oriented work. Many existing knowledge management studies in project contexts are focused either on the knowledge itself with the project as background environment (Souza et al., 2022; Favoretto & Carvalho, 2021) or project knowledge management that emphasises project-oriented knowledge (Gasik, 2011). However, the investigation to study knowledge and project coordination in conjunction is underdeveloped and lacks evidence. For example, Handzic & Durmic (2015) show that knowledge management practices can foster the development of projects in a feedback loop but provide less insights on how distinct project management activities are influenced and shaped with stakeholders’ knowledge work. This means the interactions between knowledge management and project management require further exploration in terms of how they dynamically shape each other. The present study extends this body of evidence by uncovering an interaction between knowledge-oriented practice and project coordination-oriented practice, which provides evidence on the aforementioned gap by contributing to the integration of project coordination and knowledge management in temporal environments.

In addition, the present study shows that such interaction occurs in different project stages and the activities within each project-oriented coordinating knowledgeability change across different stages as well as the actualisation of ICT affordances/constraints towards a co-evolution. This has implications on knowledge work from a temporal organising perspective (Bakker et al., 2016) that ICT-based knowledge management and project coordination are intertwined in temporal contexts within which they shape each other so that they moves the project going forward. Further, this extends existing studies of the interaction dynamics that foreground knowledge, ICT, and project context in the ICT-based inter-organisational knowledge exchange practice and uncovers their evolving relationships over time. For example, Li et al. (2023) argue that a project environment provides distinct temporal stages such as conceptualisation and design stage where different knowledge domains and skills are dynamically formulated and shared, but there is limited evidence to explain how knowledge and project management interact at each distinct stage. Similarly, Yeong & Lim (2010) state that knowledge management and project management have an interactive relationship in their nature (e.g., continuous feedback and alignment), in the condition of factors such as ICT and culture, together shape the success of project work. This shows an interesting interaction between knowledge and project management but does not show how the relationship may change as a project moves forward. Therefore, the identified co-evolution framework and their three detailed variations in the present study provide new insights to this area and illuminate future directions in integrating these elements together for deeper investigation.

# CHAPTER 6 CONCLUSIONS

## 6.1 Answers to Research Questions

IS and Organisation scholars have shown the growing significance of ICT use to support human knowledge work within inter-organisational settings in the digital era. The overall aim of this research was to conceptualise the role of ICT in the shaping of inter-organisational knowledge exchange (IOKE) practice for inter-organisational collaboration. The research questions were set out as:1) What are the characteristics of ICT-based inter-organisational knowledge exchange practice in inter-organisational collaboration? 2) How does ICT facilitate or inhibit inter-organisational knowledge exchange practice in inter-organisational collaboration? 3) How to integrate ICT into an ICT-based inter-organisational knowledge exchange framework for inter-organisational collaboration? By investigating the context of European Living Labs, this research developed a practice lens to explore and explain the shaping of ICT-based IOKE practice, with the support of Sociomateriality Theory and Affordance Theory. In light of the findings, the present research was able to answer these research questions, through a combination of research objectives, as discussed in the ensuing paragraphs.

The first research objective was to identify the ICT facets that characterise the interorganisational knowledge exchange practice. To achieve this objective, this research has leveraged a practice perspective to fully capture the characteristics of ICT-based IOKE practice. Such practice is characterised by ICT affordances and constraints, knowledgeabilities, and multi-layer contexts. Drawing on a practice lens, actors in ICT-based IOKE practice recurrently develop their knowing in practice. Knowledge is viewed as a human capability that is continuously enacted and accomplished in human knowledgeable practices. ICT mediate such enactment of knowledgeability by affording or constraining distinct human abilities (i.e., actualised ICT affordances/constraints) that allow actors to accomplish their knowledge work or hold them back in terms of engaging in knowledge exchange. ICT-based IOKE practice is also constructed within a multi-layer context: a combination of inter-organisational, intra-organisational, and environmental contexts. This context is not stable nor predetermined but is continuously accomplished and developed as actors immerse themselves in ICT-based IOKE practice. This means, contextual factors such as inter-organisational structure, culture and climate are not only influencing human enactment of human knowledgeabilities and human situated use of ICT, but also recurrently shaped and developed in ICT-based IOKE practice over time. Such multi-layer context constitutes the context of European Living Labs and shapes its distinct characteristics such as real life approaches and sustainability. These facets including knowledgeabilities, ICT affordances and constraints, and multi-layer contexts shape the characteristics of ICT-based inter-organisational knowledge exchange practice in inter-organisational collaboration (answering research question 1).

The second research objective was to explore how ICT facilitates or inhibits inter-organisational knowledge exchange practice. To achieve this objective, this research has identified various ICT afforded abilities and constrained abilities that mediate the enactment of diverse human knowledgeabilities. Drawing on the affordance theory, ICT is viewed to have both an enabling nature that makes the work easier to be done and a constraining nature that holds back people from achieving their intended goals. Through the actualisation of different bundles of ICT affordances in situated practice, humans are able to enact their distinct knowledgeability. While experiencing different bundles of ICT constraints in situated practice, humans can encounter different difficulties to develop specific know-how in practice. These actualised ICT affordances or constraints are viewed as various ICT afforded/constrained abilities, which mediate the enactment of diverse knowledgeabilities and accordingly shape the way how ICT mediates (facilitates or inhibits) inter-organisational knowledge exchange practice in inter-organisational collaborations (answering research question 2).

The third research objective was to propose an ICT-based inter-organisational knowledge exchange framework for inter-organisational collaboration. To achieve this research objective, this research has identified diverse enacted knowledgeabilities associated with distinct ICT affordances/constraints and proposed four ICT-based IOKE frameworks throughout a project lifecycle. There are three distinguished knowledgeabilities identified in this study: conditional knowledgeability, core knowledgeability, and resulting knowledgeability. The conditional knowledgeability (i.e., inter-connecting) shows people’s know-how to cultivate relationship in inter-organisational collaboration. The core knowledgeability shows people’s know-how to achieve collaboration goals; and the resulting knowledgeability (i.e., co-ordinating) shows people’s know-how to direct project performance. The present study found that core knowledgeabilities vary as the project moves forward, and the patterns of core knowledgeabilities evolve into three different variations in terms of the different project lifecycle stages: shared understanding and interactive commenting are core for the inception stage, expertise accumulating and collaborative problem solving are core for the middle stage, and insights spreading and co-constructing are core for the completed stage. The associated ICT affordances/constraints also change as knowledgeabilities change, which shows a co-evolution between ICT affordance/constraints and knowledgeability in practice over time. These variations of ICT affordances/constraints and knowledgeabilities shapes three distinguished frameworks of ICT-based IOKE practice for different project lifecycle stages. The situated multi-layer contexts at different project stages are also constructed with different characteristics. By abstracting knowledgeabilities across different project lifecycle stages, this research has also proposed an integrated framework of ICT-based IOKE practice for the overall project perspective. These four distinguished ICT-based IOKE frameworks have integrated ICT, human knowledge and their situated contexts, which explains the role of ICT in the shaping of inter-organisational knowledge exchange practice at a sufficiently detailed level (answering to research question 3 and fulfil the research overall aim).

## 6.2 Theoretical Contribution

By re-conceptualising ICT-based IOKE practice, this research has addressed existing theoretical gaps and accordingly provided significant theoretical contributions to the extant knowledge and research, as discussed in the ensuing narratives.

First, although current studies have shown the vital role of ICT in supporting IOKE practice, there is less evidence to understand the dynamic nature of IOKE taken into account the dynamic nature of ICT (Zhu et al., 2021). Currently there exist many diverse and prominent understandings that show ICT has a dynamic nature (Orlikowski & Iacono, 2001; Zhu et al., 2021), but a theoretical gap remains in understanding the relationship between the dynamics of ICT and the dynamics of knowledge exchange processes in inter-organisational settings. The findings of the present study address this theoretical gap by proposing an integrated framework that can be contextualised across the different stages (one integrated framework and its three variations across different project stages). The frameworks indicate that ICT-based IOKE practice has a dynamic nature, characterised by diverse and evolving knowledgeabilities, ICT affordances/constraints and multi-layer contexts. Due to the temporal dimension of inter-organisational collaboration, the patterns of knowledgeabilities, their associated ICT affordances/constraints and the situated contexts can co-evolve over time. Accordingly, the present study extends existing research towards an evolving dynamic of ICT-based IOKE practice, which largely enriches existing ICT affordance studies in knowledge management and innovation settings. In addition, the present study demonstrates diverse sets of ICT afforded/constrained abilities that facilitate or inhibit the enactment of distinct human knowledgeability in ICT-based IOKE practice. This provides further evidence of how a bundle of actualised ICT affordances/constraints mediate distinct achievement of human knowledge work for existing studies. The co-evolving ICT-based IOKE frameworks across different project lifecycle stages also demonstrate when and how ICT affordances/constraints are bundled to enact specific human knowledgeability over time. This largely enriches affordance studies towards focusing on a more complex co-evolutionary dynamics and thus informs future research to investigate in the future.

Secondly, although priori studies have identified diverse knowledgeabilities or knowing in practice in human ICT-enabled knowledge works (Hsiao et al., 2012; Marabelli & Newell, 2014; Orlikowski, 2002, 2006), there is limited evidence to fully capture the nature of human knowledge from the perspective of ICT. The present research addresses this theoretical gap by identifying the sociomateriality nature of knowledge: knowledge is shaped by not only social dimension (human purpose to know-how) but also the material dimension (the use of material artefacts such as ICT to fulfil the purpose). In addition, the present study also indicates that different knowledgeabilities have specific relations: knowledgeabilities may be enacted only under the condition of the enactment of other certain knowledgeability (in the present study, core knowledgeabilities can be enacted only under the condition of the enactment of inter-connecting knowledgeability); The enactment of knowledgeabilities may also result to enactment of other certain knowledgeability (in the present study, the enactment of core knowledgeabilities can result into co-ordinating knowledgeability). The identification of these inter-relationships among human knowledgeabilities extends current understanding of how human knowledge are intrinsically developed as they engage in ICT-based IOKE practice.

Third, the present study contributes to the extant literature with a focus on the contextual development of ICT-based inter-organisational knowledge exchange practice by uncovering a multi-layer context and its evolving nature. This informs future research to not just focus on the inter-organisational context but also intra-organisational and wider environments when investigating ICT-based knowledge work. The evolving nature of the contexts demonstrates a dynamic perspective on the environment of inter-organisational collaboration, which informs future research to unpack more about how such a dynamic is shaped and to what extent it influences the ICT-based knowledge work.

Fourth, the present study contributes to the studies that attempt to investigate knowledge management and project management (i.e., project coordination in particular) in conjunction. By demonstrating a relationship between core knowledgeability (i.e., know-how in the pursuit of project goals) and the resulting knowledgeability (i.e., know-how for project coordination), the present study integrates both knowledge-oriented and project coordination-oriented practices and thus provide new insights on the interactive relationship between knowledge and project management. Further, by demonstrating a co-evolutionary process among knowledge, ICT, and project coordination activities over different project stages, the present study extends existing knowledge on the evolving dynamics between knowledge and project coordination. This provides further insights on the integration of knowledge management and project coordination-related management and thus informs future research direction when interrogating this interdisciplinary area.

## 6.3 Practical Contribution

In terms of a practical contribution, the study provides a better understanding of ICT-based knowledge management for European Living Labs. Specifically, the research has identified how ICT can be leveraged towards understanding and addressing the needs of their customers, suppliers, business partners or governments – traditional Living Labs stakeholders - with the aim of developing better products and services. Different activities that afford distinct knowledgeabilities are identified, which allows Living Lab managers to organise distinct project activities to improve their knowledge management throughout the project. Living Lab project members can also develop their knowledge or skills on project collaboration by better understanding what and how knowledgeabilities are enacted in their inter-organisation practice. Schuurman et al. (2015, p. 12) argues that current Living Lab literature is rather silent and posits Living Lab as an ‘everything is possible’ concept that “resemble[s] an empty box…that you can put whatever methodology or research approach inside”. Therefore, this research can add value to the understanding of Living Lab’s internal abstract interactions, specifically inter-organisational knowledge exchange, so that it can attempt to partially fills the ‘box’ and make it explicit and structural.

In addition, this study provides insights not only for Living Labs, but also for similar project-based temporary inter-organisational work settings where knowledge exchange through the use of ICT is essential. Specifically, this study can inform the design processes of ICT artefacts and applications that are typically used for inter-organisational collaboration and communication. This study has identified different technology affordances and constraints that reveal what project ICT users need to know or not about existing ICT artefacts, which is of great value for ICT product designers. In addition, this study offers insights into how project stakeholders could use ICT to support their collaboration across their project stage. By understanding how ICT mediates different knowledgeabilities, project stakeholders may use ICT smarter to support their collaboration, largely improving project workplace effectiveness and facilitate inter-organisational digital transformation.

## 6.4 Limitations and Future Research

This research has its own limitations in terms of the research scope and methodology. This may inform future research to investigate in more depth and width.

With regards to the research scope, this research has deeply investigated ICT-based IOKE practice for inter-organisational setting. However, as discussed in literature review (2.4.1), inter-organisational collaboration only represents one form of many inter-organisational relations. ICT-based IOKE practice can also take place in other settings such as inter-organisational coordination and inter-organisational cooperation. The characteristics of the setting may vary and the ICT-based IOKE practice that take place in that setting may also vary in its nature. This calls for future research to study ICT-based IOKE practice in other settings towards a more generalised understanding to ICT-based IOKE practice.

With regards to the research methodology, this research has adopted Glaserian version of Grounded Theory Methodology and attempted to strictly follow the principles suggested in the Grounded Theory such as keeping open mind to existing theories until the late stage of analysis. However, although the researcher attempted to only use relevant theories for developing theoretical sensitivity, it is unlikely to put the awareness of those theories entirely aside during data analysis (Bryman, 2012). This may result that the proposed theory cannot be entirely closed to the data. This could be addressed by examining the proposed theory of this study with other approaches such as deductive approach in order to confirm its credibility.

In addition, there are more research methods that could be applied for investigating the research phenomenon. As introduced in methodology chapter (3.3.1), observations and diaries are also suitable for this research. However, due to the constraints exposed by the global pandemic since early 2020, this research is unable to get access to conduct these strategies for data collection. A welcome extension of this research for future research is therefore to utilise other research methods to enrich the data set in order to further strengthen the proposed theory.

Further, this research selects European Living Labs as a context, which is appropriate to study ICT-based IOKE practice for inter-organisational collaboration. However, due to the fact that the concept of Living Labs is still under developing in Europe, many Living Lab-based projects are not very identifiable. This raises difficulties for this study to sample data. As a result, this research established an inclusive data sampling criteria (described in section 3.4.3) so that different use of Living Labs can be taken into account in the research context. Accordingly, a potential research area for future research to investigate Living Labs is thus to establish exclusive criteria where projects with strict and formal Living Lab methodology can be selected in order to strengthen the characteristics of Living labs. In addition, this research has concluded a temporal dimension of ICT-based IOKE practice, which largely is the result of the sampled data that are all fixed-term projects with temporal dimension in nature. Additional research could be to explore and investigate other inter-organisational collaboration settings with long term durations.

# APPENDINCES

**Appendix A. Interview Guide for Inception/Middle Stage**

**Interview Guide**

(Inception/Middle Stage – Project Leader)

**Introduction**

In this research, I am interested to identify the role of information communication technologies (ICT) in collaboration activities within Living Labs. About your **XXX** project, I will be inviting project partners from this project like yourself for an interview, to discuss their experiences and opinions in relation to how you have used various technologies to facilitate your communications and collaboration during this project.

The interview will last **around 70 to 80 minutes** during whichI will ask you to **provide your experiences, attitudes, understanding, perceptions or any other insights.** You can freely discuss your opinions and there is no time limitation. Most importantly, **you have the right to stop the interview at any time** if you feel uncomfortable or simply wish to withdraw from the research.

I will be audio recording the interview for later analysis. If you don’t wish to be audio recorded, I will keep handwritten notes. All your information will be kept strictly confidential and will only be accessible to the research team members. All information that can potentially identify will be redacted. You can find more information in the consent form, and your participation in this research entails you have understood and agreed to all information in the consent form.

Can you please confirm you give your consent for this interview and its recording? (Recording starts)

**Background**

1. Can you tell me a little bit about your experience, as for example your previous involvement in funded projects, other living labs projects and so on?
2. Could you tell me a few things about your role in this project?
   1. What does this role entail and what are your main responsibilities?
3. Could you give me some information about the project? I would like to know what the aims of the project are, when it was launched, what is its current status, and when you got involved in it and in what capacity.
   1. Which are the partner organisations in this project and what are their role in the project?
4. Who do you generally work and collaborate with most often for this project from within your own organisation and from the partner organisations?

**IOKE Practices**

1. Can you talk to me a little about your experience with the project so far? How would you evaluate it? Why?
   1. How has the collaboration been going so far in your opinion?
   2. During the project, what were your normal ways to communicate with partners? (Technologies?)
   3. Among these partners, did you have particular communication approach for particular partners?
   4. What are your expectations from your partners with regards to this project?
2. What methodology does the lab typically follow? What methodology do you follow for this particular project?
   1. Are there any differences in the methodology you typically follow as a Living Lab and the one you follow for this project?
   2. (if different) Why did you choose to adapt the methodology for this project?
3. Considering that a project based on the Living lab methodology brings together partners with different experiences and objectives, I would be interested to know how do you integrate all the expertise and contributions of the different project partners. Can you tell me a little bit about this?
4. I realise in this project your partners may want different value, so during the project activities, how did you reciprocate each other?
   1. Do you think how such mutual value are reflected from their different contributions?
5. What is the workplan of this project? *(if they need prompt or explanations: what are the main work packages and tasks for this project),* and how have they been allocated to the partners?
   1. how do you evaluate the progress of the project so far? Why?
   2. so far, what work have you completed per stage?
6. Are there any activities that have deviated from the plan?
   1. In your opinion, what were the reasons for these deviations?
   2. Did you do anything (as an individual or as a partnership) to address the issues you just described?
   3. With hindsight, do you think there was something that could have been done differently to avoid these issues?
7. Which things have gone particularly well so far with this project? Why do you think so?
   1. Generally, in your opinion, what are most important things that make a Living Lab project successful?
8. When do you find it most necessary or useful to collaborate with others? How does this collaboration usually take place?
9. Have you faced any challenges in your collaboration with your partners so far? What challenges were these?
   1. *(if relevant)* Have you used ICTs to overcome these challenges?

**ICT in Use**

1. Do you use any applications or software in this project specifically for collaboration purposes? For example, do you use any software or systems to monitor the project or to share ideas with your partners?
   1. Can you give me some examples of how you have been using these across the different project stages?
   2. *(if changes are spotted*) Based on what you told me, it seems that the way you use technology across the different stages has changed. Have I understood correctly? *(If yes)* Why do you think this has happened?
2. Are there any ICTs that you prefer more than others for collaborating with others in the Living Lab? Why do you say this?
   1. What kind of activities do these ICTs help you with?
   2. How will you evaluate ICT’s help on these activities?
   3. What is it in these ICTs that makes them more useful or better?
3. How was your experience of using these ICTs in collaborating with others? Would you say it was more positive or more negative?

If more negative:

* 1. What kind of problems did you experience?
  2. Were you able to address them? How?
  3. Based on this experience, do you think if you will continue using the same ICTs for your collaboration or potentially move on to some other applications?
  4. Which features or functions of ICTs do you find to be more important for supporting collaborative activities?

If more positive:

* 1. Which features or functions of ICTs did you find to be particularly important and useful for your collaboration?
  2. Can you recall a notable experience where technology was particularly useful for your collaboration?
  3. Are there any issues that you find more challenging when using ICTs for collaboration purposes?
  4. How do you usually address them?

1. If you compare this project to previous ones you have worked on, are there any differences in how ICTs are used? (If yes) Why do you think there are differences?
2. As the project moves forward, do you think that there may be some other ICTs that can be helpful in your collaboration with a) the partner organisations b) with the partners from within your own organisations c) with achieving the goals of the project?

**End**

Thank you very much for providing these very insightful thoughts and opinions. Do you have something to add further?

1. Do you have anyone in this project you would recommend me to interview for getting more insights, if possible?
   1. Can I get their contacts?

**Appendix B Interview Guide for Completed Stage**

**Interview Guide**

(Completed – Project Leader)

**Introduction**

In this research, I am interested to identify the role of information communication technologies (ICT) in collaboration activities within Living Labs. About your XXX project, I will be inviting project partners from this project like yourself for an interview, to discuss their experiences and opinions in relation to how you have used various technologies to facilitate your communications and collaboration during this project.

The interview will last **around 70 to 80 minutes** during whichI will ask you to **provide your experiences, attitudes, understanding, perceptions or any other insights.** You can freely discuss your opinions and there is no time limitation. Most importantly, **you have the right to stop the interview at any time** if you feel uncomfortable or simply wish to withdraw from the research.

I will be audio recording the interview for later analysis. If you don’t wish to be audio recorded, I will keep handwritten notes. All your information will be kept strictly confidential and will only be accessible to the research team members. All information that can potentially identify will be redacted. You can find more information in the consent form, and your participation in this research entails you have understood and agreed to all information in the consent form.

Can you please confirm you give your consent for this interview and its recording? (Recording starts)

**Background**

1. Can you tell me a little bit about your experience, as for example your previous involvement in funded projects, other living labs projects and so on?
   1. Did your previous experience have any impact on the development of this XXX project?
2. Could you tell me a few things about your role in XXX project?
   1. What did this role entail and what were your main responsibilities?
3. Could you give me some information about the project? I would like to know what the aims of the project were, when it was launched, and when you got involved in it and in what capacity.
   1. Which were the partner organisations in this project and what were their role in the project?
4. Who did you generally work and collaborate with most often for this project from within your own organisation and from the partner organisations?
5. Would you describe this as a successful project or a failed project? What made it a successful/failed project in your opinion?

**IOKE Practice**

1. Can you talk to me a little about your experience with the project:
   1. How was the collaboration with the project partners in your opinion?
   2. Initially how do you reach out your partners? As project moving forward, are you reaching out new partners? is there any change on such reaching out approach?
   3. During the project, what were your normal ways to communicate with partners? (Technologies?)
   4. Among these partners, did you have particular communication approach for particular partners?
   5. What were your initial expectations from your project partners in the beginning of the project?
   6. How would you evaluate your partners’ contributions in this project?
2. What methodology does the lab typically follow? What methodology did you follow for this particular project?
   1. Were there any differences in the methodology you typically follow as a Living Lab and the one you followed for this project?
   2. (if different) Why did you choose to adapt the methodology for this project?
3. Considering that a project based on the Living lab methodology brings together partners with different experiences and objectives, I would be interested to know how did you integrate all the expertise and contributions of the different project partners. Can you tell me a little bit about this?
4. I realise in this project your partners may want different value, so during the project activities, how did you reciprocate each other?
   1. Do you think how such mutual value are reflected from their different contributions?
5. What was the workplan of this project? *(if they need prompt or explanations: what are the main work packages and tasks for this project),* and how were they allocated to the partners?
   1. how were you evaluating the progress of the project along the different stages?
   2. Have you completed all tasks and activities per each stage? (if not all stages were completed) What work was left incomplete and why?
6. Were there any activities that deviated from the plan?
   1. In your opinion, what were the reasons for these deviations?
   2. Did you do anything (as an individual or as a partnership) to address the issues you just described?
   3. With hindsight, do you think there was something that could have been done differently to avoid these issues?
7. Which things have gone particularly well with this project? Why do you think so?
   1. Generally, in your opinion, what are the most important things that make a Living Lab project successful?
8. If you were to redo this project, would you do anything differently? From setting up the consortium and selecting the partners, to designing the workplan, choosing the ICTs etc.
9. When do you find it most necessary or useful to collaborate with others? How does this collaboration usually take place?
10. Have you faced any challenges in your collaboration with your partners during the project? What challenges were these?

*(if relevant)* Have you used ICTs to overcome these challenges?

**ICT in Use**

1. Do you use any applications or software in this project specifically for collaboration purposes? For example, do you use any software or systems to monitor the project or to share ideas with your partners?
   1. Can you give me some examples of how you have been using these across the different project stages?
   2. *(if changes are spotted*) Based on what you told me, it seems that the way you use technology across the different stages has changed. Have I understood correctly? *(If yes)* Why do you think this has happened?
2. Are there any ICTs that you prefer more than others for collaborating with others in the Living Lab? Why do you say this?
   1. What kind of activities do these ICTs help you with?
   2. How will you evaluate ICT’s help on these activities?
   3. What is it in these ICTs that makes them more useful or better?
3. How was your experience of using these ICTs in collaborating with others? Would you say it was more positive or more negative?

If more negative:

* 1. What kind of problems did you experience?
  2. Were you able to address them? How?
  3. Based on this experience, do you think if you will continue using the same ICTs for your collaboration or potentially move on to some other applications?
  4. Which features or functions of ICTs do you find to be more important for supporting collaborative activities?

If more positive:

* 1. Which features or functions of ICTs did you find to be particularly important and useful for your collaboration?
  2. Can you recall a notable experience where technology was particularly useful for your collaboration?
  3. Are there any issues that you find more challenging when using ICTs for collaboration purposes?
  4. How do you usually address them?

1. If you compare this project to previous ones you have worked on, are there any differences in how ICTs are used? (If yes) Why do you think there are differences?
2. As the project moves forward, do you think that there may be some other ICTs that can be helpful in your collaboration with a) the partner organisations b) with the partners from within your own organisations c) with achieving the goals of the project?

Thank you very much for providing these very insightful thoughts and opinions. Do you have something to add further?

1. Do you have anyone in this project you would recommend me to interview for getting more insights, if possible?
   1. Can I get their contacts?

**Appendix C Ethics Approval Letter**

Graphical user interface, text, application

Description automatically generated

# ABBREVIATIONS

IT – Information Technology

ICT – Information and Communication Technology

IOKE – Inter-organisational Knowledge Exchange

IOC – Inter-organisational Collaboration

IOR – Inter-organisational Relation

KE – Knowledge Exchange

KM – Knowledge management

IOKM – Interorganisational Knowledge Management

IS – Information Systems

MIS – Management Information Systems

CGT - Classic Grounded Theory

In. – Inception Stage

Mi. – Middle Stage

Co. – Completed Stage

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