



The
University
Of
Sheffield.

Factors affecting the adoption and use of Electronic Patient Record (EPR) systems in cancer treatment services

Thomas Poulter

Submitted in fulfilment of the requirements for the
degree of Doctor of Philosophy

Information School, University of Sheffield

August 2019

Abstract

Background: Healthcare services around the world have developed computerised information systems to gradually replace traditional paper-based medical records. In oncology services, a diverse range of multi-organisational patient record systems are currently undergoing continuous development and improvement. Achieving technology acceptance in clinical environments is a complex aspect of the development and implementation of socio-technical systems. Whilst there has been previous research conducted about technology acceptance in oncology, gaps and limitations remain unexplored, particularly in relation to the full range of EPR system functionality. From a clinical end users' perspective, this research aimed to discover the factors that influence clinicians' attitudes towards and their use of oncology EPR systems.

Methodology: This mixed methods research comprised two studies. In the first exploratory study, a patient records survey questionnaire was conducted to gather information about participants' use of patient records and clinical information systems at a large regional cancer hospital. The findings and themes that emerged from the first study were used in conjunction with a social-technical systems theoretical framework to design and structure the second study. In the second study, in-depth qualitative interviews were conducted with oncologists to further investigate their views and identify key factors that affect their adoption and use of EPR systems. Phenomenography was used as the main qualitative approach for analysing the interview transcripts, and the researcher identified categories of description and the "outcome space" that explains the different ways that oncologists think about EPR systems. Following triangulation of the results, the findings were developed into recommendations for further research and practical guidance for health informatics practitioners in the form of a conceptual reference model, CICERO (Comprehensive, Integrated, Customised Electronic Records for Oncology).

Findings: The exploratory study found that while the majority of respondents found the existing EPR systems easy to use, a range of factors affected the full adoption and use of these systems. Medical staff, in particular, reported problems with accessibility, integration, and usability. The qualitative study found that the alignment of technology, tasks, and individuals could be improved with increased emphasis on understanding the fit between oncologists and the clinical tasks they perform. Phenomenographical analyses produced an outcome space that included three categories of description related to the qualitatively different ways in which oncologists think about EPR systems. In the first category, oncologists thought of EPR systems as a simple legal record of a patient's care and treatment; in the second category, where most oncologists were positioned, they viewed EPR systems as a means of providing information to aid memory and communication; and in the third category, oncologists thought of EPR systems as advanced tools for clinical workflow, decision support, and interoperability.

Conclusion: Various socio-technical factors should be considered when designing, developing, and implementing EPR systems in oncology, with a view to maximising technology acceptance by clinical end users. In line with prior studies, the key factors identified were accessibility, integration, and usability. Additional factors included clinical staff participation in system design and development activities. In summary, oncologists are more likely to perceive EPR systems in the third category of description and adopt them if they can see specific benefits being gained from their use.

Keywords: Oncology, information systems, electronic patient records, technology acceptance, cancer services, socio-technical systems.

Acknowledgements

The study described in this thesis was conceptualised, designed, and conducted by the author, Thomas Poulter. However, the research would not have been possible without the help and support of the following individuals and organisations.

The research was financially supported by The Clatterbridge Cancer Centre NHS Foundation Trust and Lancashire Care NHS Foundation Trust.

Firstly, I would like to thank my supervisor, Professor Peter Bath, whose expertise and advice have guided me through a long, challenging and rewarding period of my life with regards to completing my PhD, helping me to make a longstanding dream become a reality. There were some difficult times along the way, and I am very grateful for Professor Bath putting his faith in me and supporting me through the process.

The completion of this research has been an almost decade-long journey. As a mature student in a relatively senior position in my career, I was fortunate to secure backing and sponsorship from the Executive team of the NHS trust where I was formerly employed. I have many people to thank for supporting me over the years, but I would not have been able to start this endeavour without the backing and encouragement of Andrew Cannell, the former Chief Executive of The Clatterbridge Cancer Centre, and subsequently my line manager and Deputy Chief Executive, Yvonne Bottomley. I will always be grateful for the opportunity afforded to me to undertake this research while simultaneously being trusted to deliver on my day job as Associate Director of Information Management and Technology; it was a difficult balancing act, but supporting the delivery of the best cancer treatment services for patients was always my top priority.

The person I would like to thank the most is my wife Helen Poulter-Clark, for her support, friendship, and advice, and her encouragement to finish this project that I started back in 2010. I will be eternally grateful for everything Helen has done for me and my girls over the last few years. I am also grateful to Molly and Faye for supporting me, and I hope that my ambition and determination to complete this research will provide them with a role model to work hard and never give up on their dreams.

I would also like to thank my parents and brother and sister for their unconditional love and support. I am very privileged to have such a supportive family.

Publications, presentations and posters

Several publications, posters and papers have been produced from the research presented in this thesis:

1. An Analysis of Electronic Document Management in Oncology Care

Full paper presented at the 15th International Symposium for Health Information Management Research (ISHIMR) in Zurich, Switzerland, September 2011, and selected for publication in the *Health Informatics Journal* as one of the highest-rated papers following peer review.

Poulter, T., Gannon, B., & Bath, P. A. (2011). An analysis of electronic document management in oncology care. In P. A. Bath, T. Mettler, D. Raptis, and B. A. Sen (eds.), *Proceedings of 15th International Symposium for Health Information Management Research (ISHIMR 2011)* (pp. 23-33). Zurich, Switzerland: University Hospital.

Poulter, T., Gannon, B., & Bath, P. A. (2012). An analysis of electronic document management in oncology care. *Health Informatics Journal*, 18(2), 135-146.

2. Requirements for Oncology EPR systems, a mixed methods approach

Poster presented at the 15th International Symposium for Health Information Management Research (ISHIMR) in Zurich, September 2011.

Poulter, T., & Bath, P. A. (2011) Requirements for oncology EPRs – a mixed methods approach. In P. A. Bath, T. Mettler, D. Raptis, and B. A. Sen (eds.), *Proceedings of 15th International Symposium for Health Information Management Research (ISHIMR 2011)* (pp. 543-544). Zurich, Switzerland: University Hospital.

3. The use and usability of EPR systems in oncology

Paper presented at Medical Informatics Europe (MIE) conference in Pisa, Italy, August 2012.

Poulter, T., & Bath, P. A. (2012). The use and usability of EPR systems in oncology. *Studies in Health Technology and Informatics*, 180, 398-402.

4. ‘Onco alerts’ to support acute oncology services

Short paper and poster presented at Medical Informatics Europe (MIE) conference in Pisa, Italy, August 2012.

Poulter, T., & Bath, P. A. (2012). ‘Onco Alerts’ to support acute oncology services. *Studies in Health Technology and Informatics*, 180, 1191-1193.

5. Requirements and benefits of oncology EPR systems

iSchool research seminar delivered on 20th June 2013 in partial fulfilment of the MPhil to PhD upgrade process.

6. CICERO: an emergent conceptual model for onco-EPR systems.

Short paper submitted to MEDINFO 2013, the 14th World Congress on Medical and Health Informatics, Copenhagen, August 2013.

Poulter, T., & Bath, P. A. (2013) CICERO: An emergent conceptual model for onco-EPR systems. *Studies in Health Technology and Informatics*, 192, 1131.

7. The impact of a new acute oncology service in acute hospitals: experience from the Clatterbridge Cancer Centre and Merseyside and Cheshire Cancer Network

Neville-Webbe, H. L., Carsar, J. E., Wong, H., Andrews, J., Poulter, T., Smith, R., & Marshall, E. (2013). The impact of a new acute oncology service in acute hospitals: experience from the Clatterbridge Cancer Centre and Merseyside and Cheshire Cancer Network. *Clinical Medicine*, 13(6), 565-569.

8. A phenomenographic approach to identifying factors influencing the adoption and use of EPR systems in cancer services

Poster presented at the 17th International Symposium for Health Information Management Research (ISHIMR) in York, United Kingdom, June 2015.

Poulter, T., & Bath, P. A. (2015). A phenomenographical approach to identifying factors influencing the adoption and use of EPR systems in cancer services. In *Proceedings of the 17th International Symposium on Health Information Management Research* (pp.297-298).

Articles in preparation for publication in peer-reviewed journals

1. Oncologists' perspectives on electronic prescribing and medicines administration (ePMA) of systemic anti-cancer treatment (SACT) in the UK

Poulter, T., Armitage, N., Griffiths, R. W., & Bath, P. A. (2019). Pending peer review for publication in the *European Journal of Cancer Care*.

2. What do oncologists think of electronic patient record systems? (title tbc)

Poulter, T., & Bath, P. A. (2019). Being prepared for submission to the *Health Informatics Journal*

Contents

Abstract	iii
Acknowledgements	iv
Publications, presentations and posters	v
Contents	vii
List of Acronyms and Abbreviations	xiv
Glossary	xv
Chapter One: Introduction	2
1.1 Overview	2
1.2 A brief epidemiology of cancer	3
1.3 Organisation of Cancer Services	4
1.4 Setting for the study	10
1.5 Information Requirements	12
1.5.1 Generic information.....	13
1.5.2 Service information	14
1.5.3 Information about groups and populations of cancer patients	15
1.5.4 Information about individual cancer patients.....	16
1.6 Rationale for this Study	18
1.7 Study Aims and Objectives	19
1.8 Motivation for Undertaking the Research	20
1.9 Structure of the Thesis	20
1.10 Conclusion	22
Chapter Two: Literature Review	24
2.1 Introduction	24
2.2 Literature search methods	25
2.3 Electronic Patient Record (EPR) systems	26
2.3.1 Trends in the use of EPR systems.....	28
2.4 Oncology EPR systems	29
2.5 Development of EPR systems in the United Kingdom	29
2.6 Development and use of EPR systems in cancer services	33
2.6.1 Specialist requirements for oncology EPRs	33
2.6.2 History of onco-EPR and the use of ICTs in cancer services	34
2.7 Functions and capabilities of oncology information systems	41
2.7.1 Information systems for systemic anti-cancer treatment (SACT).....	42
2.7.2 Information systems for radiotherapy planning and treatment.....	47
2.7.3 Information systems for diagnostic and support services	52
2.7.4 Integration, cross-organisational systems, and remote access	53
2.7.5 “Big data,” predictive analytics, clinical research, and precision medicine	55
2.8 Challenges associated with implementing EPR systems	57
2.9 Socio-technical systems	60
2.10 Technology acceptance and adoption	61
2.11 FITT: the theoretical framework selected for this study	66
2.12 Limitations of the existing research	72
2.13 Synthesis of the literature and development of the CICERO model	73
2.14 Conclusion	76

Chapter Three: Design and Methodology	78
3.1 Introduction	78
3.2 Research methodology	78
3.3 Research paradigms.....	79
3.4 Overview of research design	80
3.5 Ontological and epistemological assumptions of the study	83
3.6 Research approaches.....	85
3.6.1 Qualitative approach	85
3.6.2 Quantitative approach	86
3.6.3 Differences between qualitative and quantitative approaches	87
3.6.4 Rationale for adopting a mixed methods approach.....	88
3.7 Phenomenography, the approach to the qualitative study.....	89
3.7.1 Overview	89
3.7.2 Origins and history of phenomenography	89
3.7.3 The distinction between phenomenography and phenomenology	91
3.7.4 Phenomenographical research in healthcare	94
3.7.5 Phenomenographical research in information systems.....	94
3.7.6 Key concepts in phenomenography and their application in this study	95
3.7.7 Rationale for adopting phenomenography in this study	98
3.8 Case study site: The Clatterbridge Cancer Centre NHS Trust	98
3.9 Data collection methods	100
3.9.1 Phase 1: Quantitative study	100
3.9.1.1 Survey questionnaire	100
3.9.2 Phase 2: Qualitative study.....	100
3.9.2.1 Semi-structured interviews	101
3.10 Data analysis	102
3.10.1 Phase 1: Quantitative data analysis.....	102
3.10.2 Phase 2: Qualitative data analysis	103
3.10.2.1 NVivo	105
3.11 Ethical issues	105
3.12 Research quality	106
3.12.1 Reliability	107
3.12.2 Validity	107
3.12.3 Generalisability and Transferability	108
 Chapter Four: Exploratory Research (Quantitative Study)	 112
4.1 Introduction	112
4.2 Research questions.....	112
4.3 Methods	113
4.3.1 Questionnaire design and development	113
4.3.2 Ethics approval and pilot study	116
4.3.3 Setting, population and sampling method	118
4.3.4 Recruitment of participants	118
Coding process	119
4.3.6 Data analyses	119
4.3.7 Instrument reliability and validity	120
4.3.7.1 Internal reliability	120
4.3.8 Validity	122
4.4 Results	123
4.4.1 Descriptive analyses	123
4.4.1.1 Response rate	123

4.4.1.2	Sample Characteristics	124
4.4.1.3	Use of paper-based medical notes	124
4.4.1.4	Access to patient medical notes	124
4.4.1.5	Tasks supported by EPR systems	126
4.4.1.6	Reported uses of EPR	126
4.4.1.7	Self-reported levels of IT literacy and preference for eLearning	127
4.4.2	User satisfaction with current EPR systems.....	128
4.4.3	Perceived impact of fully electronic patient records	132
4.4.4	Positive and negative aspects of the current EPR systems	133
4.5	Discussion	138
4.6	Limitations	140
4.7	Conclusion	140

Chapter Five: Qualitative study 142

5.1	Introduction	142
5.2	Qualitative study research aims	142
5.3	Research methods	143
5.3.1	Qualitative study design	143
5.3.2	Research setting and EPR systems used by oncologists	144
5.3.3	Sampling and recruitment	146
5.3.4	Ethics Approval	147
5.3.5	Data collection	147
5.3.6	Planning and preparing for phenomenographical interviews	148
5.3.7	Pilot study	149
5.3.8	Data analyses	150
5.3.9	Reliability and validity	158
5.4	Summary of Results	160
5.4.1	Sample characteristics	160
5.4.2	Overview of the results of phenomenographical analyses	163
5.4.3	Overview of oncology EPR categories of description and outcome space	166
5.5	Detailed analyses and results	169
5.5.1	C1: EPR as a simple activity log / legal record	170
5.5.2	C2: EPR as a tool for workflow support and communication	175
5.5.3	C3: EPR as an integral part of the clinical work of oncologists	180
5.6	Patterns of conceptions	185
5.7	Strengths and limitations of the interview study	188
5.8	Further research required	189
5.9	Conclusion	190

Chapter Six: Discussion 192

6.1	Introduction	192
6.2	Triangulation	193
6.2.1	Confirmation of results	194
6.2.2	Completeness of results	200
6.3	Data triangulation	205
6.4	Theoretical triangulation	206
6.5	Methodological triangulation	216
6.6	CICERO conceptual model	217
6.7	Differentiation of the study from others in the literature	233
6.8	Overall study strengths and limitations	235
6.9	Conclusion	236

Chapter Seven: Conclusion	238
7.1 Introduction	238
7.2 Research questions.....	240
7.2.1 User satisfaction with EPR systems	241
7.3 The Oncology EPR outcome space	243
7.4 Final version of the CICERO model	244
7.5 Validity and Reliability	245
7.6 Strengths and limitations of the research	247
7.7 Contribution to new knowledge	249
7.8 Implications for policy and practice.....	251
7.9 Implications for future research	252
7.10 Conclusion	253
Bibliography	254

List of Tables

Table 1.5.1-1 Categories of cancer information	12
Table 2.3-1 Key trends in global EPR adoption.....	28
Table 2.6-1 Applying the computer to processes in oncology care	35
Table 2.6-2 Core data items and functionality in Galligioni et al.'s EOPR.....	39
Table 2.10-1 Overview of technology acceptance models and frameworks	64
Table 2.11-1 Assessment of acceptance models for the study	67
Table 3.7-1 A comparison of phenomenography and phenomenology.....	92
Table 3.7-2 Key concepts in phenomenographic research	96
Table 3.7-2 Key concepts in phenomenographic research (continued)	97
Table 3.10-1 The stages of phenomenographic data analysis.....	104
Table 4.3-1 Overview of survey questionnaire and rationale for questions.....	116
Table 4.3-2 Cronbach's alpha co-efficient for CUSQ constructs	121
Table 4.4-4 Overall satisfaction with EPR systems by user group	129
Table 4.4-10 Perceived impact of fully electronic records: negative statements.....	133
Table 4.4-11 Medical staff comments.....	134
Table 4.4-12 Nursing staff comments.....	135
Table 4.4-13 Administrative staff comments	137
Table 4.4-14 Radiographer staff comments	137
Table 4.4-15 Allied Health Professional Comments	138
Table 5.3-1 Overview of clinical information systems used by CCC oncologists	145
Table 5.4-1 Sample characteristics	162
Table 5.5-1 Summary of conceptions of EPR systems	184
Table 5.6-1 Patterns of conception for individual oncologists	187
Table 6.4-1 Socio-technical issues identified during oncology EPR implementation.	214
Table 6.6-1 CICERO: Summary of socio-technical factors affecting adoption of Onco-EPR.	232

List of Figures

Figure 1.3.1 Distributed model of healthcare for cancer.....	6
Figure 1.3.2 Comprehensive cancer centre model.....	7
Figure 1.4.1 Map of CCC service delivery locations.....	11
Figure 2.2.1 Search strategy spider diagram	26
Figure 2.5.1 Sheikh's schematic model of the NHS Care Records Service	31
Figure 2.10.1 The original version of the technology acceptance model (TAM)	61
Figure 2.11.1 The FITT model.....	70
Figure 2.12.1 CICERO v1 – a conceptual model for oncology EPRs.....	75
Figure 3.4.1 Basic overview of research design.....	81
Figure 3.4.2 Stages of the research process.....	83
Figure 5.3.1 Process of phenomenographical analyses.....	158
Figure 5.4.1 FITT Dimensions and interview themes	164
Figure 5.4.2 Oncology EPR outcome space	168
Figure 5.5.1 Conceptions within category of description C1	162
Figure 5.5.2 Conceptions within category of description C2.....	168
Figure 5.5.3 Conceptions within category of description C3.....	173
Figure 5.6.1 Example of participant (MO2) with conceptions in multiple categories	186
Figure 6.4.1 Sequential Mixed Methods Design with Emphasis on the Qualitative Phase	217
Figure 6.6.1 SSM Rich Picture Diagram of a Cancer Care System	220
Figure 6.6.2 CICERO UML2 Component Diagram.....	222
Figure 6.6.3 CICERO v3 Conceptual Model.....	225
Figure 6.6.4 CICERO functional modules and components.....	226
Figure 7.3.1 Oncology EPR outcome space	243

List of Appendices

- Appendix A Exploratory study approval letter, NHS National Research Ethics Service
- Appendix B Patient Records Survey
- Appendix C Main Study University Ethics Application and Approval
- Appendix D Qualitative Study Interview Preparation and Schedule
- Appendix E Invitation to participate in main qualitative study and information sheet
- Appendix F Member checking: summary of results
- Appendix G NVivo coding structure example

List of Acronyms and Abbreviations

A&E	Accident and Emergency
CCGs	Clinical Commissioning Groups
CDMI	The Clinical Digital Maturity Index
CIO	Chief Information Officer
CfH	Connecting for Health
COSD	Cancer Outcomes and Services Dataset
CNS	Clinical Nurse Specialist
CReST	Cancer Rehabilitation and Support Team
DGH	District General Hospital
DoH	Department of Health
ED	Emergency Department
EHR(s)	Electronic Health Records
EMR(s)	Electronic Medical Records
EPR(s)	Electronic Patient Records
GP	General Practitioner
HES	Hospital Episode Statistics
HiMSS	Healthcare and Information Management Systems Society
HISS	Hospital Information Support System
HSCIC	The Health and Social Care Information Centre
HSR	Health Services Research
HES	Hospital Episode Statistics
IDCR	Integrated Digital Care Record
IM&T	Information Management and Technology
IfH	Information for Health
IARC	International Agency for Research on Cancer
IOM	Institute of Medicine
IOS	iPhone Operating System
IT	Information technology
OECI	Organisation of European Cancer Institutes
LSP	Local Service Provider
MDT	Multi-disciplinary Team
MPI	Master Patient Index
NAO	National Audit Office
NCI	National Cancer Institute
NCDS	National Cancer Dataset
NHS	National Health Service
NICE	The National Institute for Clinical Excellence
NPfIT	The National Programme for IT in the NHS
PACS	Picture Archiving and Communications System
PAS	Patient Administration System
PCT	Primary Care Trust
PET	Positron Emission Tomography
RCT	Randomised Controlled Trial
SACT	Systemic Anti-Cancer Treatment
SRO	Senior Responsible Owner
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

Glossary

Term	Definition
Connecting for Health (CfH)	NHS Connecting for Health was a national unit set up by the UK Department of Health, established on 1 April 2005. The CfH agency was responsible for the planning and delivery of the National Programme for IT (NPfIT) during the years 2005-2012.
Clinical Commissioning Groups (CCG)	The NHS groups responsible for the purchasing of healthcare services, usually at a sub-regional level for acute and community services, but with some regional or national groups responsible for commissioning specialist services.
Commissioners	Refers to the NHS organisations that are responsible for specifying healthcare service requirements and agreeing contractual terms for their delivery, with provider organisations. The equivalent term to “Payers” in the USA healthcare system.
Local Service Provider (LSP)	The term used to describe the organisations that were awarded contracts to implement EPR systems.
National Programme for Information Technology (NPfIT)	The National Programme for IT (NPfIT) was the NHS digital transformation programme, planned and delivered by CfH. It comprised a number of national infrastructure projects and regional contracts with LSPs to implement EPR systems.
Order Communication and Results Reporting	A term used in the NHS for EPR system functionality used for ordering diagnostic tests and recording the acknowledgment of results. Equivalent to Computerised Physician Order Entry (CPOE) in the USA.
Provider organisation	A term used in the NHS to refer to an NHS healthcare provider e.g. hospital, as distinct from an NHS trust, responsible for commissioning services.

Chapter One: Introduction

1.1 Overview

This thesis is concerned with the development and use of information systems within the field of cancer treatment services in the UK National Health Service (NHS). It considers the information and functional requirements from a clinical end user's perspective, with the aim of improving the development and implementation of information systems and, ultimately, contributing to improved clinical outcomes for patients. While significant funding is provided for cancer research, it is mainly concerned with improving treatments and the search for a cure; relatively little research has examined the organisation of services, information requirements, and the use of electronic systems to support service delivery.

It is widely accepted that oncology electronic patient record (EPR) systems improve patient safety, clinical efficiency, and the availability of medical information (Shulman, 2008). However, it is critical to establish principles of safe practice that govern the design of an EPR system, its functionality, and its integration within the clinical workflow of treatment centres. In fact, the processes of evaluating potential EPRs for a treatment centre and implementing an EPR both provide opportunities to evaluate overall practice principles, thereby improving patient safety and clinical efficiency (Shulman, Miller, Ambinder, Yu, & Cox, 2008).

To provide a novel contribution to the existing body of research, this study presents the results in the form of a conceptual reference model, named CICERO. CICERO stands for Comprehensive, Integrated, Customised Electronic Records for Oncology and is presented in a form that can be used for both practical implementation guidance for practitioners and as a direction for future research in this field. The model is explained further in Chapter Two, following a review of the existing literature on oncology EPRs, models of technology acceptance and use, and other fields relevant to this study.

This introductory chapter explains the context for the study, including a brief epidemiology of cancer (Section 1.2), providing an overview of what cancer disease is and its incidence and mortality statistics for the UK. The epidemiology is followed with an explanation of how cancer treatment services are organised globally and in the UK (Section 1.3), explaining how this affects information system requirements. Section 1.4 then describes the primary setting for the research project, a large regional cancer treatment centre in North West England, UK. Section 1.5 provides an overview of different categories of information requirements for cancer services, emphasising the point that effective cancer therapy can only be provided if the right information is available to clinicians in the right format at the right time.

The remaining sections of Chapter One explain the motivation for the study (Section 1.8), the research questions (Section 1.6), the aims and objectives of the study, and its importance in relation to current developments in the NHS and the health informatics research community (Section 1.7). The concluding section provides an overview of the structure of the thesis and a summary of this introduction chapter (sections 1.8 and 1.9).

1.2 A brief epidemiology of cancer

In order to understand the information system requirements of any particular healthcare condition and clinical speciality, it is important to establish a level of knowledge about the history, origins, biology, prevalence and treatment of that condition. This section therefore provides a contextual overview of cancer epidemiology before considering different aspects of the information systems required to support effective treatment and care of patients diagnosed with cancer.

Cancer is the name given to a range of specific illnesses resulting from abnormal cell growth (NCI, 2010). It is a group of diseases that exhibit a multiphase progression where cells have metabolic and behavioural modifications, making them grow excessively (WHO, 2008). Oncology is the clinical specialty focused on managing cancer growth and tumours, incorporating prevention, diagnostics, therapies and ongoing research through clinical trials. The word oncology is derived from a Greek word *Onkos*, which means a tumour or a mass of swelling, followed by the word "ology" which means "the study of" (Creswell, 2010).

There are over 200 different kinds of cancer disease (Cancer Research UK, 2017), each with different causes and symptoms that need a variety of different treatments. The most common types of cancer can be categorised into five main groups. Carcinomas develop from abnormal cell growth both inside the body and on skin and other surfaces outside; the most common cancers in this category are breast, lung, and colon. Sarcomas are a type of cancer disease that occurs in the structural parts of the body, including muscle, fat, and bone, for example. Cancers that develop in the lymph nodes and immune system are called lymphomas (Cancer Research UK, 2017). Malignancies derived from cells of the bone marrow and lymphoreticular system comprise mainly leukaemia, lymphomas, and myeloma (Hancock, 1996). The fifth main category comprises neurological cancers, also referred to as central nervous system disease (Cancer Research UK, 2017).

World Health Organisation statistics report that cancer is one of the main causes of death throughout the world, second only to cardiovascular disease (WHO, 2018). The International

Agency for Research on Cancer (IARC), part of the World Health Organisation, projected that some 9.6 million people worldwide would die from cancer-related disease in 2018. The estimated figures for the year 2030 are 23 million new cancer diagnoses and 15 million cancer-related deaths.

Global cancer survival statistics have revealed that individuals residing in the UK have a reduced likelihood of surviving all of the standard survivorship terms used for clinical performance and outcome measurement (i.e., one, two, and five years), compared with the majority of other developed nations (APBI, 2014). Whilst the UK fares well in the successful treatment of some disease, e.g., acute leukaemia and testicular cancer, in most cases, outcomes (e.g., survival) are worse than those of comparable countries. Overall, it was reported in 2002 that cancer patients in the most advanced and well-funded European medical systems have a 10% higher likelihood of long-term survival than individuals being treated in the UK (Baker, 2002). Whilst there have been some improvements in recent years, analyses of comparative data in 2014 found that the UK survival rates are still notably lower than those of the rest of Europe in all of the main disease groups (APBI, 2014).

Another key issue facing the provision of cancer treatment services is the ageing population. In the UK and other developed countries, people are living longer with increased life expectancy, but, with the complexity of increasing co-morbidities, cancer treatment is often provided in conjunction with treatment for other diseases or illnesses.

Developing and improving cancer services, including information systems, may help to improve clinical outcomes. If computerised clinical systems and patient records can be deployed successfully to generate intended efficiency savings, this will theoretically allow more funding to be allocated to the provision of front-line services. While it is not the intention of this research to provide evidence in support of this possibility, it is an important point to acknowledge and highlight in the context of this study. It is also important to understand the context of how cancer services are organised for the delivery of treatment and care, as this has implications for how information systems work at national, regional, and local organisational levels. The following section therefore provides an overview of how cancer services are organised, highlighting some of the key features of service delivery models that have direct implications for the design, implementation, and use of EPR systems in oncology.

1.3 Organisation of Cancer Services

In addition to understanding cancer disease, as detailed in the previous section, in order to fully understand information system requirements for oncology it is also important to know how

services are designed, commissioned, and organised at different levels (e.g. nationally, regionally, and locally). Cancer treatment is arguably more diffuse and complex than many other clinical specialities in healthcare; given the complexity of the disease itself, distinctive forms of service delivery are required, which, in turn, raise distinctive information requirements. In this section the organisation of cancer services is described, in order to ensure a solid foundation of knowledge upon which information systems can be designed appropriately, with the aim of contributing to more efficient and effective service provision that should ultimately lead to improved patient outcomes.

The Organisation of European Cancer Institutes (OECI) set a principle and approach to oncology that is founded on the concept of a comprehensive view of the patient and an integrated framework for the cancer “research-to-care” process (i.e. using the results of clinical trials to improve routine treatment options). One strategic goal of the OECI is to establish the requirements in order to specify the design of a “Comprehensive Cancer Centre,” the European Union (EU) model of an oncology treatment hospital that has all necessary resources and capability to best reduce mortality and morbidity and improve the patient’s quality of life, as well as the probability of survival. The prevailing view from the member institutions is that to achieve improved oncology performance and outcomes requires the effective alignment and combination of prevention, diagnosis, therapies, rehabilitation, research and ongoing learning. On an international level, there appears to be a consensus that the development of Comprehensive Cancer Centres would achieve the required amount of integration to best fulfil the needs of the patient by aligning and merging all supporting infrastructures, information systems, clinical expertise, and capability (Ringborg, Pierroti, Storme, & Tursz, 2008).

In their report on managing cancer in the EU, Ringborg et al. (2008, p. 772) stated that “it is at the institutional level that cancer can and must be fought, because this is where the main elements of cancer research and clinical treatment are integrated and controlled.” However, the treatment centres have direct access to a wide range of scientific and clinical resources that usually need to be combined if they are to be fully utilised and effective (Ringborg et al., 2008). The impact of the changes related to the UK’s planned exit from the European Union in 2019 (known as “Brexit”) is potentially significant and is currently being assessed by the National Health Service at the time of writing. The areas of focus for impact assessment include workforce implications, medication costs, and participation in EU clinical research trials. One area where impact is already being seen is in the recruitment and retention of EU nationals, which is creating staffing shortages in some areas of the NHS. However, with regards to the organisation of cancer services, the EU has limited legal jurisdiction over the way in which healthcare service provision is organised and delivered in member states (McKenna, 2017). Restructuring under Brexit is therefore not likely to bring about significant changes in the organisation of cancer care services in the UK, at least in the short term.

Cancer treatment services are organised on a number of different levels and in different ways. For example, they may be organised geographically, by anatomical site, tumour group, stage of disease, care pathways, patient type, or treatment specializations. Within national healthcare systems, cancer services are structured in various formats, covering public and private funded institutions, primary care settings, secondary care setting such as acute hospitals, tertiary centres, and charitable organisations.

Donaldson (2005) represented different cancer service delivery arrangements as models. She referred to the distributed model as the most common; in this approach, oncology clinicians operate in the community, and the patient moves from one medic and laboratory to another, struggling to align and understand disparate and occasionally contradicting information, as depicted in Figure 1.3.1. Furthermore, clinicians struggle to obtain information, which results in wasted effort and inefficiencies; the primary care general practitioner (GP) frequently has minimal information about the patient's diagnosis and treatment plan. Diagnostic tests and treatment are provided in numerous locations, not just at the time of initial diagnosis and treatment, but also during the overall course of treatment and subsequent monitoring via outpatient review clinics (Donaldson, 2005).

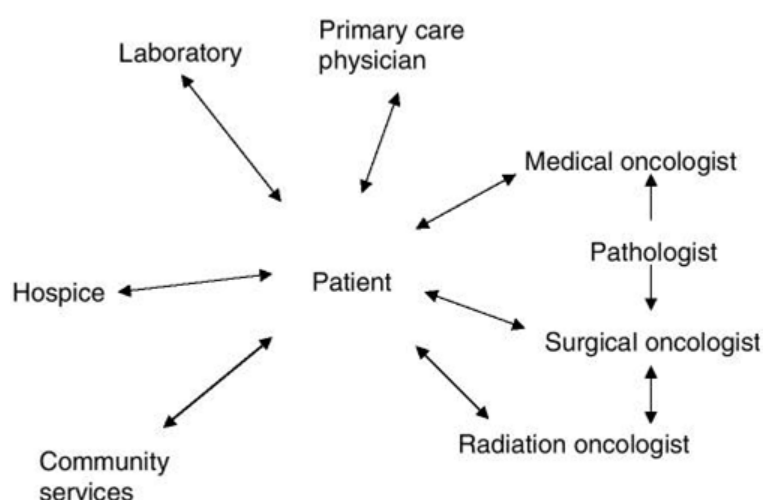


Figure 1.3.1 Distributed model of healthcare for cancer

(Reproduced with permission, Donaldson, 2005, p. 178)

An alternative model is a comprehensive cancer centre, in which oncologists and other healthcare professionals are located together in a single facility. Examples of these centres in the USA are Dana Farber, M.D. Anderson, and Memorial Sloan-Kettering. In England, UK, centres that utilise a similar model are The Clatterbridge Cancer Centre NHS Foundation Trust, The Christie NHS Foundation Trust, and The Royal Marsden NHS Foundation Trust. However, even in these settings, patients are often transferred between different provider organisations that maintain separate patient record systems. A care coordinator, like a clinical nurse specialist

(CNS), may facilitate the coordination of care, and patients in this situation have an increased likelihood of participating in clinical trials with strict protocols and subsequent monitoring arrangements.

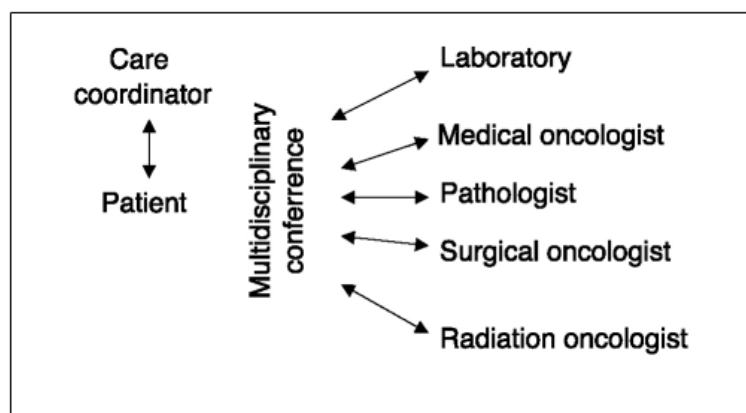


Figure 1.3.2 Comprehensive cancer centre model

(Reproduced with permission, Donaldson, 2005, p. 178)

In the comprehensive cancer centre model (Figure 1.3.2), tumour specialist groups (TSGs) and multidisciplinary teams (MDTs) comprising a range of healthcare professionals develop a comprehensive care plan for patients. MDT meetings, which may take place at regular intervals following initial treatment, may (but often do not) directly include the patient or their relatives (Joishy, 2001).

In the UK, until the mid-1990s when the Calman-Hine report (Calman & Hine, 1995) was published, the pattern of cancer treatment services and the ways in which they were commissioned developed in a relatively *ad hoc* manner. Many health care professionals recognized that this *ad hoc* approach was inadequate for the provision of modern comprehensive care (Hancock, 1996). The complex nature of cancer diseases means that there are a range of different healthcare settings which may be most appropriate for different conditions and stages of illness. General practitioners, district nurses, and other specialists provide community-based care at the primary level, and a range of specialists within acute care settings may deal with cancer patients, including cardiologists, general surgeons, urologists, gynaecologists, and haematologists. Tertiary services are provided by cancer specialists, including clinical and medical oncologists in specialist cancer centres or oncology units, which may be part of district general or teaching hospitals.

An important group of service providers supporting cancer patients are the charitable and voluntary sectors, whose support is generated by the high cultural profile of cancer in Western countries. While this support can be positive from a patient's perspective, and publicly-funded

cancer services welcome the involvement and support of these “third sector” agencies, the number and type of organisations involved with service provision can potentially lead to fragmentation and discontinuities in the delivery of care (Hancock, 1996). Individuals who have completed treatment and are in a subsequent rehabilitation phase are particularly impacted by the disintegrated nature of healthcare service provision and the effects of this are amplified at a regional level, when services are provided across multiple organisational boundaries; this inevitably leads to increased spending and reduced quality of care (Skolarus, Zhang, & Hollenbeck, 2012). This issue is an important problem related to the research presented in this thesis, as well-designed electronic patient record systems with “system-wide” interoperability have the potential to alleviate at least some of the inefficiencies currently experienced by both patients and clinicians.

Another disadvantage of fragmented service organisation is that, for commissioners responsible for the procurement of services, the overall view of requirements for a particular disease type can become unclear, as specific aspects of care must be purchased from separate providers. In the UK, the purchasing of cancer care is managed through the same mechanism as most other clinical services in the NHS, the contracting cycle (Wenzell, 2017). This is an important consideration, as the disjointed approach to commissioning services can lead to disjointed information systems and patient records.

The Calman-Hine report, mentioned previously, introduced a structured model for the delivery of oncology services and the specification for hospitals to undertake a clearer role in the overall NHS healthcare system (Calman & Hine, 1995). This report described the three interrelated levels of service provision (i.e., GPs in primary care, cancer departments in acute hospitals and dedicated cancer treatment centres) as a “cancer network.” The report also set out seven principles for the development of cancer services (Calman & Hine, 1995, p. 6). Firstly, the authors stated that consistently good quality care should be accessible regardless of location to achieve the highest possible rates of survivorship and quality of life; treatment should be provided as near to the patient’s residence as possible. Secondly, they said that both citizens and clinical staff should be educated to assist with early identification of cancer symptoms, highlighting the importance of screening programmes. Next, they emphasised the importance of reliable and easy to understand information about treatment options and their potential outcomes. Fourthly, they referred to the importance of services being “patient-centred” (p. 6), taking into consideration the needs and preferences of patients’ families and carers, acknowledging they might not have the same views as clinical staff. The fifth principle stated that General Practitioners (GPs) are an important ongoing aspect of cancer care for both the patient and their family throughout the end to end cancer pathway, from prevention through to, in some cases, bereavement. In relation to this point, the Calman-Hine report emphasised the importance of cross-sector communication—an issue that is particularly relevant to this thesis,

due to clinicians' dependency on effective IT solutions for information sharing. The sixth principle affirmed the importance of mental health in oncology care, acknowledging that psychosocial aspects of care should be continually reviewed. Finally, the seventh principle recognized that cancer registration and ongoing examination of treatment and outcomes are vital. This final point again underscores the need for efficient and effective information systems for recoding all relevant aspects of individual patient medical records (Calman-Hine, 1995).

As mentioned previously, Calman-Hine (1995) also recommended three stages of care. General practice was to be positioned as the main patient focus and co-ordination of care, and Calman and Hine (1995) advised that close working relationships and effective working relationships between GPs, hospital cancer departments, and treatment centres would be required. This was aimed at establishing clear trends in referral and subsequent clinical review activities to achieve improved outcomes. The next level was to be delivered by "Designated Cancer Units" which, the report recommended, should be set up in the majority of acute hospitals. The report stated that Units should be of adequate scale to provide other hospital departments with specialist advice and services to manage the common cancers. The third level, which is the focus of this study, is "Designated Cancer Centres," which afford the specialist oncology advice and treatment for all disease groups, including the most frequently occurring cancers, within specific locality areas, together with rarer cancer disease types, referred from the acute hospital-based Oncology Units. These centres were also to provide oncology-specific diagnostic tests and advanced treatment techniques, including various types of radiotherapy. For the purposes of this thesis, the study site for the research presented here is classed as a designated cancer centre, as it incorporates all of the key features specified by Calman-Hine and provides coverage of the most comprehensive range of information systems, dealing with both common and rare cancer types with the full range of treatment modalities.

Based on the model proposed by the Calman-Hine Report, England was divided into 34 cancer networks. Founded on the concept of coordination and development rather than hierarchical "command" management, clinical networks were defined as "linked groups of health professionals and organisations from primary, secondary, and tertiary care working in a co-ordinated manner, unconstrained by existing professional and [organisational] boundaries to ensure equitable provision of high quality effective services" (Scottish Executive, 2002, p. 1). The Scottish Executive report compared these with fluid networks, stating that they were a move away from traditional "hub and spoke" operational structures and that the requirements of the network would take priority over the priorities for individual hospitals.

As delivery of the NHS Cancer Plan has progressed, the number of cancer networks has decreased from 34 to 28, and there are now approximately 1,500 multi-disciplinary teams operating within them. Although the Calman-Hine report (1995) made high-level recommendations for the organisation of cancer services, McCarthy (2007) highlighted the

important point that cancer networks were established without a very detailed specification of their structure or operating model; they were therefore developed slightly differently on a regional basis, according to local needs (McCarthy, 2007). In addition, investigation by Bate and Robert (2002) found that many regional cancer networks are actually relatively hierarchical in their network arrangements (Bate & Robert, 2002).

Following the Calman-Hine report (Calman & Hine, 1995), the NHS Cancer Plan (DoH, 2000) was developed in response to the recommendations, with the aim of providing a detailed approach to meeting the challenges posed by the trends in UK incidence and survivorship. According to the plan's Executive Summary (p. 5), for the first time the government's intention was to provide a complete strategy combining all aspects of cancer care, across the entire spectrum of prevention through to end-of-life care, with all of the associated financial investments required for resources, drugs, infrastructure, and IT solutions (DoH, 2000).

Donaldson (2005, p. 180) referred to the initial stages of implementing the NHS Cancer Plan as a "remarkable example of what can be accomplished through the use of logistical engineering." However, a key question remained how the use of information in cancer services can be optimised to support advances in cancer research and delivery of treatment services, and how information systems could be improved to provide more effective and efficient delivery of cancer service operations. The concept of cancer networks presents unique challenges for informatics, requiring information systems to support complex clinical pathways that cross multiple organisational boundaries. In cancer networks, the requirement for remote access, sharing patient records, and accessing diagnostic test results across multiple organisations has a corresponding complexity that arguably exceeds that of individual hospital systems. In the following section, the case study site for the research presented in this thesis is introduced as an exemplar of the complexity of cancer network arrangements. The study site is a comprehensive cancer treatment centre situated within the Merseyside and Cheshire Cancer Network in the North West of England, UK. The site comprises a wide range of different clinical pathways, multiple clinic locations, and partnership working arrangements with other organisations; all of these characteristics of the site create distinctive challenges for clinicians using oncology EPRs.

1.4 Setting for the study

As explained in sections 1.2 and 1.3, understanding how cancer treatment and care services are organised provides important context and background information for this research. In order to investigate the challenges associated with the complex information system requirements arising from service delivery arrangements, an NHS comprehensive cancer treatment centre was selected as the case study site.

The primary site for this study is the Clatterbridge Cancer Centre (CCC) NHS Foundation Trust (referred to as “the Trust”), one of England’s dedicated non-surgical cancer treatment centres serving a population of approximately 2.3 million people in the Cheshire and Merseyside region of North West England, UK, as shown in Figure 1.4.1. Operating from a healthcare campus in Bebington on the Wirral, the centre provides services via a consortium of regional hospitals and has fostered effective working relationships with other healthcare providers with the aim of providing high-quality cancer treatment services for the resident population. In addition to Cheshire and Merseyside, the centre also provides oncology care for residents of the Isle of Man and some areas of North Wales.

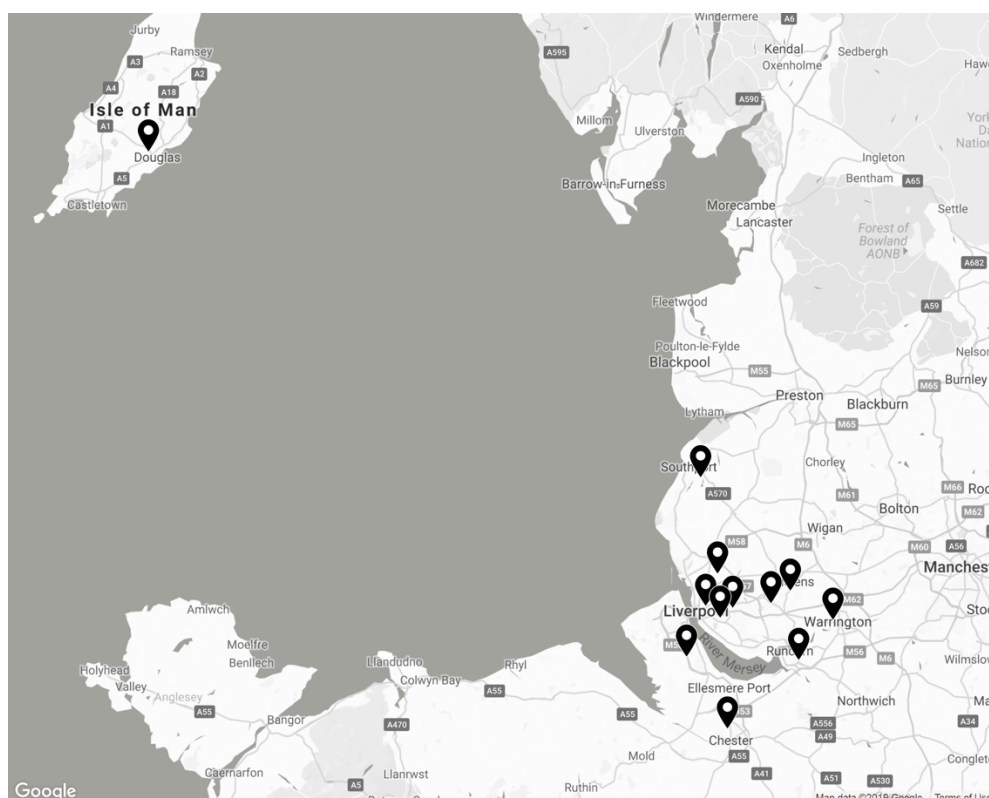


Figure 1.4.1. Map of CCC service delivery locations

CCC is one of three comprehensive cancer centres in the NHS in England, the other two being The Christie NHS Foundation Trust, serving the population of Greater Manchester and surrounding area, and The Royal Marsden NHS Foundation Trust, serving the population of Greater London. In other areas of England, cancer treatment services are usually provided in smaller oncology Departments within acute Teaching or District General Hospitals. In Scotland and Wales, similar arrangements are in place, but with each country having only one dedicated cancer treatment centre: The Beatson NHS Trust in Glasgow and The Velindre NHS Trust in Cardiff. Further details about study site for this research, The Clatterbridge Cancer Centre NHS Foundation Trust, are provided in Chapter Three, Research Design and Methodology (Section 3.8).

1.5 Information Requirements

In the previous sections various background information was provided, explaining the epidemiology of cancer, the service delivery arrangements and the identification of the case study site. This section now provides further context by introducing the different categories of cancer-related information. Before the main category of interest in this study is explained, related to individual cancer patient records, three other categories are briefly summarised as further important positioning of the study. These categories are mentioned because although general, service, and population information about cancer is not a focal point for EPRs, the information requirements in these categories can have direct implications for individual medical records held in EPR systems.

One of the key themes identified by Calman-Hine (1995) was the importance of having comprehensive, accurate, and reliable information available in a timely manner. Recognising the diverse range and types of different information available, in response to the Calman-Hine report and the White Paper *The New NHS, Modern, Dependable* (1997), the Cancer Information Strategy (NHS Executive, 2000) identified four main categories of cancer information. Examples of the type of information included within each category are provided in Table 1.5-1 below. The following subsections will then elaborate on each category to provide further context for the research in this study.

Generic	Services	Groups/Populations	Individual Patients
<ul style="list-style-type: none"> • Prevention of cancer • Risk factors for the development of cancer • Screening/detection of cancer before symptoms develop • Symptoms of cancer • Diagnostic techniques • Treatments available • Palliative care • Research, development and clinical trials 	<ul style="list-style-type: none"> • The characteristics of a high-quality cancer service (e.g. based on guidance documents) • The availability of cancer services e.g. specialist teams, special facilities such as radiotherapy • The outcomes achieved by specific cancer teams/services 	<ul style="list-style-type: none"> • Incidence rates • Mortality rates • Survival rates • Access to care • Stage of disease at presentation • Treatment and care delivered 	<ul style="list-style-type: none"> • The patient (e.g. age, gender, ethnicity, address) • Previous medical problems • Referral • Diagnosis and extent (stage) of disease • Results of individual investigations • Treatment and care received • Follow up • Recurrence, progression of disease and death • What the patient knows about his/her condition

Table 1.5.1-1 Categories of cancer information

(Reproduced from various pages of NHS Executive, 2000)

1.5.1 Generic information

While this category is not an area of specific focus for the study or the CICERO model, a basic overview provides relevant contextual information for the research presented in this thesis. General information related to cancer encompasses a wide range of information that is based upon established knowledge and facts that have emerged over the course of many years of ongoing clinical research and practice developments in oncology. According to the Cancer Information Strategy, the format and content of this type of information is likely to be comparable, regardless of geographical area. A wide range of people will require information on similar cancer-related subject areas in a variety of formats and levels of detail (NHS Executive, 2000).

There is a plethora of generic information available about cancer, which may be provided in oral, written, internet, and media formats. The Cancer Information Strategy recognised the limitations of this category of information, explaining that generic information is required by many users with a range of requirements and can be challenging to access for some people. Individuals with limited English proficiency, or people with particular communication needs (e.g., impaired vision), could be especially disadvantaged.

The Cancer Information Strategy (NHS Executive, 2000) stated that, even though cancer is a well-covered topic in mainstream media, there is evidence to indicate that public knowledge of information related to many different cancer-related issues (e.g. the most common types of cancer and how to check for signs) is very limited. Previous research (e.g. Rees & Bath, 2001; Barnes, Khojasteh, & Wheeler, 2017) found limitations in the delivery of relevant information for people dealing with cancer, in addition to the extent to which cancer patients view this information as essential. The previous studies revealed shortcomings in the approach to provision of information, in addition to the volume and type provided. Information must be appropriate to a patient's specific situation; moreover, providing surplus information that is not directly relevant can cause misunderstandings and unnecessary distress for patients (NHS Executive, 2000). The strategy also recognised challenges of information literacy among members of the public as a key component of this problem of public awareness. People who lack experience and education reading medical texts (i.e. most members of the public) may struggle to evaluate whether the generic information they find online, or elsewhere, is credible, or even to understand the meaning of what they read (Brewster & Sen, 2011).

Over recent years, new approaches to the provision of generic cancer information have developed. In addition to the consolidation and improvement of cancer information resources on the internet, social marketing and "information prescriptions" (Brewster & Sen, 2011) have been further developed to provide improved access to generic information about cancer.

According to the UK Department of Health's more recent consultation on NHS information requirements, patients require, and should be provided with, much more health-related information than is currently publicly available and easily accessible, to empower them to participate in plans for their care and to be aware of which services are on offer for their use. The Department of Health plans to create an NHS "information revolution" to ensure that citizens are provided with the knowledge and information to take more accountability for their own lifestyle choices and healthcare. The aim of this initiative is to provide UK citizens with improved access to detailed, reliable, and straightforward information about illnesses, therapies, lifestyle decisions, and how to take care of their own and their friends and relatives' health. The "information revolution" is also concerned with new and innovative approaches to providing healthcare, such as online consultations and patient portals for access to medical records. The government planned to provide a range of online services, which will increase efficiency by enabling patients and carers to engage with healthcare service provision at any time, from any location (DoH, 2010). From 2010 to 2014, progress was made in advancing these plans at NHS hospitals in England. However, the evidence base for increased efficiency remains very limited in 2019, highlighting the need for more robust research to be undertaken in this area.

The current NHS Information Strategy, "Personalised Health and Care 2020: Using data and technology to transform outcomes for patients and citizens, A Framework for Action," was published in 2014 (Department of Health, 2014). This updated national plan maintains the focus on empowering patients through provision of information, stating that:

Better use of data and technology has the power to improve health, transforming the quality and reducing the cost of health and care services. It can give patients and citizens more control over their health and wellbeing, empower carers, reduce the administrative burden for care professionals, and support the development of new medicines and treatments". (DoH, 2014, p. 2)

1.5.2 Service information

In contrast to generic information, information about services is usually specific to a particular place and time. Different users are likely to require much of this information in similar ways (NHS Executive, 2000). Examples of service information include pamphlets, flyers, and communication materials developed by different NHS Trusts and other organisations, such as hospices. Types of information within this category may include the features of a high-performing cancer service (e.g., based on NICE standards); the provision of specific cancer services in different geographical areas (e.g., rare disease teams and treatment facilities like radiation therapy centres); and their associated clinical outcomes.

Since the publication of the Cancer Information Strategy (2000), a wide range of service-specific guidance has been issued by the National Institute for Health and Care Excellence (NICE), and a clear focus on measuring and reporting clinical outcomes has developed. In 2009, an evaluation of all existing cancer data sets resulted in the design and development of a new integrated data set intended to support the delivery of increased service performance and clinical outcomes for cancer patients, necessitated by the Cancer Reform Strategy. This new statutory reporting requirement was named the Cancer Outcomes and Service Dataset (COSD), and it included all important data items for cancer information in a single place: waiting times, registry data, and clinical audit (NCIN, 2011).

Following its launch by the Information Standards Board, the COSD, which contains over 700 data items, became the new statutory reporting requirement for all cancer services in the NHS in England, starting in October 2012. It replaced the previous National Cancer Dataset and includes the cancer registry datasets, along with supplementary disease-specific data fields appropriate to specific tumour groups. A new systemic anti-cancer therapy (SACT) dataset was also subsequently published and implemented in 2012/13.

These datasets are relevant to this research and the development of the CICERO model because any integration and expansion of national datasets necessitates a change in recording practices at cancer treatment centres, with regards to the data elements that are collected and entered into EPRs and other clinical information systems for individual cancer patients. The ever-increasing requirement for in-depth intelligence about cancer disease profiling directly impacts the design and development of information systems at the cancer treatment centre level. If data collection processes and EPR systems are not configured and optimised to allow data recording in the most efficient manner, they can lead to significant disruption, frustration, wasted resources, and poor data quality.

1.5.3 Information about groups and populations of cancer patients

Although this category of information is not the main focus of this research, it is important to understand the requirements for reporting at aggregated population level, as this has direct implications for data collection at an individual patient level and for the general question of how EPR systems need to be configured and used.

Information about groups and populations of cancer patients is primarily generated by combining data about individual patients, including their diagnosis, treatment, and clinical outcomes. This category includes information on cancer staging (i.e., how advanced the cancer is at the point of diagnosis), incidence, mortality, and survival rates. It also includes information about the

availability and delivery of different oncology treatment modalities. All NHS hospitals are expected to record a minimum dataset of activity information, using computerised patient record systems, for all inpatients with a cancer diagnosis (e.g., clinical procedures and inpatient stays). This information is assembled at national level as hospital episode statistics (HES) data and is published by the Department of Health's Information Centre.

Information recorded about individual cancer patients should not be viewed as important only at the individual patient or organisational level; when aggregated to the population level, this information yields insights into collective patterns of incidence, mortality, and survivorship. EPR systems in cancer services must therefore be designed to support this aggregation; as such, the CICERO model seeks to address this aspect, amongst others, by offering a comprehensive scope of information and functional requirements.

1.5.4 Information about individual cancer patients

This category of information is the main focus of the research presented in this thesis. Specifically, this thesis examines the various systems that clinicians use to enter and access individual patients' information; manage their diagnosis, treatment, and care; and maintain their medical records. Information related to individual cancer patients is detailed and precise and is required and used by numerous different clinical workers, in accordance with information governance and confidentiality rules, during the patient's course of treatment and rehabilitation. Patients and their family members may also require access to their records; in the NHS, this is facilitated by a subject access request (SAR), usually in the form of a photocopy of the contents of the medical records file, with third-party information redacted. The primary sources of information in this category are medical records (primary care, acute hospitals, hospices, etc.); electronic systems (e.g. for information on diagnostic tests, inpatient stays and theatre); and clinical correspondence transferred between healthcare providers (e.g. between GPs and hospitals).

A number of information management problems can occur in relation to individual patient records. Firstly, information can be hard to extricate from medical records, as they often contain illegible handwriting and/or have details missing. Secondly, many patients transfer regularly between primary, secondary, and tertiary care providers (e.g. from an acute hospital to a dedicated cancer centre and then back to primary care), and frequently this will involve several different medical records files being created in isolation. Thirdly, medical records are often not readily available at the time when they are required. In addition to this, there is evidence of inadequate information sharing between healthcare providers, and information about discussions that have taken place with patients is not always recorded (NHS Executive, 2000).

From the very wide range of information and material involved during patient care, a clinician requires a small representative sample of items useful for decision-making, which should be presented to the clinician in a rapidly accessible manner. The required information needs to be delivered at the point of care. This requirement of information representation is made even more important, and difficult, by the increase in information content during care delivery and the current constraints associated with human-computer interaction. Illness is best treated when the facts and relationships developed through several techniques are brought together to provide a synthesis which yields insights that the clinician cannot acquire by focusing on a single perspective alone (Reiser, 1978). Although this observation by Reiser was made four decades ago, it is still relevant today. Developments in information and communication technology, especially the evolving shift towards digital information management, support this synthesized approach by enabling the rapid transfer of multi-media information between various clinical care locations (Shrestha, 1998).

In summary, evolving information systems offer some improvements while also introducing new difficulties. Efficient information transfer facilitates the synthesis of multiple perspectives and data sources across treatment centres, which is beneficial but, at the same time, this process can lead to an information overload that makes communication difficult. This is another reason why research is required to better understand the current challenges that affect clinicians' use and acceptance of this technology: the overall goal of research in this area is to determine how systems can be developed and deployed to maximise the positive affordances of technology while minimising its drawbacks.

Information generation activities and requirements across the health care spectrum generate a huge amount of clinical data, corresponding to vital patient information accumulated at various healthcare settings. However, these data are often institutionalised and have not been fully exploited (Black, 1989) or integrated within the patient clinical records.

The challenges of effectively managing all of the clinical information related to individual cancer patients are further exacerbated by the apparent difficulties in the design, development, and implementation of electronic patient record systems that can provide all of the required functionality for oncology records, with efficient and effective workflow process and positive user experience. The focus of this study is on these specific issues, with the aim of gaining an improved understanding of the factors that affect adoption and use of IT solutions in cancer services.

1.6 Rationale for this Study

Having discussed the requirements for cancer service information in Section 1.5, this section now elaborates on why this study is necessary to help address current deficits in EPR system maturity. The NHS Cancer Information Strategy (NHS Executive, 2000) concluded that there was an urgent need to improve the recording of information related to individual patients with cancer, and communication of this information between providers of cancer care, in order to improve the quality of care. The wider collection and use of computerised information on individual cancer patients is seen as a very high priority in this regard. Improved development, implementation, and use of electronic patient record systems would greatly enhance access to information in different parts of a hospital and would provide opportunities for transmission of essential information to health professionals who are involved in the patient's care, but who work in other hospitals or in the community.

The development and implementation of information systems using information technology is the obvious approach to addressing this requirement, and it is generally accepted that well-designed information systems, if implemented successfully, can deliver significant benefits. The individual patient information category of cancer service information described in this chapter, and the issues associated with the use of information technology in supporting effective information systems, are therefore the focus for this thesis, with a particular emphasis on how electronic patient records are used to support the clinical work of oncologists.

The implementation of IT systems in healthcare is a complex activity, and it is well-known that IT projects have a high failure rate. Several independent research firms have studied IT project failure in a broad range of industry sectors. By the early 1990s, numerous management consulting and research organisations, including The Standish Group International Inc., Boston; KPMG, Toronto; Gartner Inc., Stamford, Connecticut; and the Aberdeen Group, Boston, had already pronounced IT project failure a serious problem (Tichy & Bascom, 2008). This is an important aspect of the context for this study because, despite an accumulation of best practices research identifying success factors, IT implementation projects are still frequently unsuccessful. Kaplan and Harris-Salamone's (2009) review of the literature about health IT success and failure cites statistics which indicate that, across industry sectors, at least 40% of "generic" IT projects either are abandoned or fail to meet business requirements, while fewer than 40% of large systems purchased from vendors meet their goals. Some sources report failure rates as high as 70% (Kaplan & Harris-Salamone, 2009).

Several research reports have been published concerning IT failures specifically within healthcare, including some systematic and thoughtful publications describing lessons learned

from IT interventions that had null, negative, or disappointing outcomes (Kaplan & Harris-Salamone, 2009). Kaplan and Harris-Salamone (2009) cited the case of the London ambulance service's computer-aided despatch project as a case in point. According to Kaplan and Harris-Salamone (2009), despite calls for increased research, there were still not enough published research reports of health care IT failures, removals, sabotage of systems, or how failures became successes or were otherwise redefined. As in other sectors, IT-related failures in health care often are covered up, ignored, or rationalized; consequently, mistakes are repeated (Kaplan & Harris-Salamone, 2009).

An inadequate understanding of how people and organisations adopt IT has been one of the major factors leading to the failure of healthcare information systems (Kijisanayotin, Pannarunothai, & Speedie, 2009). As recommended by Berg (1999), due to the complex nature of human-computer interaction and the need for a holistic view of workflow processes, a socio-technical approach should be applied to the design and development of clinical IT solutions. The uptake and adoption of IT systems has been studied extensively, with an emphasis on understanding this phenomenon via the development of technology acceptance models.

This research study is motivated by a combination of the factors described above: the need for more modern, integrated information systems to support improvements in cancer services; the complexity and high failure rate of healthcare IT developments; and the need to focus on socio-technical aspects to maximise the acceptance and adoption of EPR systems.

1.7 Study Aims and Objectives

The overall aim of this project is to develop an improved understanding of the factors affecting the implementation and use of information systems within cancer care, from a clinical end-user's perspective. It is anticipated that this research will provide the foundations for future evidence-based developments in cancer treatment services and health informatics, with a view to improving healthcare services for both clinicians and patients. The specific objectives of this study are to:

- Establish the most important factors that affect the adoption and use of EPR systems by oncologists working in comprehensive cancer centres.
- Establish the different ways that oncologists think about and experience the use of EPR systems and identify their perceptions of the barriers to successful implementation.

- Develop and refine a model for a customised, integrated, comprehensive electronic record system for oncology (“CICERO”) and to provide associated implementation guidance for use of this system in cancer services.
- Make recommendations for how oncology EPR systems are designed and developed, based on the requirements of oncologists.

The research project will be used to inform future developments related to oncology EPRs, both in operational practice in NHS hospitals and in relation to further research studies.

1.8 Motivation for Undertaking the Research

There are two main reasons for undertaking this study. Firstly, the field of cancer services is an area of significant research activity; however, comprehensive, evidence-based guidance regarding the development and implementation of IT solutions is relatively scarce. The literature review in Chapter Two demonstrates that limited research has been undertaken to establish clinical user requirements or to examine the socio-technical factors that influence the development and implementation of EPR systems in cancer services.

Secondly, from 2008 until 2017 the researcher worked within a cancer centre where he was responsible for the design and implementation of clinical IT solutions. He was interested in exploring the factors that might influence the successful delivery of a complex work programme to develop and implement EPR systems in practice, in support of the organisation’s aim to become a world-class treatment centre.

1.9 Structure of the Thesis

This thesis is organised in seven chapters as follows:

Chapter One: Introduction. This chapter provides a comprehensive overview of the research study, including its background, the context of the research topic, the research aims and questions, and the content of this thesis.

Chapter Two: Literature review. This chapter firstly specifies the scope of the literature subject areas. It then critically evaluates the literature on electronic patient record systems, the development and use of information systems in cancer services, the challenges associated with EPR implementation, and methodologies for systems analysis and design. It emphasises the core theoretical ideas and current relevant research into EPRs, highlighting gaps in empirical

research and the importance of this study in attempting to fill these gaps. Chapter Two also introduces the CICERO conceptual model as a framework for presentation of the functional and socio-technical components of an “Onco-EPR.”

Chapter Three: Design and Methodology. This chapter is devoted to the overall design of the research study and consideration of choosing the methodology. It explains the rationale for adopting a socio-technical systems approach and why an interpretive, mixed methods approach was selected for this study. It describes the data collection and phenomenographical analysis procedures in detail, and it also explains how the researcher established credibility and trustworthiness for this research study.

Chapter Four: Exploratory Research (Quantitative Research). This chapter provides further information about the primary study site’s Information Management and Technology (IM&T) Strategy and the oncology IT systems market. It reports the findings from an initial study at the primary research site, which used a patient records survey to obtain the views of staff working in the oncology centre, regarding paper-based medical records, existing EPR systems, and perspectives on the potential impact of fully electronic patient records.

Chapter Five: Qualitative Study. This chapter presents the main empirical research conducted, a series of qualitative interviews with oncologists working at the case study site. In this chapter, the details of the study are presented, with results of phenomenographical analyses and the categories of description that emerged to form the “outcome space” related to oncologists’ experiences when using EPR systems.

Chapter Six: Discussion. The sixth chapter combines and triangulates the results of the exploratory study and the subsequent in-depth qualitative study with analyses of the theoretical framework used to inform the design. The final version of the CICERO reference model, introduced in Chapter Two, is also presented in this chapter.

Chapter Seven: Conclusion. In the final chapter, a summary of the results is presented, along with an explanation of the novel contributions this study has made to the existing body of research on socio-technical systems and technology acceptance in healthcare. The conclusion chapter also explains how the study results can be used by practitioners working on EPR system projects and offers suggestions for future research studies.

1.10 Conclusion

This chapter provided the background and context for the research presented in this thesis, explaining the requirement for the study and the details of the case study site. The rationale for the study was provided with the aims and objectives and an explanation of how, and why, the researcher was motivated to undertake the investigation in this subject area. In the previous sub-section, the structure of the thesis was also outlined. The next chapter provides further background and context for this research by offering a review and analyses of the existing literature about EPR systems in oncology and relevant theoretical frameworks, highlighting deficiencies and limitations where appropriate.

Chapter Two: Literature Review

2.1 Introduction

The previous chapter introduced the general subject area and context for this research, including an overview of the case study site. To further contextualize the thesis, this chapter presents a literature review that was initially developed during the early stages of this PhD project and subsequently updated throughout the study. The chapter explores a wide range of literature about the development of EPRs and other patient-focused information systems used in cancer treatment services, as well as the theoretical and conceptual frameworks of technology acceptance that informed this study. Firstly, Section 2.2 explains the search strategy, concepts, keywords and information sources that were used to produce a comprehensive understanding of the development and use of EPR systems in oncology. The sections that follow then explain what EPRs are and how they are used in healthcare (Section 2.3); describe how the use of information and communication technology (ICT) systems has developed in cancer services over time, highlighting key developments and research studies (Section 2.5); and present examples of the use of ICT systems to support specific aspects of oncology. Section 2.7 explains the functions and capabilities of information systems for supporting the main oncology treatment modalities and associated support services. This section also addresses requirements for integration and cross-organisational systems, and it includes a review of the literature relating to “big data,” predictive analytics, clinical research, and personalised medicine. Section 2.8 then explains the challenges associated with EPR system implementation.

In sections 2.9 and 2.10, the concept of socio-technical systems is explained, and various approaches and methodologies for evaluation are explored and analysed in relation to system usability, adoption, and acceptance. This leads on to an explanation of the theoretical framework adopted for the study in Section 2.11. At the end of this chapter, a synthesis of the literature is presented, as well as a description of how a conceptual reference model, CICERO, was developed to assist with defining the scope for the overall programme of research in relation to the range of information systems used in cancer treatment services. Finally, the limitations of the existing research are highlighted in Section 2.14, before the conclusion of the chapter (2.15).

This literature review addresses three main areas of research. Firstly, the literature that was reviewed to provide background and context to topics relevant to the study are presented; these include developments from a service management and policy perspective, explaining the history of EPR developments in the UK NHS. This is important context for the study, as previous attempts to increase adoption and use of systems have often faced complex challenges, and a solid understanding of the lessons learned is required in order to identify the areas where future

EPR-related research efforts should be focussed. Secondly, the review then focusses on the specifics of oncology EPR system functionality and requirements, with reference to the empirical research that has been conducted previously to evaluate the impact of IT implementations in this specific area. This area is also important because it establishes the specific aspects of EPR systems that have previously been investigated, identifying key findings, potential gaps, and limitations, to ensure that the research presented in this thesis makes a useful and novel contribution to the existing body of knowledge. Thirdly, leading approaches to analysing EPR system adoption and acceptance are reviewed, with reference to theoretical models in the field of socio-technical systems and their application in previous empirical studies. This area is equally of relevance, as the outcomes of previous studies may have been affected by the various methods used to examine different aspects of system design, development, implementation, adoption and acceptance. For this study, it was therefore important to conduct a literature review with this broad scope, to ensure coverage of previous work in the related subject areas.

2.2 Literature search methods

Concepts and keywords were established using the topic of the thesis, and a range of searches were conducted using the Internet and a number of subject databases, including CINAHL, MEDLINE, EMBASE, HMIC, ZETOC, ASSIA, the Web of Knowledge, and the Cochrane Library. Figure 2.2.1 below is a spider diagram representing the range of topics developed to assist in the specification of search terms. Spider diagrams are a helpful technique for producing an overview of the subject area (Burton and Howse, 2017). They help extract complicated topics into a simple visual format by branching subjects, themes, and sub-topics. Searches for relevant European literature were also conducted using the EFMI Evaluation website, a useful resource of existing ICT studies in healthcare that includes details of healthcare ICT evaluations from a range of countries (Ammenwerth, Gräber, Herrmann, Bürkle, & König, 2003). Where appropriate, thesaurus searches and Boolean logic were used to ensure all relevant papers were identified. Using the most relevant results, citation searching identified further literature for the review.

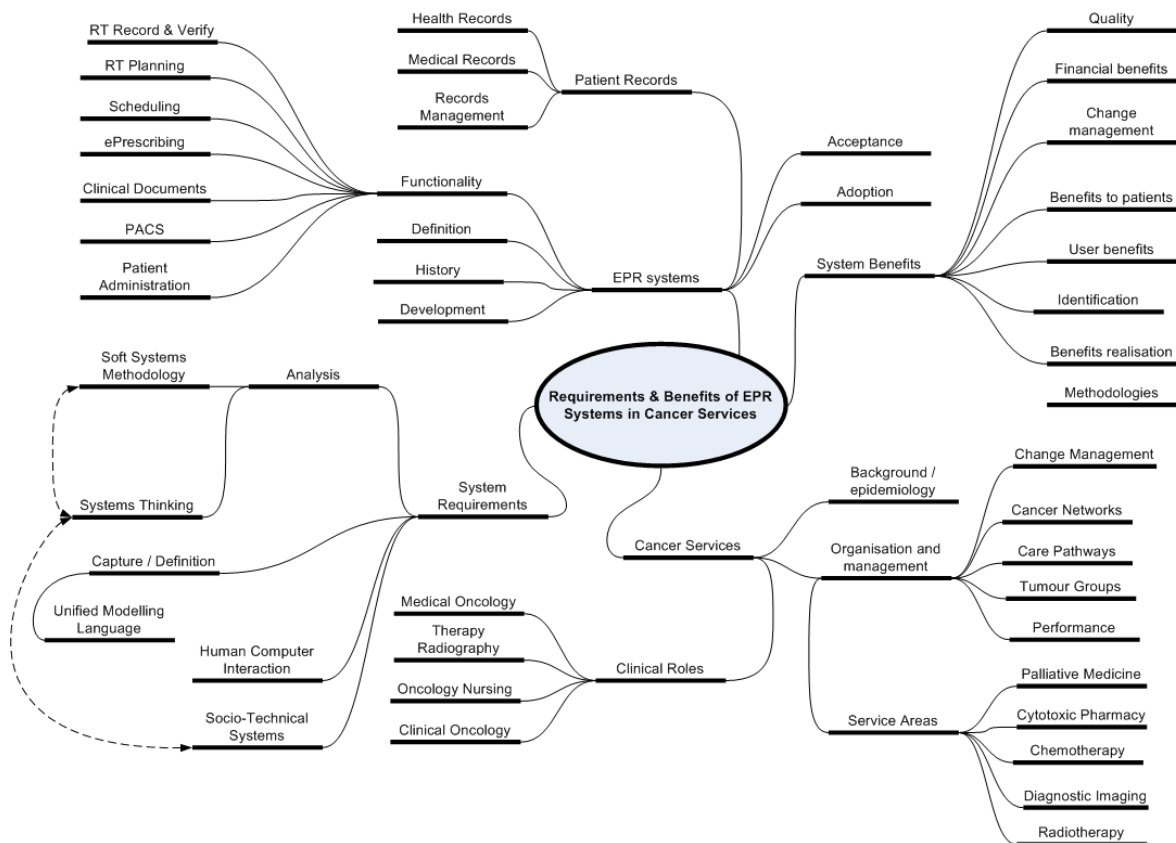


Figure 2.2.1 Search strategy spider diagram

To limit results to contemporary research related to EPR systems and cancer service developments, searches were restricted to publication dates ranging from 1960 to the present. Results were examined to identify those that were relevant for inclusion in the review. Searches were not limited to UK publications but, for practical reasons, only documents written in English were reviewed. Several books on healthcare informatics and the development and delivery of cancer services were also reviewed; however, journal articles provided the most relevant current information and covered many aspects of the subject. Additional sources were also reviewed based on recommendations made by the external examiners of this thesis.

2.3 Electronic Patient Record (EPR) systems

As noted in Section 2.1, the first part of the literature review is concerned with providing further background and contextual information of relevance to the study presented in this thesis. As the focus of the research is on the adoption and use of EPR systems in cancer services, it is important to provide a clear definition of what EPR systems are. This section therefore provides this information with reference to literature published by relevant industry bodies.

The Healthcare Information Management Systems Society's (HIMSS) definition of an Electronic Health Record (EHR) is a "longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting" (Handler et al., 2003, p. 2). The HIMSS

definition goes on to list the information included, such as “patient demographic details, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports” (Handler et al., 2003). HIMSS also describes the benefits of EHR systems, including the automation and streamlining of clinical work processes; the functionality to produce a comprehensive record of all episodes of care; and support for other activities such as clinical decision support, quality assurance, and reporting outcomes.

According to the Institute of Medicine (IoM):

An EHR system includes (1) a longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or healthcare provided to an individual; (2) immediate electronic access to person- and population-level information by authorised, and only authorised, users; (3) provision of knowledge and decision support that enhance the quality, safety, and efficacy of patient care; and (4) support of efficient processes for healthcare delivery. (Institute of Medicine, 2003, p. 1)

In addition, the IoM refers to eight key areas of functionality provided by an EHR solution, including “health information and data, results management, order entry/management, decision support, electronic communication and connectivity, patient support, administrative processes, and reporting and population health management” (IoM, 2003, p. 1). In this regard, the acronym EHR includes electronic medical records (EMRs), which refer to electronic record systems used at specific hospitals, and computerised patient records (CPRs), which relate to systems primarily concerned with the provision of healthcare to individual patients. Although the terms EPR, EHR, EMR, and CPR are often used interchangeably (Lobach & Detmer, 2007), the specific longitudinal aspects of EHRs, as distinct from EPRs and EMRs, have been noted. One of the first papers to clarify this distinction was the NHS *Information for Health* strategy document (Burns, 1998).

Extensive research has been conducted on the design and deployment of EPR systems in healthcare organisations. A thorough examination of the research literature since 2008 examined how EPRs are defined; how their functionality is applied and used in practice; which clinical staff have access to systems; the data items that are used and studied; what the aims of research are in this area; what data capture methodologies have been utilised in EPR studies; and what the outcomes were (Häyrinen, Saranto, & Nykanen, 2008). In developing a definition for different types of EHRs, Häyrinen et al. (2008) made a useful distinction between EPRs, EMRs, and other acronyms for electronic records used in healthcare, terms which are often used synonymously by those working outside the health informatics profession.

An EMR is mainly concerned with medical treatment and normally includes data relating to admissions to specific hospital departments, such as: surgical records, high dependency unit records, medical assessment records, accident and emergency department systems, pathology lab systems, pharmacy systems, and radiology reporting. Häyrinen et al. (2008) cited two examples of “inter-departmental EMRs,” which contain data from more than one hospital department: obstetric records and ePrescribing systems. A hospital EMR includes the majority of an individual patient’s clinical data from a specific hospital, and an “inter-hospital EMR” includes a patient’s clinical information from more than one hospital. According to Häyrinen et al. (2008), an EPR contains most of a patient’s clinical data from a specific hospital, usually for specific episodes of patient care. On this basis, as this research is concerned with the development and use of patient record systems in comprehensive cancer centres that (although focused on oncology as a specific clinical specialty) operate as hospitals in their own right, the term EPR has been adopted for use throughout the thesis.

2.3.1 Trends in the use of EPR systems

In addition to the extensive academic research literature on EPR systems, several consultancy firms and commercial research organisations have also produced papers analysing market trends in the global adoption of EPR systems. In 2010, Accenture, a management consultancy firm, produced a comprehensive report (Neumann, 2010) which explained that the “connected health ICT market” was very fragmented but evolving rapidly on a global scale. Table 2.3-1 summarizes the key trends in global EPR adoption by healthcare provider organisations.

Trend		Example/description
1.	Most trends impacting international EPR markets are driven by local healthcare systems and country-specific cultural standards/laws	<ul style="list-style-type: none"> • Cultural standards in each country • Each target country has a unique healthcare system with its own set of rules (e.g., payment structure, policies) • Many markets are primarily served by small local EPR vendors and service providers
2.	Nearly all target international EPR markets are planning for the labour shortage	<ul style="list-style-type: none"> • International EPR markets are identifying the need for additional resources with both ICT and clinical skills to support future use of EPR systems • International markets will have to improve the use of technology or consider alternative delivery models to cope with the shortage
3.	Emerging and technologically advanced markets are seeking cloud-based solutions to manage costs and improve use of EPR	<ul style="list-style-type: none"> • Hospitals in countries with small budgets to invest in EPRs may lean towards cloud-based solutions to keep costs manageable • Emerging markets, such as China and India, have the opportunity to reach maturity quickly with cloud-based solutions
4.	Some countries (e.g. Spain and Australia) are driving regional and national EMR programmes, attempting to integrate EMR systems across larger geographic areas	<ul style="list-style-type: none"> • Regional models create a small number of buyers (regions or states) that select EMR solutions for a large number of hospitals and ambulatory sites • Implementation and integration of EMRs across a region or nation create large-scale opportunities for long-term projects

Table 2.3-1 Key trends in global EPR adoption
(adapted from Neumann, 2010)

In the United States, the introduction of the American Recovery and Reinvestment Act of 2009 (ARRA) had a significant impact on the level of EPR development and implementation. The Act, which included sections referred to as Health Information Technology for Economic and Clinical Health (HITECH), provided financial incentives as a stimulus for healthcare practices to implement EPR systems that comply with “meaningful use” (MU) criteria. These criteria will be explained in further detail in the following section.

2.4 Oncology EPR systems

While the USA’s National Cancer Institute has developed a functional profile for an ambulatory oncology EPR, and software vendor solutions are subject to accreditation by the Certification Commission for Health Information Technology (CCHIT) as part of the regime, MU in the USA includes a broad range of both functionality and data-related measures. In addition to the core clinical quality measures that indicate MU, the author of this study has previously highlighted that a set of measures specific to oncology services were developed; these were concerned with weight screening, blood pressure measurement, and smoking (Poulter, Gannon, & Bath, 2012).

In the UK, a similar focus on reporting key clinical outcomes has been evolving over recent years, and, in 2012/13, a new national Cancer Outcomes and Services Dataset (COSD) was planned for implementation, to include the most significant data components of cancer information in a single standard, consolidating cancer waiting times, cancer registration, and cancer audit reporting.

The concept of MU is essentially that, if the adoption of healthcare ICT can make a measurable difference to health costs and outcomes, the success of ICT should become a self-fulfilling prophecy, in that it will gain clinical support and priority as an area for investment based on its facilitation of meaningful benefits for patients. The American Recovery and Reinvestment Act of 2009 (ARRA), which required the development of MU in healthcare is, therefore, intended as a means to stimulate the development and adoption of EPRs (Poulter et al., 2012).

As noted in Section 2.1, the initial sections of the literature review are concerned with literature focused on EPR services, service development, strategy, and policy, before moving into the findings of empirical research studies later in this chapter.

2.5 Development of EPR systems in the United Kingdom

Having provided the definition of EPR systems and the key issues surrounding their development and implementation in oncology, the relevant clinical speciality for this study, this

section now explains further context in relation to EPR systems in the UK National Health Service, of which the case study site is a part. It is relevant to explain developments in the UK here because in addition to the fact that it the UK is the home country for this research study, the UK National Health Service is a globally unique healthcare system. Due to the way that the NHS is organised nationally, whilst there are similar clinical functional requirements to those of healthcare systems in other countries, there are also some distinct differences. For example, the majority of EPR systems outside of the UK have a billing module with sophisticated pricing and invoicing systems that interface with healthcare insurance companies (Hall, 2015). In contrast, the UK EPR systems need to produce commissioning datasets (CDS) to report contracted clinical activity levels to Clinical Commissioning Groups (CCGs). The NHS also has a range of national Information Standards Notices (ISNs) that specify mandatory reporting requirements. It is therefore relevant context to elaborate on how EPR systems have evolved in a UK context over the last two decades.

Following the publication of “Information for health: an information strategy for the modern NHS” (Burns, 1998; Wyatt & Keen, 1998) in 2002, the National Health Service (NHS) in England initiated a large-scale ICT-enabled transformation of healthcare. The main vehicle for this effort, the National Programme for Information Technology (NPfIT), was to create a comprehensive “cradle-to-grave” EHR called the NHS Care Records Service (NHS CRS). The intention was to deliver clinical ICT systems that could share patient information across all NHS hospitals and community healthcare organisations for all English citizens (Sheikh et al., 2011).

The CRS model comprises a number of components connected to a central “spine” of national services. These components include the patient demographics service, a national master patient index (MPI) used to issue and validate NHS numbers, and the summary care record system. For the purposes of this research, the detailed care record can be thought of as the EPR system installed at each NHS provider organisation (i.e. provider of healthcare services, usually a hospital, rather than a commissioning body). Figure 2.5.1 below shows a schematic model of the CRS developed by Sheikh et al. (2011).

Sheikh et al.’s (2011) study evaluated the deployment and use of the NHS CRS in acute hospitals in England across three areas of the country referred to as “clusters”: North-Midlands and East; South; and London. A mixed-methods, case study-based longitudinal evaluation was conducted at a dozen of the first sites to adopt the CRS systems in the three geographical areas of NPfIT. The organisations were opportunistically sampled in accordance with their current or planned phase of deployment and to ensure variation in relation to a range of factors, such as geographical area, clinical services delivered, organisation status and the type of ICT applications being implemented. The empirical work was completed in six workstreams in order to gain insights into how the trusts included in the study implemented (or failed to implement)

the CRS systems in their organisations to establish the local impact of deploying the new systems, the associated costs of this deployment, and whether the new applications made more clinical information available in outpatient clinics (Sheikh et al., 2011).

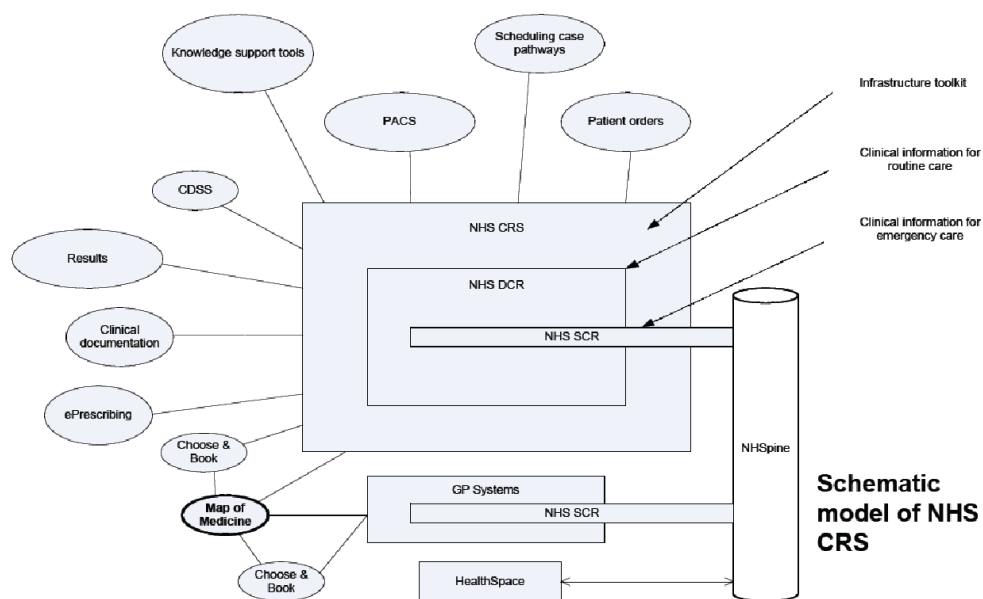


Figure 2.5.1 Sheikh’s schematic model of the NHS Care Records Service

(Reprinted with permission from a 2010 presentation to the NHS CfH Evaluation Programme)

In conclusion, Sheikh et al.’s evaluation established that deployment of the CRS applications had been resource-intensive and difficult, with minimal tangible benefits for clinical users or patients. However, the authors observed that new methods of information management were emerging at some organisations as the systems developed (Sheikh et al., 2011). The authors acknowledged that these outcomes do not necessarily mean long-term benefits will not emerge in the future and referred to those that have been realised in some healthcare organisations outside of the UK; they suggested, however, that these outcomes could take several years to achieve. Despite this, the study reported that among the key stakeholders interviewed, there was still significant belief in the vision of NPfIT and the future benefits that the CRS systems could offer. In a future where survival of healthcare organisations will be increasingly dependent on their functioning as commercial business units, even in public sector models such as in the UK, these organisations will almost certainly be required to automate and measure clinical and business processes using some components of the CRS solution set. The recent departure from a centralised delivery model to more local ownership and flexibility is an improved approach, although Sheikh et al. advised that this shift needs to be supported by NHS-wide standards and incentives to ensure ongoing progress towards integrated EPR systems (Sheikh et al., 2011). In 2019, whilst the legacy of NPfIT has at least provided national infrastructure and successful advancement in some areas of digital transformation (e.g. radiology), only the foundations for EPR have been provided in some parts of the country; to date, the majority of NHS hospitals

still have not received the expected CRS solutions to provide fully functional, integrated EPR systems (Wachter, 2016).

Ten years after the launch of NPfIT, some of Sheikh et al.'s findings were reflected in a different approach to informatics in the NHS, with the development of CRS systems focused more on local choice and control over the EPR systems used. These CRS systems emphasised standards for interoperability and information sharing. In 2012, the Department of Health's information strategy was published: "The power of information: putting all of us in control of the health and care information we need" (Department of Health, 2012). In relation to the development and use of EPR systems, this strategy document described the following key ambitions:

Information is recorded once, at our first contact with professional staff, and shared securely between those providing our care—supported by consistent use of information standards that enable data to flow (interoperability) between systems whilst keeping our confidential information safe and secure. . . . Our electronic care records progressively become the source for core information used to improve our care, improve services and to inform research, etc.—reducing bureaucratic data collections and enabling us to measure quality. (Department of Health, 2012, p. 5)

The strategy document cited cancer services as an exemplar in several case studies, including an explanation of the role of the "rich and widely respected" cancer registries and the National Cancer Intelligence Network in the section titled "Connected information for integrated care," and the use of patient decision aids (PDAs) and information prescriptions in the sections about "Better access to better information" (Department of Health, 2012).

However, although this strategy highlighted cancer services as a clinical specialty with relatively advanced information management processes and initiatives, the NPfIT actually delivered very little of the specialised EPR functionality that is required for oncology, and the 2012 strategy was vague on the details of how EPR systems should be developed and integrated going forward. In the next section (2.6), the specialist requirements for oncology are explained with reference to the literature, and a brief history of "onco-EPR" developments is provided.

More recently, during the period of the Conservative and Liberal Democrat coalition government (2010 to 2015), an updated strategy was produced, called "Personalised Health and Care 2020: Using Data and Technology to Transform Outcomes for Patients and Citizens" (DoH, 2014). This publication was referred to as a "framework for action" and stated four main aims: giving patients increased control over their own healthcare and lifestyle choices; empowering carers; reducing the administrative load for healthcare workers; and supporting the development of new drugs and therapies (DoH, 2014).

In October 2018, a consultation paper was published, setting out a further updated vision and strategy for how information technology should be used to modernise healthcare services in the NHS. The paper, “The future of healthcare: our vision for digital, data and technology in health and care” (Department of Health and Social Care, 2018), sets out priorities including establishing a modern technology architecture; mandating all technology suppliers (e.g. EPR vendors) to fully comply with interoperability standards or cease doing business with the NHS; using commercial off-the-shelf (COTS) systems (as opposed to systems developed in-house); and enabling NHS organisations to select products from any vendor that adheres to their standards.

The overall trend here is a shift towards a standardisation strategy focussed on rationalising the number of EPR suppliers in the NHS to one where more choice is available for healthcare provider organisations, but only from suppliers who adhere to the standards that will facilitate interoperability and shared care records. As the EPR systems used in oncology are heavily dependent on interaction and use in conjunction with other hospital systems, the focus of this most recent strategy aligns with the aims and recommendations of the research presented in this thesis.

2.6 Development and use of EPR systems in cancer services

Having provided an overview of the recent history of EPR system developments in the NHS in Section 2.5, with reference to relevant literature, this section now presents more detailed information about the design, development, and implementation of EPR systems, specifically in an oncology context.

2.6.1 Specialist requirements for oncology EPRs

Cancer treatment is one of the most complicated, multi-disciplinary, and information-intensive clinical specialties in healthcare; arguably, this could make it both particularly well-suited for the application of EPRs and computerised provider-order entry systems (Snyder et al., 2011) and a particularly challenging clinical specialty for EPR technology. Oncology has unique data needs compared with other specialties, and EPRs suitable for primary care and general acute hospitals often lack this functionality. Examples of specialist requirements include: tumour staging (tumour-node-metastasis [TNM] nomenclature and others); multi-disciplinary complex workflow processes (diagnostics and treatment planning); chemotherapy prescribing and administration; radiotherapy ordering and treatment planning; toxicity review and control; clinical trial and protocol administration; medicine formulary, stock control, and dispensing; and rehabilitation and support services (ASCO, 2009).

EPR systems for cancer treatment centres must accommodate the unique clinical processes that distinguish oncology from other clinical specialties. Particularly challenging is the ordering and administration of chemotherapy and other anti-cancer treatments (Shulman et al., 2008). A treatment plan and treatment flow sheets are critical components of an oncology record; as such, these elements must be included in whatever EPR system is used to support oncology care (Balogh et al., 2011). General EPRs are frequently adopted in oncology settings, which require that these systems be adapted to accommodate the information needed to provide care to this complex patient population. In these situations, an oncology-focused EPR or some form of an electronic chemotherapy ordering system that has the ability to interface with the general EPR must also be adopted (Hede, 2009).

2.6.2 History of onco-EPR and the use of ICTs in cancer services

The earliest example of an oncology-specific EPR system in the literature is the Oncology Clinical Information System (OCIS), developed in the 1970s by Bruce Blum, Technical Director at the Johns Hopkins University Oncology Center in Baltimore, Maryland, USA. In a series of papers published between 1977 and 1989, Blum and his colleagues described the development of the OCIS, starting with a report about the clinical information display system (CIDS), which was first developed as a prototype for the OCIS to support the management of patient therapy (Blum & Lenhard, 1979). The prototype system included functionality to support the management of patient therapy including a patient data system, a patient abstract (summary record), a tumour registry, an appointment system, a census system, and a CIDS.

At the beginning of the 21st century, the application of computers to processes in oncology care was considered by Chamorro (2001) from a nursing perspective. For oncology nurses, the “future” CPR should be able to provide, on demand, a comprehensive view of the patient's initial treatment course of chemotherapy along with the patient's response to treatment. For example, a graphic display of haematological response measured against the treatment schedule could be generated, providing information in a rapid manner. The patient's general tolerance for treatment could also be ascertained quickly from review of the nursing diagnoses. A nurse overseeing a clinical trial could aggregate data periodically on patients enrolled in the study to date and ascertain the degree of gastrointestinal toxicity associated with a new regimen (Chamorro, 2001).

Table 2.6-1 presents various examples of ICT-supported activities, categorised into process areas. Chamorro (2001) also identified the potential use of aggregated data from the CPR system, providing the most reliable source of information for outcomes research.

Process	Example of activity
Administrative	<ul style="list-style-type: none"> • Patient identification and registration • Co-ordinated or centralised scheduling
Financial	<ul style="list-style-type: none"> • Authorisation and certification by third-party payors • Medical billing and accounting • Claims history
Archival and retrieval	<ul style="list-style-type: none"> • Medical history and family pedigree • Social history, self-defined cultural associations • Environmental exposures, health risk-assessment reports • Comprehensive problem list, including nursing diagnoses • Documentation of patient's expectations regarding life support • Scanned copy of signed advance directive • Transplantation records
Communication	<ul style="list-style-type: none"> • Care planning and tumour boards • Teleconferences and consultations • Community referrals outside healthcare arena
Knowledge access and decision support	<ul style="list-style-type: none"> • Body surface area calculations • Published scientific literature • National Cancer Institute, American Cancer Society educational materials • Scales inventories tools (i.e. psychosocial pain) • Patient education materials
Data processing	<ul style="list-style-type: none"> • Biologic signal processing • Laboratory test values and tissue typing • Histology and cytology • Imaging studies, including high-resolution films • Anthropometric, biochemical and immunologic measurements • Graphical display of haematologic response measured against treatment schedule • Tumour markers and objective measurement of tumour response
Therapy and controls	<ul style="list-style-type: none"> • Clinical pathways, protocols, algorithms • Drug dose calculations • Intravenous monitoring and control • Ventilator support • Treatment flow records on chemotherapy, radiotherapy and biotherapy • Patient performance status scales • Pain and fatigue measurements
Research	<ul style="list-style-type: none"> • Clinical trials • Study enrolment and data submission • Outcomes research and health services research
Regulatory	<ul style="list-style-type: none"> • Institutional reporting to federal and state agencies

Table 2.6-1 Applying the computer to processes in oncology care

(Reproduced pending permission from Chamorro, 2001, p. 28)

More recently, Clauser, Wagner, Bowles, Tuccio, and Greene (2011) conducted a comprehensive examination of the application of ICT to help both cancer treatment service providers and patients, stating that few studies had considered how ICT could most effectively integrate the diverse dimensions of cancer care (Clauser et al., 2011, p. 198). Clauser et al. examined the factors contributing to successful delivery of contemporary care treatment services, paying particular attention to where ICT could help create a patient-centric service delivery model. Clauser et al. reviewed literature focused on the quality of cancer services in order to investigate the following questions: "How does ICT support modern cancer care? What are the challenges in using ICT to support patient-centred cancer care? How are technology

and performance measurement currently used to help cancer organisations in these transitions?” (Clauser et al., 2011, p. 198). The authors identified three main areas where information technology could make an important impact and improve the quality of oncology services: clinical decision support, care co-ordination, and continuity of care. The conclusion suggested approaches for making progress with research and policy developments for ICT-supported cancer care.

Wallace (2007) described the potential benefits of improved cancer services, whereby ICT solutions can assist with predictive analytics if they are well-designed for comprehensive data capture. In addition, Wallace (2007) reviewed other studies demonstrating the potential for technology to improve cancer services from both the patient's view and as part of a system-wide improvement plan, including Hesse, Hanna, Massett, and Hesse (2010), who emphasised that the implementation of ICT is not enough to achieve quality improvements in service delivery; a socio-technical systems approach is required to ensure the best alignment of patients, hospitals, policies, procedures and technology (Hesse et al., 2010). Clauser et al. (2011) explained several factors that are significant for the improvement of cancer services, which were identified during a 2010 IoM workshop on Rapid Learning Health Systems (IoM, 2010). These included cancer registry systems, a nationwide oncology database, and EPR applications with real-time clinical decision support functionality.

Expanding further on Clauser et al.'s (2011) range of predicted developments in healthcare IT, Sittig (2006) identified point-of-care decision support as one of seven new types of healthcare technology that were under development and were expected to be in routine clinical use in healthcare facilities in developed countries during the course of this research study, creating an opportunity to re-engineer all stages of cancer treatment pathways. These seven items were:

- (1) The next generation Internet (a USA government scheme intended to improve, enhance and revolutionise the Internet and its supporting infrastructure);
- (2) Real-time clinical decision support systems;
- (3) Off-line, population-based systems;
- (4) Large, integrated, individual patient-level phenotypic and genotypic databases with intelligent data mining capabilities;
- (5) Wireless, invasive and non-invasive physiologic monitoring devices;
- (6) Natural Language Processing (NLP) systems; and
- (7) Mathematical models of complex biological systems. (Sittig, 2006, p. 813)

Reflecting on these areas in 2019, there have been a growing number of technological advances during recent years, as predicted, with various global, national, regional and individual organisation examples of research initiatives and project implementations, in the UK, USA, and many other developed countries. For example, with reference to item (4) above, in the UK a national programme called the 100,000 Genomes Project was initiated in 2012 with the aim of sequencing the complete genomes of NHS patients. A specific workstream was established to focus on some common types of cancer, and by December 2018, more than 90,000 whole genome sequences had been mapped (Dheensa et al., 2018). Although biometric data is not within scope of EPR systems, this area is still particularly relevant to the research reported in this thesis, as the integration of this patient-level phenotypic and genotypic data with the data recorded in EPR systems will ultimately facilitate advanced predictive analytics that can be used for personalised medicine treatments for cancer disease. This in turn may influence the perceived value and usefulness of EPR systems from a clinician's perspective, thereby affecting adoption and use of technology in oncology care.

With reference to this comprehensive approach to data capture and analysis, Clauser et al. (2011) suggested that "systems-minded" cancer hospitals view the complete care pathway in a holistic manner and make adjustments, if required, to improve care coordination and delivery (Clauser et al., 2011, p. 205). In the development of multi-disciplinary healthcare centres, there is a trend toward improving the coordination of clinical services, facilitating collaboration and communication among oncology surgeons, radiation oncologists, and medical oncologists in treatment planning and delivery. However, further development is required, particularly in primary care environments, to include community-based clinicians within the teams and to find ways to optimise and measure care coordination processes, especially in light of the ubiquitous interfaces between community care and acute and tertiary oncology care across the range of cancer care pathways (Clauser et al., 2011).

Sittig (2006) argued that, within the context of potential increases in demand for healthcare services, lessons learned from history, and the unintended consequences of technology (e.g., less efficient clinical workflow processes and user resistance) researchers and health informatics practitioners should continue to study the successes and failures of health ICT developments. They must also be shrewd in scanning the horizon for future technological innovations and ensure that they are ready for further changes in healthcare (Sittig, 2006, p. 818).

Although several examples of clinical ICT system development and implementation projects exist in oncology, research papers about the implementation of comprehensive EPR systems, particularly in dedicated cancer treatment hospitals, are limited. Highlighting the lack of penetration of ICT that has been achieved in healthcare compared to other industries, Galligioni

et al. (2009) cited a survey of Italian healthcare organisations which found that only two fifths of them had adopted an ICT system, predominantly for supporting administration processes. Within medical oncology units in Italy, fewer than 50% were still using paper-based patient records, and only 1.3% used EPRs for comprehensive management of oncology patients (Associazione Italiana di Oncologia Medica, 2004).

Galligioni et al. (2009) described the development and use of an oncology-specific EPR system, which adopted a user-centred design that allowed clinical users to inform the end solution and how it developed. This is an important feature of Galligioni's study, whereby clinical stakeholders were engaged in process design workshops. This is now a well-established approach to system design based on methods such as participative design (Schuler & Namioka, 1993) and the concept of "agile development," which emerged during the 1990s (Highsmith, 2000). For the project at Santa Chiara hospital in Trento, Italy, a project team of doctors, nurses and ICT specialists established the data set and functional requirements through analysis of user requests (Galligioni et al., 2009). The aim of the project, which started in 1997, was to design, develop and implement a web-based oncology EPR system (EOPR) with a tele-consultation module for the "total management" of cancer patients. In developing the system, the task force attempted to obtain a detailed comprehension of the relevant care processes by analysing all clinical activities and the associated paperwork (Galligioni et al., 2009). The software was then designed and developed with a user interface based on a simple "point and click" principle, utilising common features such as radio buttons, check boxes and drop-down menus for coded data, and free text fields for unstructured information recording. The core data types and functionality that were included in the system based on user requests are shown in Table 2.6-2.

Data type/category	Functionality
Demographic data	<ul style="list-style-type: none"> Imported from a regional demographic database to avoid transcription errors and duplications
Anamnestic data ¹	<ul style="list-style-type: none"> Including risk factors and past and recent medical history with chronic medications
Laboratory and instrumental data	<ul style="list-style-type: none"> Imported from the corresponding repositories, with the automatic highlighting of abnormal values
Pathological/clinical diagnosis	<ul style="list-style-type: none"> Based on the International Classification of Diseases for Oncology (ICD) and tumour-node-metastasis (TNM) system
Therapeutic programme	<ul style="list-style-type: none"> Covering the entire process of care with the detailed doses, schedules, sequences and supportive drugs for all regimens. Therapies are proposed with automatic dose setting and updated sequencing and cumulative drugs doses and relative dose intensities are also automatically updated and recorded. All the therapies are traced with the names of the doctors and nurses and the date and time of prescription and administration
Self-updated chronological summary of clinical course	<ul style="list-style-type: none"> Showing the sequence of different accesses, treatments, responses and toxic effects. Data are automatically extracted from any single patient's access and grouped in chronological order
Working agendas	<ul style="list-style-type: none"> To arrange and synchronise patient appointments with the different clinical activities
Data extraction	<ul style="list-style-type: none"> Of all clinical activities, patients and tumours characteristics, treatments and resource consumption etc.

Table 2.6-2 Core data items and functionality in Galligioni et al.'s EOPR

(Reproduced from Galligioni et al., 2009, p. 350)

Another important feature of Galligioni's (2009) study is the similarity in the operational model used by the cancer centre in Trento, Italy and that which is adopted by the case study site in the UK. In both cases the core EPR system was first developed and implemented for use in the medical oncology (i.e. chemotherapy or SACT) area before being further developed to include radiotherapy and then rolled out to peripheral clinic locations at other hospitals. This is an important similarity, as no other studies were identified that specifically highlighted the requirements and challenges related to both comprehensive functionality and remote access from other hospitals.

Galligioni et al. (2009) identified the main attributes for successful implementation and use of EPR systems as: "user involvement in the design; flexible web technology; development of

¹ "The information content of signs, symptoms, laboratory test results, and other events that constitute the medical record has been analysed and it has been determined that the meaning of sign and symptom information can be described in a multiple-dimensional matrix. This multi-dimension meaning concept of signs and symptoms facilitates a logical structure for the storage of clinical information. This structure is not an arbitrarily imposed one, but an intrinsic, although not commonly recognized, attribute of medical information" (Brunjes, 1971).

appropriate functions for total patient management based on clinicians' needs; and short and long-term assistance" (Galligioni et al., 2009, p. 352).

A more recent example of onco-EPR development is an EPR-based cancer diary system (Ries, Golcher, Prokosch, Beckmann, & Bürkle, 2012): a cancer data visualisation tool that was developed as an extension to a commercial EMR system in use at the Comprehensive Cancer Center Erlangen-Nuremberg, University Hospital Erlangen, Germany. Ries et al. (2012) described an EPR development concerned with the visualisation of all oncology related data into a "cancer diary" presented on just one screen of the application. The application logs and outcomes of a user questionnaire showed increased use and more positive usability of the cancer diary in comparison with conventional searching for relevant data in the core EPR system. The review of this development found that this consolidated view of oncology information with aggregated staging codes, diagnostic results, multi-disciplinary team (MDT) decisions, and clinical actions could be a very useful EPR extension for hospitals providing oncology services focusing on cancer care, for example within comprehensive cancer centres (Ries et al., 2012).

The majority of research papers describe ICT system developments related to a specific area of cancer treatment services, such as radiotherapy systems or electronic prescribing systems for chemotherapy. In a review of progress toward establishing cancer-related standards for EPRs, Yu (2011) stated that the support of oncology functionality would require careful focus on how EPRs are constructed, the oncology-related information that they contain, and clinical decision support functions that facilitate safe care and efficient processes. Standardising software functionality would enable the exchange of electronic information and improve the interoperability of oncology EPR systems (Yu, 2011). The literature search found limited evidence of research conducted about the design and implementation of comprehensive EPR systems with coverage of all areas of clinical functionality, with the exception of Galligioni et al.'s (2009) Italian study and, more recently, Sicotte, Clavel, and Fortin's (2016) report on an Onco-EPR deployment in Canada.

In concluding this section, the literature review found evidence of research about oncology information systems, the use of information technology and the development of EPR systems in cancer services, dating back to the 1970's. However, the scope and focus of research studies is variable, with the older literature demonstrating how clinical workflow could be computerised for processes such as ordering laboratory tests. During the last four to five decades, as both technology and medical science have advanced, research studies in oncology information systems have increased in their frequency and level of detail, but they have often focussed on a specific treatment modality, disease group, or particular aspect of system functionality. In contrast, the present study investigated multiple aspects of system functionality and workflow

processes across diverse treatment modalities and disease groups. The next section summarises the literature in relation to the different functions and capabilities of oncology EPR systems.

2.7 Functions and capabilities of oncology information systems

Having discussed the development of electronic record systems in cancer care in the previous section, this section now focusses on the wide range of functionality required in oncology, with analyses of reference documents and empirical studies concerned with the specification, development, and evaluation of EPR systems. As noted by Häyrinen et al. (2008), as well as earlier in this review (Section 2.3), the term EPR is used to include a range of information systems, from medical records produced in a specific hospital department to comprehensive and longitudinal patient information covering multiple departments or hospitals. Häyrinen et al. (2008) reported that a limited number of research publications provided descriptions of the structure of EPRs or the terminology used to explain them, and this was confirmed in the original search results for this review in 2011. Although a subsequent, more recent search in 2019 found that further literature had been published about EPRs generally, studies with a particular focus on cancer service requirements were still limited. In a study concerned with oncology-specific EPRs, Kanas et al. (2010) produced a schematic of the components in a “generic” EMR system. These authors recommended the development of oncology-specific systems to improve outcomes research.

The most comprehensive reference source for oncology EPR requirements identified in the search was the HL7 Ambulatory Oncology EHR functional specification (HL7, 2010), although the status of the specification is not clear because, following the first release for comment, the oncology workgroup was put on hold, pending a review of an overlapping project being conducted as part of the USA National Cancer Institute’s cancer Biomedical Informatics Grid (caBIG) programme. However, by virtue of the fact that the specification relates to ambulatory care, it could not be considered a comprehensive specification covering all oncology information system requirements.

In the following sub-sections, the specific areas of functionality within clinical information systems used in both radiation oncology and SACT are defined and explained (2.7.1), and a brief review of developments and research on these systems is provided. This is followed by a section about information systems for diagnostic and support services, then a summary of relevant papers related to integration, cross-organisational systems, and remote access in sub-Section 2.7.4. Finally, relevant literature about oncology system developments relating to “big data,” predictive analytics, clinical research, and personalised medicine is reviewed.

2.7.1 Information systems for systemic anti-cancer treatment (SACT)

As outlined in Chapter One, the delivery of SACTs is one of the main functions of a cancer treatment centre, and an electronic prescribing system for chemotherapy can be classed as one of the core EPR sub-systems for oncology (Shulman et al., 2008; Sklarin et al., 2011). The adoption and use of this specialist functionality with the wider context of oncology EPRs is an important issue within the literature and is of particular interest for this research study.

ePrescribing systems have been in use in acute hospital settings in the UK since the early 1990s (Slee, 2005a, 2005b), and a substantial volume of research literature has reported on the impact of introducing these systems, with particular emphasis on improvements in patient safety due to reductions in drug-related errors (e.g. Voeffray et al., 2006; Small et al., 2008; Huertas et al., 2006). Although there has been little success in the efforts to reduce them, medication errors, which have been defined as “any error in the prescribing, dispensing, or administration of a drug, irrespective of whether such errors lead to adverse consequences or not,” should be the most avoidable cause of patient harm (Williams, 2007, p. 343).

In the USA there has also been much interest in the cause and impact of medication errors. Statistics relating to the rate of medication errors vary due to different definitions and study methods, but a landmark US IoM publication reported that mistakes in medicine contribute to up to 98,000 deaths in the USA annually (Kohn, Corrigan, & Donaldson, 1999). Although this figure has been questioned, other studies have reinforced it (e.g. McDonald, Weiner, & Hui, 2000). The percentage of medical errors is reported to be in the range of two to 14% of inpatients, with one to two percent of patients in the USA suffering harm as a result, mostly caused by mistakes in the prescription of drugs. Drug prescribing, dispensing, and administration mistakes are thought to kill up to 7,000 patients annually and are responsible for 5% of admissions to hospital in the USA (Williams, 2007) – a similar admission rate to that of cancer (Hepler & Segal, 2003).

In the UK, a comprehensive review of medicines management in NHS hospitals reported that just under 11% of inpatient stays incurred adverse incidents, almost half of which could have been prevented. Approximately 33% of these incidents lead to increased morbidity or death, and each one results in an average of 8.5 additional days in hospital. If the information from the organisations included in the study is transferable and is applied across the NHS, this problem has been estimated to cost the NHS £1.1 billion each year (Audit Commission, 2001). More recently, the UK government planned actions in response to 36 different medication error-related studies conducted at leading Universities. These studies reported that there was limited evidence of the financial impact of medication errors and had to use studies measuring harm and adverse drug reactions to make estimates. The estimated cost of drug interactions that could certainly have been avoided was £98.5m (Wise, 2018).

Drug mistakes are commonplace in healthcare organisations due to fundamental systemic problems in prescribing processes and governance arrangements, but human error is also a significant factor, as stated in the landmark report “To err is human” (Kohn et al., 1999). Almost three quarters of medication decisions are made by junior doctors, even though they have limited experience of prescribing drugs (Audit Commission, 2001). Some research has also found that junior medics and other clinicians more generally are prone to increased levels of mistakes when they are under stress, fatigued, distracted, or working in a clinical area or hospital with which they are unfamiliar (Orton & Cruzelier, 1989).

In their research into the deployment and use of national EPR systems in acute hospitals in England, Majeed et al. (2009) found a significant disparity between the theoretical benefits and empirical evidence regarding the effect of ICT on the quality and safety of healthcare, stating that “although seminal reports on quality and safety of healthcare invariably recognise ICT as one of the main vehicles for making radical improvements in delivery of healthcare, our work shows that realising these will require substantial effort and time” (Majeed et al., 2009, p. 14). In healthcare, a significant amount of current technology is evidenced only with face validity or insubstantial empirical evidence. Accordingly, there is a need for more detailed and comprehensive assessment of emerging technologies, which, unless researched appropriately, may not develop to the level needed for their potential benefits to be fully realised in clinical environments (Majeed et al., 2009).

Although progress has been made in the development and use of electronic information systems in healthcare, there is still limited understanding of how, why, and under what circumstances ICT solutions should be expected to work successfully (Kaplan & Harris-Salamone 2009). Healthcare organisations require clinical information systems that not only have the potential to provide benefits in theory, but have also been empirically proven to do so in practice. Further research on this subject is therefore very important. As well as there being little research on this, there is limited understanding of what makes ICT solutions work successfully; the following paragraphs explain what is currently known about this area.

A study about creating a detailed multi-disciplinary methodology for minimising the volume of systemic anti-cancer medicine errors at the USA National Institutes of Health Clinical Centre found seven main areas in which advancements were required: “protocol development, computer-system enhancements, dose verification, information access, education for health care practitioners, error follow-up, and infusion pumps” (Goldspiel, DeChristoforo, & Daniels, 2000, p. 5). Development of electronic prescribing systems was one of the key objectives for the NHS National Programme for IT (NPfIT); however, the CRS aspect of the programme was fraught with delays. Some progress was made in delivering the electronic prescription service workstream, but this progress was limited in scope, mostly concerned with community-based prescriptions that are issued by GPs and dispensed by community pharmacies. Although the

implementation of electronic prescribing systems in an acute setting was within the original scope of NPfIT, and clinicians reported it as one of the top five functional requirements for hospital systems (Swindells, 2008), the functionality for chemotherapy prescribing, which was identified as a priority by Lord Warner (Slee, 2005a), was not developed as part of the National CRS solutions. In 2010, chemotherapy prescribing functionality was effectively removed from the scope of Local Service Provider (LSP) contracts. Since then, although functionality has evolved in recent years, there has been no further centrally commissioned provision of ePMA systems. However, there are directives for implementation of locally procured solutions.

In 2005, a specification of requirements for Cancer Services Electronic Prescribing Systems was published by Connecting for Health with a view to informing the National Programme for IT. The specification highlighted the fact that specialist prescription and delivery of cytotoxic medicine has particular information requirements including treatment plans, patient consent, treatment checklists, toxicity levels, previous cannulation data, and response to treatment of different disease sites (Slee, 2005b).

Several studies have also described the specialist functionality required for chemotherapy prescribing (e.g. Shulman et al., 2008; Levy et al., 2011). One of the key areas of functionality within an onco-EPR solution is a chemotherapy prescribing system that allows automatic dose adjustment based on laboratory test results, integrated with treatment scheduling. For hospitals outside of the NHS, the chemotherapy functionality should automatically populate a clinical flow sheet and billing module (Schwartzberg, 2005). Similar to other businesses, hospitals need to be able to capture charges accurately. Nonetheless, in hospitals, patients will follow different clinical pathways, and complex processes are needed to ensure that patients are charged correctly for all costs incurred, including clinicians' time, use of medical equipment, and drugs. For hospitals outside of the NHS in England and Wales, this already-challenging process can be further complicated by insurance and charging requirements, which make the process of capturing this data convoluted and ineffective, sometimes resulting in lost revenue. Wexler and Bucci (2010) noted that patient charge capture in hospitals involves complicated and incoherent systems, operational activities, and clinical procedures. Although charge capture is an unfamiliar term within the NHS, an increasing emphasis on patient-level costing systems (PLICS) and service line reporting follows the same basic principles; in both charge capture and PLICS, each stage of the care pathway incurs a cost that should be accounted for by specific service lines or clinical functions, and this information should be used as business intelligence to inform clinical service developments and improvements.

While the functionality of chemotherapy ePrescribing systems is no longer within scope of the NHS NPfIT, these systems are still regarded as a priority by government advisory groups, who have stated that handwritten prescribing of SACTs should be replaced by electronic forms or

prescribing systems as rapidly as possible (NCAG, 2009). Additionally, the Manual for Cancer Services was updated in 2010 and, as part of the National Cancer Peer Review Programme, a standard was set for all NHS cancer treatment services to use electronic prescribing systems for all chemotherapy prescribing. This updated manual also specified standards for local configuration and variation to ePrescribing systems and outlined standard operating procedures for validating the incorporation of individual drug regimens (NCAT, 2010). However, even as recently as 2017, many NHS cancer services were still not using ePrescribing for chemotherapy, and those that were had yet to achieve full compliance with the specified standards (Creswell, Slee, & Sheikh, 2017).

The prevention of medication errors in chemotherapy is particularly important due to the cytotoxic nature of the drugs. However, while general recommendations for preventing medication errors in chemotherapy have been made (Cohen et al., 1996), and the use of standardised forms has been demonstrated to have a positive impact on the completeness of chemotherapy prescriptions and rate of medication errors (Thorn et al., 1989; Dumasia, Harris, & Drelichman, 2006), the development of robust electronic systems for chemotherapy management remains a problem area.

The literature does include some research evidence from implementation of electronic prescribing (ePrescribing) for chemotherapy in practice. For example, in a UK study of just under 2,000 prescriptions for anti-cancer drugs in 2005 (Small, Barrett, & Price, 2008), every new cycle of chemotherapy prescribed was assessed for error and analysed by different categories, including method of prescribing (ePrescribing system, spreadsheet or manual), prescribing clinician, treatment protocol, and severity. The research found that electronic prescribing reduced mistakes by 42%, and errors occurred in a fifth of all spreadsheet-based prescriptions in comparison with 12% of electronic prescriptions. The study concluded that deployment of the advanced functionality, systems integration, and clinical training were critical for the overall use of the ePrescribing solution to be optimised (Small et al., 2008).

Voeffray et al. (2006) undertook research to evaluate the impact of an electronic order entry system on the volume of prescribing errors identified by the cytotoxic pharmacy service in an acute teaching hospital in Switzerland. A multi-disciplinary team standardised existing chemotherapy protocols, and a computerised physician order entry (CPOE) system was created using FileMaker Pro, a software development product. The chemotherapy regimens were implemented on the system in phases and the impact on prescribing was assessed during 15 months of pre-implementation and 21 months of post-implementation of the electronic system. Mistakes were categorised as either major (e.g. dosing and medication-name related) or minor (e.g. infusion-related). Prior to the system going live, 141 errors were identified in 940 chemotherapy prescriptions (15%). Following the introduction of the electronic system, 75 errors were noted on 1,505 prescriptions (5%). Within these 75 mistakes, 60 (92%) were identified on

protocols that had been prescribed using the paper-based method. A statistically significant reduction in the volume of errors was apparent when half of the chemotherapy regimens were prescribed via the electronic system. The study found that following deployment of the ePrescribing system, errors in chemotherapy prescribing were almost eradicated, and safety was significantly enhanced (Voeffray et al., 2006).

In another European study to investigate the impact of chemotherapy ePrescribing on medication errors, at a Spanish hospital, Huertas Fernandez, Baena-Canada, Martinez Bautista, Arriola Arellano, and Garcia Palacios (2006) used a similar approach to Voeffray et al. (2006). The intention was to identify and analyse the occurrence of errors in manually-prescribed chemotherapy orders and to compare this against error rates found in an electronic prescribing system. Information from the ePrescribing system was used for a prospective analysis with paper-format prescription sheets used as the control group. Two reviewers examined the prescriptions for cancer patients, analysing them to identify various types of errors. The percentage of prescriptions including at least one mistake and the median number of their occurrence were computed for each group.

In this study, a minimum of one error was identified in all the paper-based prescriptions and in 13% of electronically prescribed cycles of chemotherapy ($p < 0.001$). The median number of faults per electronic prescription was 0 (range: 0–1), compared with a median of 5 (range: 1–12) in paper-based prescriptions ($p < 0.001$). Omitted prescriptions were the most frequent type of error when the electronic system was not being used. Mistakes interpreting dates, misinterpreted abbreviations, and illegible handwriting were common errors found in paper prescriptions, but errors of this type were not present in any electronic prescriptions. The study concluded that an ePrescribing system for SACT is a powerful tool that was found to reduce chemotherapy-related drug errors and ensure clinicians' adherence to safe chemotherapy procedures (Huertas Fernandez et al., 2006).

The literature on ePrescribing also covers the important issue of integrating electronic prescribing tools into wider EPR systems and aligning them with clinical workflow processes. DesRoches, Agarwal, Angst, and Fischer (2010) conducted a survey of clinicians concerning their use of electronic prescribing systems in outpatient settings and found that those who use ePrescribing systems integrated within a comprehensive EPR system have different attributes, perceptions of potential benefits, and levels of acceptance compared to clinical users who use separate stand-alone systems. The authors provided an example, explaining that, although just over half of the doctors surveyed indicated that they usually checked a patient's medical history when prescribing, users of integrated systems were much more likely to respond that they do this compared to others using disparate clinical systems. These findings are relevant to the USA's policy on MU of EPR systems, as many of the disparate, so-called "best of breed" clinical information system products for electronic prescribing were unable to meet the MU

requirements; thus, there was likely to be an increase in the implementation of comprehensive, hospital-wide EPR systems (DesRoches et al., 2010). This prediction was proven correct in subsequent years with extensive adoption of EPR systems throughout the USA.

As reported by Johnson and Fitzhenry (2006), while the evidence suggests that electronic prescribing can reduce costs, errors and pharmacists' time in validating prescriptions, other publications report problems where the impact of the systems can be disruptive to clinical processes and create difficulties when implementing these ICT solutions (Han, Carcillo, et al., 2005; Payne, 1999). This is a key issue to consider, as it highlights the fact that development of robust software with decision support and safety features is only one part of ensuring successful implementation of these systems in practice. Further research is required to clarify other contributing factors.

2.7.2 Information systems for radiotherapy planning and treatment

Radiotherapy is a treatment modality that uses high-energy x-rays (radiation). It is used for both radical and palliative treatment, i.e., for curative treatment and for symptom relief for patients with terminal disease. The high-energy radiation is used to destroy cancer cells and reduce the size of neoplasms. Different forms of radiation are used for oncology, including gamma rays, charged particles, and x-rays (Evans, 2005). Radiotherapy can be delivered via linear accelerator machines (often abbreviated to "linac") to provide external-beam treatment (from outside of the human body) or via radioactive substances inserted inside the body at the location of cancerous cells (brachytherapy). Often used for thyroid cancers, systemic radiation is another form of radiation therapy that uses radioactive materials, such as iodine, to travel within the patient's bloodstream and destroy malignant cells (Neal, 2009).

Analysis conducted by Delaney et al. and the Collaboration for Cancer Outcomes Research and Evaluation (CCORE) reported that it would be appropriate for just over half of all cancer patients (52%) to have radiation therapy as part of their overall treatment plan (Delaney, Jacob, Featherstone, & Barton, 2003). It is estimated that within the cohort of patients who survive for 5 years or more, radiotherapy treatment is a significant factor in two fifths of all cases, either as a single treatment modality or in combination with surgery and/or chemotherapy (Bentzen et al., 2005).

The deployment of ICT and electronic information systems in radiotherapy has developed rapidly over the last two decades. Clinical information systems used in radiotherapy departments can be grouped into three main categories. The first is a hospital EPR system that contains a range of information in the patient's medical record, the second is an electronic treatment planning system, and the third is a record-and-verify (R & V) system, which allows treatment

parameters to be configured automatically and verified on linear accelerators (Han, Huh, et al., 2005).

To explain how information systems operate within a radiotherapy department, computerised treatment planning systems (TPS) are used to specify dose distributions and the beam shapes that linear accelerators use to target tumours, optimise control, and minimise any damage to surrounding tissue. Patients' bodies are presented in the TPS as anatomical models, in which the neoplasm targets can be highlighted. The overall workflow process for treatment planning includes numerous stages. The medical physics department is responsible for the integrity of the combined electronic systems and medical equipment to ensure that accurate, reliable calculations and dose distributions are generated (Evans, 2005).

Within TPS, R & V systems, and picture archiving and communication systems (PACS), the Digital Imaging and Communications in Medicine – Radiotherapy (DICOM-RT) standard is used for the electronic transmission of data, including image, dose, structure set, plan, treatment record, brachytherapy record, and treatment summary record. The data outputs are generated from the TPS and sent to the R & V system to remove the possibility of transcription errors. Most TPSs also now replace traditional manual planning techniques (i.e., by hand and calculator) with automatic dose calculations using 3D imaging studies and extremely accurate Monte Carlo algorithms² to specify dose distribution (Miller, 2003).

Miller (2003) explained that information systems in clinical oncology have developed in three main phases. The first phase was when entirely paper-based information systems were used:

In the period up to the early 1970s, oncology systems were entirely paper-based. Radiotherapy was hand planned. Schedules were written in diaries, and radiotherapy treatment delivery was verified by signature alone. Complex statistical analysis of any sort required very specialised knowledge, so outcome analysis was difficult. (Miller, 2003, p. 2)

The second phase is referred to as the “hybrid and disconnected oncology information system.” During the mid- to late 1970s, as mentioned earlier in the review with reference to Blum and Lenhard's (1979) work at Johns Hopkins Hospital, computers started to appear in cancer departments. Initially, they were only used routinely for treatment planning and linear accelerator R & V processes. Departments wishing to undertake reporting of prospective or retrospective data for analysis utilised separate stand-alone systems. These statistical software packages

² “Monte Carlo simulation is, in essence, the generation of random objects or processes by means of a computer” (Kroese, Brereton, Taimre, & Botev, 2014, p. 1).

were completely separate from the TPS and R & V systems, which are usually installed on different ICT networks or stand-alone PCs (Miller, 2003).

Miller's statements about this second phase were partly based on evidence from Serber, Mackey, and Young in their 1980 report about the development of a clinical information system at Memorial Sloan Kettering (MSK) Cancer Center in New York. Although this oncology information system was designed in 1977, the authors refer to MSK as being late-comers to the field of computerised data management. MSK administrators had never intended to design their own information system for clinical oncology and initially planned to take advantage of the well-regarded laboratory, administrative, and statistical systems already available from other sources. However, they found that the multiphase process of developing cancer treatment protocols made it impossible to segregate the oncology data into the discrete laboratory, administrative, and statistical categories of the generalised systems. As Serber et al. (1980) stated, "even systems designed for medical research were ultimately rejected for being too biased toward statistics at the expense of general clinical and administrative reporting" (p. 728). They added that as a clinical investigation develops, common data needed to be utilised for a range of different purposes. The researchers therefore decided to design a single system suited to the differing needs of all those involved in the clinical evaluation of therapeutic agents. These needs were divided into three categories: data entry and retrieval; generalised searches; and support systems (Serber et al., 1980).

During this early period, clinical users' limited computing experience and the relatively high expense of ICT led to the emergence of disparate, disconnected systems (Miller, 2003). To be effective, an oncology information system needs to be accessible by all clinical users who need information within the system, and as all employees in radiotherapy have a requirement for some segments of the record, there was a high level of demand for user licences and computer terminals. During the 1970s and 1980s, this type of distributed access was too cost-prohibitive for any individual hospital department to consider, even if appropriate ICT solutions had been in existence (Miller, 2003).

The third and final phase described by Miller is the "integrated computerised oncology information system." From the mid-1990s, the availability of personal computers and mid-range ICT systems made the development of customised, fairly detailed oncology ICT solutions possible. The reduced cost of ICT enabled an expansion in computer terminals, which, in turn, led to the installation of numerous network connection sockets throughout cancer departments. The introduction of Wi-Fi access then further improved the development of oncology-specific software as desktop computer and wired networking costs decreased (Miller, 2003).

The contemporary oncology information system aims to manage the specific cancer-related workflows concerned with delivering radiotherapy and SACT by offering configuration choices

that accommodate all process requirements within a cancer department. Where required functionality is not available within the oncology information system, formalised data standards (e.g., HL7, DICOM, DICOM-RT) are used to enable reliable electronic data transfer (Miller, 2003).

In 1997, Brooks, Fox, and Davis presented a comprehensive review of radiation oncology information systems (ROIS) available at the time. Brooks et al. (1997) stated that radiotherapy-specific oncology systems could automate most of the workflow tasks within the patient treatment pathway, and the associated efficiency savings would be enough to justify investment in these systems. The researchers recognised that numerous technical factors should inform decision-making and emphasised the importance of issues related to ICT networks, databases, and computer terminals in the context of the different supplier propositions. The authors' advice to cancer treatment hospitals was that a review of reference sites with a system installed should be a prerequisite for any decision on a particular system, in addition to compliance with current and future system requirements. Finally, they advised oncology centres to consider all emerging treatment modalities and the information sources involved, as well as the key attributes and features of the system functionality (Brooks et al., 1997).

Although research about the development of comprehensive ICT systems covering all aspects of oncology remains relatively limited, in recent years a number of healthcare organisations and research projects have reported on the development of ICT systems designed specifically to support radiation oncology information requirements. Many of the studies relating to ROIS developments focus on the workflow efficiencies that can be achieved via the implementation of electronic systems in radiation therapy. For example, at the Samsung Medical Centre in Seoul, Korea, Han, Huh, et al. (2005) developed a form of EPR system known as the Comprehensive Radiation Oncology Management System (C-ROMS). C-ROMS was deployed in conjunction with a mercantile R & V system. The researchers analysed the effect of the integrated C-ROMS and R & V solution on employee workload in the radiotherapy service, and they found the C-ROMS/R & V solution reduced the average entire employee workload by 28.2% compared to manual treatment processes. The workloads for nursing and administrative roles were reduced by 86%, practitioners in the planning simulator areas reported a reduction of 62%, and ICT and scientific and technical personnel reduced their workload by one fifth. However, the impact for physicians was an increase in work of just over 28%. The overall outcome was that the C-ROMS/R & V solution resulted in a compelling decrease in the average total employee workload, thereby improving the overall efficiency of patient treatment (Han, Huh, et al., 2005). However, this outcome highlights that while a system such as C-ROMS can generate overall net efficiency savings for a cancer centre, these savings may be to the detriment of particular staff groups—in this case, clinical staff, whose workload actually increased with the introduction of the electronic solution.

Another paper explained that a radiation services department had made a significant investment in electronic TPS, when previously they had depended on manual, paper-format charts for dealing with cancer patients (Kirkpatrick et al., 2010). In 2009, the service planned to make the transition to an oncology EPR system, removing the production of paper-based charts. The main objective was to improve access to information from any location, avoiding any reduction in safety, treatment quality, information security, or efficiency. Kirkpatrick and colleagues created a multi-disciplinary team of clinical oncologists, nursing staff, therapy radiographers, clerical staff, physicists, and ICT technicians. The group mapped out all current clinical processes and related management information and activity reports; produced the design and configuration plan for the system; and created, tested, and deployed new processes using the EPR system.

Two main categories of information were noted in the outcomes: the first was information that needs to be immediately accessible to anyone in the hospital and wider healthcare community; the second was information that is only used within the radiotherapy service. Examples of information in the first category were clinical letters, history sheets, and treatment summary notes. The information that was only used in radiotherapy included radiotherapy treatment plans, daily treatment records, and quality assurance records. For management of hospital-wide information, the study site used a commercial EPR solution provided by McKesson; a concentrated effort was required to develop and introduce processes to output data from radiotherapy into that system. To manage the radiotherapy information, the researchers used the planning and R & V system provided by Varian. The requirement for concurrent access to both the EPR and the radiotherapy systems from a single computer terminal was critical, leading to new PCs and configuration of the applications. Beginning in early 2010, all new treatments were managed within the EPR system. The study reported that the EPR system made clinical data more widely available and did not have an adverse impact on patient safety, treatment quality, or information security. Nonetheless, in comparison with manual charts, the time needed for clinical staff to enter and retrieve patient data had increased substantially. Although efficiency was expected to improve with familiarisation over time, significant functionality enhancements and improved interfacing between modules and other systems were required to improve usability and acceptance of the system. Based on the cost of investment in the system and the savings it achieved by discontinuing the use of paper, the project's cost-benefit profile was expected to break even after six years (Kirkpatrick et al., 2010). Overall, the program was found to be beneficial and cost-effective, even though it increased the time needed for clinicians to enter and retrieve data.

In summary, Kirkpatrick et al. (2010) reported that successful deployment of an EPR system for radiotherapy departments required not only the effort and dedication of all staff groups and processes within the department, but also leadership and support from senior management, the organisation's ICT department, and the commercial system suppliers. To ensure that all of the

potential benefits of the EPR system were realised, more experience and system maturity was required, along with improved interfaces, system performance, and refinement of clinical workflows (Kirkpatrick et al., 2010).

Having considered the findings of previous studies specifically in the area of radiotherapy, and given the developments in recent years and focus of the present research, it is now appropriate to investigate whether Kirkpatrick et al.'s (2010) findings still bear out in today's more advanced EPR systems and oncology centres, in the context of centre-wide functionality (including integration with other treatment modalities such as chemotherapy).

2.7.3 Information systems for diagnostic and support services

In addition to radiotherapy, another important application of information systems is in the area of diagnostic and support services, including:

- patient administration systems used for booking patient appointments and for recording admissions, discharges and transfers;
- order communications and results reporting, or CPOE systems, used for requesting pathology and radiology tests;
- and PACS, used for storing and reviewing medical images.

A patient administration system (PAS) is one of the first sub-systems to be deployed as part of the overall hospital information system (Connecting for Health, 2009). It stores the demographic data of each patient, including the name, gender, home address, date of birth, registered General Practitioner (GP), and each contact with the outpatient department, admissions, discharges, and transfers. In the UK, the NHS patient record and appointment tracking system is often called a Patient Administration System (PAS). A basic PAS provides the Master Patient Index (MPI) for a hospital, and it is used to produce waiting lists and improve the efficiency of various administrative processes, such as printing reports, labels, and letters. A PAS provides the basic foundation for development of clinical functionality within an EPR system.

Patient administration systems are critical for the efficient running of hospitals because they produce vital information such as clinic lists and activity reports, enabling the organisation to capture activity, measure throughput against contracts, and report to commissioning bodies. The implementation of new consistent PASs became one of the main aims of NHS NPfIT in its initial stages, as this implementation was recognised as a necessary prerequisite for successful delivery of the CRS. However, ongoing delays and changes in the commercial service providers led to changes in the NHS PAS market and new opportunities for vendors. Importantly, the role of current suppliers and the significance of "interim" systems have both expanded, producing

new opportunities for commercial system providers and more options for NHS customer organisations (eHealth Insider, 2013).

Due to the fact that the data contained within a PAS includes patient demographic data that is common to all clinical specialties, research studies relating to PAS are wide-ranging in their scope and tend to be concerned with the use of PAS data to facilitate research into a vast range of healthcare topics. Research relating to the development and clinical use of PAS technology was not identified in the literature search for this thesis.

Picture Archiving and Communication Systems (PACS) have been included within the diagnostic and support category of sub-systems, as they are primarily support systems used to store diagnostic images, but clinical imaging also has a vital role in oncology and clinical research not only for diagnostic and treatment planning purposes but also for prognosis and review of treatment response. While there is scope for further advancement, during recent years significant progress has been made in imaging informatics, supporting clinical imaging developments and the unique requirements of oncology imaging. In 2011, Levy et al. conducted a review of the current status, restrictions and barriers to progress and potential future developments in imaging informatics for cancer care, including clinical information systems and research systems. The authors evaluated electronic systems supporting oncology processes, including order sets for diagnostic imaging, radiology review, and reporting of image assessment, as well as oncologist review and use of the radiology report for clinical decision-making. In addition, they explained the contributions of ICTs to oncology imaging, including (but not limited to) controlled terminologies, image annotation, and image-processing algorithms. With the continuing advancement of modern imaging modalities and diagnostic biomarkers, the researchers predicted that these specialist solutions were likely to continue to expand in their sophistication and functionality (Levy et al., 2011). This is an important consideration for the present study, as current and potential developments may have an impact on the adoption and use of these clinical EPR sub-systems for oncology clinicians.

2.7.4 Integration, cross-organisational systems, and remote access

A major difficulty for clinicians is the requirement for access to patient information that is usually distributed across multiple medical records and areas. This scenario is common in cancer services, because patients may receive treatment over several years and across different organisations, as well as across clinical departments. Recent progress in ICT solutions has made it possible to access medical records from almost any location at any time, enabling clinicians and patients to enter and retrieve information from an “ephemeral electronic patient record” (Quantin et al., 2009, p. 207).

Orchard (2009) explored issues related to EPR systems access across multiple cancer treatment centres in Ontario, Canada. Views about EPR access and the completeness of medical records were obtained via a web-based survey questionnaire of 5,663 oncology clinicians and administrators in Ontario. The response rate was 35%. The data were interrogated using a multi-level logistic regression model. The covariates of the model included the type and location of the cancer organisation and availability of PCs and Internet access. With reference to the results from cancer care providers ($n = 1247$), major variations in EPR access and medical record completeness were identified across the different oncology organisations. Clinicians at teaching hospitals were twice as likely to have access to their patients' electronic records as their counterparts based in community hospitals (Odds ratio [OR] = 0.45 95%, confidence interval [CI] = 0.24–0.85, $p < 0.05$) and were six times more likely to have access to other organisations' EPRs (OR = 0.15 95% CI = 0.02–1.00, $p < 0.05$). This is presumably due to the nature of community-based services working in cooperation with multiple acute hospitals in the region. In comparison with surgeons, nursing staff, radiographers, physicists and other allied healthcare professionals were more likely to have adequate access to EPRs within their organisation. The reasons for this were unclear but may be related to the physical constraints of the operating theatre environment and the nature of the clinical work being undertaken.

In conclusion, Orchard's (2009) study found that variance in accessibility across different oncology organisations and geographic locations demonstrated the disjointed nature of EPR acceptance and use in the wider cancer care system. In addition to paying attention to the technological issues relating to EPR adoption, it is vital that there is cross-organisational access to EPRs to safeguard continuity of care for patients, system efficiency, and good treatment quality (Orchard, 2009). In practice, this means that technical support teams, usually based in the healthcare provider's information technology department, should work to provide solutions for secure remote access. This could be achieved using a portal that is accessible via a virtual private network (VPN) from different organisations' IT networks.

Van der Haak et al. (2002) investigated the data protection and security requirements and technical preconditions for cross-institutional oncology EPR systems in Heidelberg, Germany. Based on the requirements of data protection and security laws, and on technical preconditions, the researchers identified three models for a shared, cross-institutional EPR system to support services provided to patients who suffer from diseases of the thorax and lungs. Van der Haak et al. (2002) suggested that a cross-institutional EPR system should be developed within the existing information processing infrastructure of the relevant institutions and that the chosen architecture concept should be extendible to other organisations. The models, which were developed in the context of two institutions requiring access to a single EPR system for patients, all used the legacy patient record system as the core component of the overall solution.

2.7.5 “Big data,” predictive analytics, clinical research, and precision medicine

As EPR systems evolve and patient information is increasingly recorded in electronic format, there is a vast and rapidly growing volume of clinical data being recorded into electronic information systems.

In today’s information society, the overall amount of data that is being collected through electronic information systems, including the Internet and connected systems and devices, has been estimated to be 35 zettabytes of data generated annually by 2020. To explain how much data this is, one zettabyte (ZB) is equal to 10^{21} bytes, or 10^{12} gigabytes (GB) (Noseworthy, 2012).

The term “big data” was originally used in the ICT industry in 2005 to define a vast quantity of data that conventional data management technologies and approaches could not process due to their significant volume and complex nature (Ularu et al., 2012). Leading technology advisory firms IBM and Gartner provide similar definitions of big data, with both companies agreeing that volume, velocity, and variety of data are key features. Volume refers to the amount of data generated by an organisation, velocity refers to data processing time, and variety refers to the range of data types that are managed within a big data system (structured and unstructured). IBM’s definition includes a fourth aspect, veracity, which refers to the extent to which senior managers and decision-makers in an organisation make use of the information to guide important organisational decisions (Ularu et al., 2012).

In parallel with the big data revolution, other related technologies have emerged and grown increasingly widespread. These include systems for big data analytics, such as advanced data mining and visualisation tools. Within the healthcare industry, many big data initiatives are focused on combining individual patients’ biological data (which is increasingly stored and analysed in electronic format) with population-level EPRs. For example, the flagship NHS “100,000 Genomes Project” in the UK is enabling new clinical research by linking genomic sequence data with EPRs. The project involves the sequencing of 100,000 genomes from 70,000 patients, including those diagnosed with cancer. This project is providing a facility for future medical researchers to investigate the most effective ways to utilise genomics in healthcare and the most effective approaches for interpretation of the data to improve individual patient treatment (Dheensa et al., 2018). Coleman and Matulonis (2016) stated that “the greatest promise for success in our assault on cancer will come from the optimized intervention of preventative and therapeutic measures specifically tailored to the individual” (p.1). The term used for this application of big data in healthcare is “precision medicine.” The National Research Council in the USA (2011) acknowledged that the term is still sometimes used interchangeably with “personalised medicine.” The term “personalised” might be misconstrued to suggest that treatment is developed and provided uniquely for each individual patient, but rather the actual

aim of precision medicine is to identify the most effective treatment for particular patients based on genetic, environmental, and lifestyle factors (National Research Council, 2011). More specifically within the oncology domain, the USA National Cancer Institute's (NCI) definition of precision medicine is “to use tumor genomic, proteomic, and transcriptomic information to prevent, diagnose or treat a disease” (Coleman & Matulonis, 2016, p. 1).

In the USA, a major big data initiative called CancerLinQ, which aims to improve cancer treatment, is currently underway. This initiative seeks to transform cancer treatment and improve clinical outcomes via the production of novel knowledge founded from individual patient-level data and advanced learning tools that support the application of that knowledge to cancer treatment (ASCO, 2015). In CancerLinQ, data is aggregated from EPRs and other source systems for three main purposes. Firstly, CancerLinQ offers clinical decision support (CDS) functionality to assist oncologists in selecting the correct treatment at the right time for individual patients. The CDS functionality is based upon published ASCO guidance and additional sources of expertise, and ultimately on the outcomes from real-world patient treatment. Secondly, CancerLinQ provides fast, high-quality information for oncologists to review their performance and outcomes against the recommended guidance and the performance of other oncologists working in the same disease groups with similar profiles of patients. Thirdly, the analytic capabilities of CancerLinQ assists in improving treatment by discovering currently concealed patterns in patient characteristics, therapies, and clinical outcomes. These patterns enables the generation of robust and innovative hypotheses for cancer research and help to advance clinical trial designs (ASCO, 2015). This type of clinical decision support is an important development in oncology EPR systems as CDS have been found to be relatively immature in its development. Silsand and Ellingsen (2016) investigated complex decision-making in healthcare settings and reported that advanced EPR systems with CDS functionality were only in use in small percentage of hospitals (Silsand & Ellingsen, 2016).

Within cancer treatment services, another big data initiative is the use of the IBM Watson super-computer at MSK Cancer Center in New York. This hospital treats more than 30,000 cancer patients annually, and Watson is now being used to link information about individual patients to a large knowledge base that includes published research articles indicating the past treatment and clinical outcomes of patients with a similar disease or other shared characteristics (Levit, Balogh, Nass, & Ganz, 2013).

Watson's data mining capability allows it to search and process vast quantities of data, meaning that it can rapidly and continually be updated with the most recent clinical research discoveries published in scientific journals and medical conferences. Furthermore, because it applies cognitive computing, Watson continuously “learns,” thus refining its accuracy and assurance in the treatment decisions it recommends to oncologists (Levit, Balogh, Nass, & Ganz, 2013).

2.8 Challenges associated with implementing EPR systems

Sklarin, Granovsky, O'Reilly, and Zelenetz (2011) described the lessons learned and proposed strategies for success following the implementation of an EHR system at MSK Cancer Centre in New York, USA. The development and rollout of an EHR system across a large institution can present many challenges because of the size, complexity, and variety of the specialty practices, as well as the existence of large legacy systems. Sklarin et al. (2011) chose to implement different components of the EHR system over decades as computer technology improved, as they developed in-house functionalities, and as vendor products became available. They reported that the implementation's success largely resulted from the formation of a well-integrated multidisciplinary implementation team that included high-level managers who were committed to supporting the end users' needs. End-user physicians, nurses, and pharmacist representatives were selected to take part in system design and encouraged by their peers to buy in. Current workflows were mapped out with all permutations, and new workflows incorporated process standardisation and improvement. Having the EPR system configured to automatically add default clinical information and values on standalone orders and customising order sets wherever feasible made it easier for clinical end users to interact with the system and encouraged them to comply with its use. Table 2.8-1 overleaf summarises the key elements for successful implementation of an EPR system in a cancer centre, according to Sklarin et al. (2011).

Several systematic reviews have emphasised the challenges related to EPR implementation. McGinn et al. (2011) conducted a systematic review to compare the conceptions that different clinical user groups have about the factors that support or impede the successful implementation of EPRs. The researchers acknowledged the requirement to include numerous stakeholders with different perspectives on the deployment process, stating that EPR users should have a significant influence on the overall success or failure of the system because they need to integrate that system into their clinical workflow processes and daily tasks. The EPR acceptance categories reported most frequently across all clinical user groups were design and technical issues; usability; integration with other systems; confidentiality and data protection; costs; efficiency; familiarity; motivation; patient and clinician interaction; time available; and workload.

In order to provide a more in-depth comprehension of the intricacies of technology deployment in healthcare, Reidl, Tolar, and Wagner (2008) studied the implementation of EPR systems in three oncology clinics in Austria using a combination of observations (of project meetings), ex-post reconstructions through interviews with stakeholders, and document analysis. Reidl et al. (2008) argued that to gain an improved understanding of the implementation of complex ICT systems in hospitals, a thorough appreciation of the complexities of clinical activities is required, in addition to including other healthcare and social organisations and their agendas. Scrupulous

planning by the project team and an influential presence of clinical stakeholders in all these areas were cited as being critical to align the various viewpoints and the associated demands (Reidl et al., 2008).

Category	Key Elements
Planning	<ul style="list-style-type: none"> ● Establish a clear definition of project’s scope from the start ● Choose a vendor who will collaborate with your team ● Supply adequate resources for utilizing the proposed system ● Announce a clear mandate that orders would only be accepted in electronic format ● Obtain long-term commitment to attend standing meetings until project completion ● Avoid combining multiple extensive changes into one implementation ● Standardize workflows and system configuration across all ambulatory and in-patient areas
Collaboration	<ul style="list-style-type: none"> ● Include front-line users and top managers from each clinical group ● Involve representatives from clinical (MDs, nursing, pharmacy), operations management and system groups ● Respect opinions of the end-users and design the system with their needs in mind ● Standardize process and treatments where possible ● Agree to compromise and commit to implement agreed plan
Workflows	<ul style="list-style-type: none"> ● Map out current flows with all permutations ● Incorporate process improvement into new workflows ● Get sign-off from all parties involved before new workflows are established
System Design	<ul style="list-style-type: none"> ● Default clinical information and values on stand-alone orders and customize order sets wherever feasible ● Test system before any implementation of new functionality ● Need order sets for efficient use of computerized provider order entry
Testing Process	<ul style="list-style-type: none"> ● Provide remote access for all participants to expedite review/approval process ● Create system mock-ups and review against workflows with the group ● Conduct scripted scenario-based testing with end-users ● Analyse results of testing sessions and develop proposals for workflow and system changes to address identified issues ● Presentations to the Steering Group for major clinical and system decisions and milestones
Roll-out	<ul style="list-style-type: none"> ● Manage the scope of the implementation ● System analysts to train super users, and super users to train their respective group ● Conduct daily debriefing sessions during the roll-out week ● Don’t make changes during the first week of implementation unless it’s a patient safety matter
Physician Management	<ul style="list-style-type: none"> ● Provide one-on-one training for physicians ● Have physician champions to present the system to their peers and encourage physician buy-in

Table 2.8-1 Sklarin’s key elements for successful implementation of EPR systems

(Reproduced pending permission from Sklarin et al., 2011, p. 413)

Yu, Gandhidasan, and Miller (2010) examined the experiences of healthcare workers at two public hospitals in Sydney, Australia after the implementation of the same oncology EPR system. They compared clinicians' experiences at the two organisations to identify lessons to inform future deployment of EPRs in public hospitals. Semi-structured interviews were undertaken with 80% of the clinical oncologists working at the two hospitals. The staff who had been influential in the decision to introduce the system were also interviewed, and their decision-making process was reviewed. NVivo software was used to analyse the interview transcripts and identify themes, including deployment methodology and processes; clinical oncologists' use of, and satisfaction with, the EPR system; project management; and the impact of the system on clinical work (Yu et al., 2010).

The two organisations in Yu et al.'s study (2010) had divergent experiences of implementing and using the oncology EPR system. One hospital used the system for all types of clinical documents. Its deployment was supervised closely by senior management and a dedicated project manager. All users contributed input to inform the use and development plans for the system, and they were provided with effective training and support. The other hospital, which lacked a clear plan for replacing manual, paper-based processes, only used the EPR system for making patient appointments and tracking the patient's attendance. A corporate policy was in place for information to be entered into the system by a central team of administrative staff dissociated from clinicians. All of the clinical staff interviewed felt that the EPR system should continuously develop to accommodate changing clinical requirements and service improvement projects (Yu et al., 2010).

In summary, Yu et al.'s study (2010) established that critical success factors for EPR deployment in cancer hospitals included a clear vision for electronic working; effective clinical leadership and senior management; dedicated project management; and input from system users with relevant training. Ongoing clinical engagement is vital for post-implementation acceptance and development of EPR systems (Galligioni et al., 2009).

As demonstrated by the literature, the required functions and capabilities of EPR systems in cancer services are complex and wide-ranging. This section presented a selection of literature to illustrate this point and to identify gaps or limitations in the studies that have previously been undertaken in this field. As mentioned at the start of this chapter, the limitations will be discussed in Section 2.12. In the following section an overview of the literature about socio-technical systems is presented, to provide further background and context for the study but also to assist with the evaluation and selection of an appropriate theoretical framework for the research presented in this thesis.

2.9 Socio-technical systems

In addition to the existing research about oncology information systems discussed in Section 2.6, the researcher reviewed numerous studies of issues related to the design, development, use, and evaluation of clinical information systems in other areas of healthcare. Those considered most relevant to this study can be broadly categorised as part of the “socio-technical systems thinking” field of research, applied within the healthcare domain. As noted by Mumford (2006), socio-technical design is actually more of a philosophy than a methodology.

A socio-technical approach views the implementation of EPR systems as being concerned with the interrelations of technology, people, and the organisations within which they work, rather than viewing these factors in isolation from one another. As Coiera (2003) explained, interaction design is concerned with the way humans interact with ICT. An individual’s use of an electronic information system does not happen in isolation but is influenced by other people working nearby and any other activities the individual must also undertake while attempting to use the computer system. Accordingly, the overall usefulness of a system is derived from how well it aligns with the entire organisational structures, processes, and workflows, not just the particular functions for which it was designed (Coiera, 2003).

Berg (1999) explored the theoretical aspects of information systems in healthcare, inspired by actor-network theory and the core concepts of computer supported cooperative work. This study emphasized the need for system design fit or alignment with work practices, as well as the importance of clinical end users’ competencies and responsibilities. Commenting on the politics of information systems in healthcare, Berg (1999) argued for a relational perspective in which we surpass the complimentary discourses of “intelligent, autonomous agents” and “supporting tools.” By adopting this relational perspective, a thorough understanding of the interrelationship between information systems and their end users can be gained.

The socio-technical approach is distinct from a perspective that focuses only on one area and neglects others (for example, focusing only on the electronic systems or leadership preferences). Socio-technical strategies are conventionally associated with a specific form of systems design in which individual solution users’ perspectives and requirements are represented via participative methods (e.g. process-mapping workshops), and in which the final configuration of the technology system is influenced at the time of design (Cherns, 1987). The main focus in this established practice is on work teams and groups and, in the research described in this thesis, on medical staff working within oncology services.

However, as Sheikh et al. (2010) highlighted, the socio-technical perspective also has a wider significance. It enables policy developers, management, ICT professionals, and/or independent assessors to balance an interest in technical functionality, in itself, with the methods that enable

this functionality to be implemented within an organisation and accepted by users and teams. It also calls attention to the impacts that occur as new socio-technical systems of work are embedded and stabilised (Sheikh et al., 2010). In an extreme case, technical functions may be deployed but not accepted or used; in more nuanced situations, the functionality exists but is not used in the manner that the system designers were expecting, with unintended (positive or negative) consequences. Therefore, the essence of contemporary EPR solutions is that they are not finalised in advance of processes of analysis and design, or by selection of a software product, and their potential impacts are not obvious at the time of deployment. Alternatively, the socio-technical “fit” of a technology within a particular working environment develops over time, possibly several years, and could be viewed more as “a set of improvisations or enactments than as any ordered linear path” (Sheikh et al., 2010, p. 2). This socio-technical systems perspective is well-suited to the aims of the research in the present study, which is to investigate how users, teams, and whole organisations experience the implementation of an EPR system.

Having explained this overview of the socio-technical perspective and the importance of a holistic approach to the evaluation of information systems, the following section explores theories related to the adoption and acceptance of information technology solutions.

2.10 Technology acceptance and adoption

Researchers and academics have developed a number of models for ICT acceptance and adoption, and they have discovered some significant factors that influence the extent of acceptance. Research conducted thus far relating to the acceptance of various types of electronic information systems and other technology has established that several important psychological and related variables can predict users’ motives (Lee et al., 2003). Specifically, perceived usefulness (PU), perceived ease of use (PEOU), and user attitudes about the system concerned have been identified as the most significant predictors of usage intentions (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012). The relationship between PU, PEOU, and attitudes has been conclusively demonstrated since Davis, Bagozzi, and Warshaw (1989) originally developed the Technology Acceptance Model (TAM) to assess IBM employees’ acceptance of new systems. Attitudes in this context are distinct from perceptions of usefulness and ease, and they can be categorised as unfavourable, neutral, or favourable feelings towards technology.

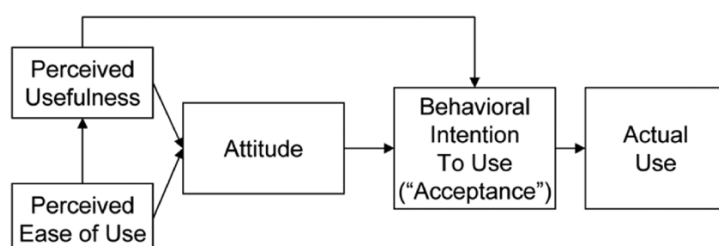


Figure 2.10.1 The original version of the technology acceptance model (TAM)
 (Reproduced with permission from Holden & Karsh, 2010)

Over the last two decades, studies relating to TAM have expanded, and the model is prominent within the main theoretical approaches applied in order to understand users' intentions to adopt electronic systems. Moreover, reconfigurations of the initial TAM (and similar models) have been designed to explicate technology acceptance in a range of specific contexts, including clinical environments. The most well-established theories and frameworks used to describe technology adoption and acceptance are the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), the Technology Acceptance Model, and the Diffusion of Innovations Theory (Gucin & Berk, 2015). Cooper and Zmud's (1990) landmark paper is now nearly 30 years old and although the approach was originally developed in a manufacturing context, the core concepts of the Technological Diffusion Approach have also been applied in many other industries and service areas.

There are numerous examples of the TAM being further developed with extensions (e.g. TAM2, ITAM, ISSM, TTF) and Table 2.10-1 below provides an overview of leading theories of technology adoption, acceptance, and use. One example cited by Ammenwerth et al. (2006) is the Information Technology Adoption Model (ITAM). Dixon (1999) attempted to improve the "system design features" of the original TAM by explaining that a computerised information system has particular elements that must be aligned with the skills of end users and the hardware devices available to them. Dixon (1999) referred to this alignment as "fit" and contended that perceived usefulness and perceived ease of use do not have a dependency on the system design features themselves, but on the extent to which end users are aligned with them. However, Ammenwerth et al. (2006) highlighted that the ITAM framework does not appear to have been formally validated via its application in other contexts, and it was also not clear why elements already acknowledged as missing by Davis (1989) were not added as part of the ITAM development. A more recent review of the literature found a small number of additional papers, but limited evidence of further validation.

Another model evaluated by Ammenwerth et al. (2006) was the Task Technology Fit (TTF), developed by Goodhue (1995). As noted by Ammenwerth et al (2006), the importance of alignment of users, systems and tasks is developed further in Goodhue's task-technology fit model (TTF). He recognised not just the IT system and end user, but additionally the intricacy and wide range of clinical tasks supported by EPR information systems. TTF is comprised of three key factors – individual abilities, IT system attributes and the detailed specifications of tasks. By investigating the impact of these three factors on performance and user assessment of the technology, TTF focuses on the interplay between these areas. Goodhue proposed that the alignment of task and technology dimensions shows the extent to which system design features meet task specifications. Incorporating the individual dimension also gives consideration to the skills and competencies of end users.

TTF enhances the other frameworks previously outlined by focussing more on alignment of its component parts. It also reflects the importance of clinical tasks to be facilitated by technology systems. However, TTF is limited to assessing the alignment of end users and information systems and between the system and tasks it is designed to support. The key aspect that TTF is lacking is that it does not consider the interplay between individuals and tasks. This is a gap in TTF as the interaction between users and tasks is an important area for inclusion in a comprehensive assessment of any socio-technical assessment. As an example, EPR system implementation programmes might fail due to oncologists not being motivated enough to undertake certain clinical tasks such as ordering blood tests and chemotherapy treatments and this important aspect does not appear to be catered for by TTF.

The Information Systems Success Model developed by DeLone and McLean (1992) focussed on the impact of an IT system on the end user and proposed that a system's impact on the wider organisation is contingent on the use of a system and the level of user satisfaction. These two elements are both also directly influenced by the quality of the computerised information system and the data quality within it. As noted by Ammenwerth, Iller, and Mahler (2006), whilst there are some examples of ISSM being applied in a healthcare context (e.g. Cho et al., 2015; Choi et al., 2013), compared to other established acceptance models, the extent to which the model has been validated in clinical environments is relatively limited. A key observation made by Ammenwerth et al. (2006), about the limitations of ISSM, was that whilst it does describe the interplay between different factors, its attention only to system and data quality suggests that, ultimately, only the IT solution's quality defines the overall effect on users. This appears to offer a restricted view of the wider socio-technical system components, largely discounting the importance of human factors, which the present study considers to be a key area for inclusion.

Model	Author	Date	Description	Key Features
Technology Acceptance Model (TAM)	Davis	1989	Focussed on predicting the factors that influence IT use.	Based on the TRA by Fishbein and Ajzen (1967) and the TPB (Ajzen, 1991), in which the TAM was extended and developed, and consisted of two beliefs: perceived ease of use and perceived usefulness.
Information Technology Adoption Model (ITAM)	Dixon	1999	Implementation and evaluation strategies are discussed as they pertain to end-user fit, user perceptions of innovation, usefulness and ease of use, adoption and utilization.	Emphasised the importance of alignment between system design features and end user's skills. Recognised that "fit" between dimensions is an important aspect for consideration, in addition to the key predictive factors previously identified.
Information Success Model	DeLone and McLean	1992	States that the effects of IT on the user (the individual impact) and thus on the overall organization depend on IT use and the user's satisfaction.	Those two aspects (IT use and user satisfaction) themselves depend on the quality of the IT system and the quality of the information in this system.
Technology Acceptance Model 2 (TAM2)	Venkatesh and Davis	2000	Reconsidered the structure of the original TAM and used empirical findings to judge the importance of the models' traditional constructs.	Excluded attitudes from the revised model, but retained PU and PEOU, as these two variables were consistently found to be strong drivers of intentions to use technology. TAM2 also incorporated measures of subjective norms to capture social influences.
Task-Technology Fit (TTF)	Goodhue & Thompson	1995	Focussed on individual performance	Takes into account not only technology and user, but also considers the complexity of the clinical tasks which have to be supported by an IT system.
The unified theory of acceptance and use of technology (UTAUT)	Venkatesh, Morris, & Davis	2003	Aims to explain user intentions to use an information system and subsequent usage behaviour.	The theory holds that there are four key constructs: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions.

Table 2.10-1 Overview of technology acceptance models and frameworks

In a review of technology acceptance studies specifically concerned with adoption of EPRs, Dimitrovski, Ketikidis, Lazuras, and Bath (2013) found that the majority of the researchers

applied modified or extended versions of TAM, or a combination with other technology acceptance models such as TAM2 or the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). Traditional TAM variables, such as perceived usefulness (PU) and perceived ease of use (PEOU), affected self-reported acceptance of EPRs in most studies. The constructs used in the extended TAM models (e.g. finesse, predictive value, and perceived trust) significantly added to the predictive power of the models (Dimitrovski et al., 2013).

Following the suggestion of Bath, Sen, Raptis, and Mettler (2012) that more research is required to build an evidence base to inform the progression of health informatics applications, including EPRs, Dimitrovski et al. (2013) concluded that technology acceptance theories needed to be further contextualised in healthcare settings, especially in relation to EPR acceptance. Holden and Karsh (2010) also proposed that the TAM approach should be contextualised for healthcare professionals due to differences between them and ICT company employees. Romano and Stafford (2011) and Walter and Lopez (2008) suggested the development of a model applicable to clinical environments that would measure adoption barriers, effectiveness, and actual use of EPRs.

Acknowledging the significant evidence base in support of the key concepts of the original TAM (e.g. that perceived usefulness is a very influence belief), Benbasat and Barki (2007) highlighted four key areas of concern with regards to how the use of TAM has evolved. Firstly, they argue that TAM diverts the attention of researchers from IT artefact design and evaluation, the antecedents of its belief concepts. Furthermore, TAM-focussed research has afforded a very restricted investigation of the wide-ranging consequences of technology adoption. Secondly, the authors profess that TAM research has evolved to produce “an illusion of progress in knowledge accumulation” (p. 212). The third point relates the failure of TAM as a theory to offer a systematic method for expanding and extending its central model, meaning its practicality and effectiveness is limited due to the continuously evolving technology adoption context. Fourthly, Benbasat and Barki (2007) refer to efforts to address the gaps in TAM in these evolving contexts and argue that they have not been based on stable and widely-accepted underpinnings, leading to theoretical misperceptions.

The shift towards integrating and expanding the traditional TAM approaches might help in building contextualised models, but this shift has to be followed by a clear and comprehensive understanding of the theories underlying technology acceptance, and it must be based on theory-driven (and not necessity-driven) criteria (Dimitrovski et al., 2013).

With regards to the use of TAM in cancer services, the literature search revealed little evidence of any comprehensive studies related to EPR system implementation. With the exception of one study about tele-oncology, the limited amount of published research related to technology

acceptance in cancer services was about patient-facing technology developments, rather than those for clinical staff working with IT systems as part of service delivery and/or record-keeping. For example, Bell et al. (2016) reported a study concerning the acceptance of a cloud-based Personal Health Network (PHN) that provided cancer patients with a secure network of relatives, carers, and clinical staff within an online system for reporting symptoms via self-assessment forms, sending messages, sharing documentation, and clinical consultations using video conferencing. Although the study was only a small-scale pilot involving 19 patients, the preliminary results of surveys and semi-structured interviews indicated a positive response to the use of technology for the purposes of patient communication and involvement in their care. In a similar study, Nguyen et al. (2017) investigated the acceptance of wearable activity trackers, used by breast cancer patients following treatment, which is often a period of physical inactivity.

Whilst these two example studies provide evidence of an awareness of technology acceptance in cancer services, as noted previously, they are concerned with patient acceptance of technological developments, rather than those affecting healthcare staff in their clinical work. Acknowledging that the most relevant studies cited earlier in the literature review had important aspects of technology acceptance within the scope and focus of their investigations (i.e. Galligioni et al., 2009, and Sicotte et al., 2016), the tele-oncology study referred to earlier was the only example of a study where technology acceptance was explicitly stated within the title or keywords of the literature. In this study Allen, Hayes, Sadasivan, Williamson and Wittman (1995) evaluated the satisfaction of oncologists before and after they used a video-conferencing facility for clinical consultations. The results indicated a reasonable level of acceptance of the solution; however, only three oncologists participated in the evaluation.

This section has outlined a number of key socio-technical system approaches and theories of technology acceptance and use. The following section describes the specific theoretical model selected for this study and the reasons why it was selected most suitable framework for guiding the research process presented in this thesis, based on a critical review of comparable theoretical models.

2.11 FITT: the theoretical framework selected for this study

Within a general theoretical approach based upon a social-technical systems perspective, various specific models and frameworks were considered for use in this study, including variations of the TAM, the technological frames theory (Orlikowski & Gash, 1993), DeLone and McLean's information system success model (2002), and Cornford, Doukidis, and Forster's (1994) evaluation framework.

Selection of an appropriate theoretical framework was approached as an iterative process in which a single, specific framework did not necessarily have to be adopted prior to commencing the empirical research phases. This is partly a reflection of the researcher's own theoretical assumptions and loyalties being open during the initial stages of the PhD and research training. As the study progressed, a short-list of relevant frameworks was evaluated to determine which could be adopted, or potentially merged and adapted, and then utilised appropriately in conjunction with data analysis to develop and validate insights and findings from the research. The researcher's summary assessment of these frameworks is summarised in Table 2.11-1 below.

Model	Strengths	Weaknesses	Suitability for present study
Technology Acceptance Model (TAM)	Extensive use in a wide range of contexts.	Accounts for less than half of computerised systems use.	Due to the TAM's limited focus and the various enhanced and improved models that have emerged over recent years, it was felt the original TAM was dated and limited in terms of its ability to reflect complex socio-technical factors that might affect acceptance.
Information Technology Adoption Model (ITAM)	Recognised the importance of alignment between system features and user's skills.	Does not address gaps already highlighted in relation to TAM.	Whilst ITAM acknowledged the importance of alignment between system design features and users, it did not address other deficiencies already highlighted by Davies (1989), and the model has not been widely used in healthcare.
Information Systems Success Model (ISSM)	Acknowledges the importance of system quality as a factor that could influence use.	Does not explain why the same system can be adopted in a different way.	Having already investigated system quality issues using the IBM survey as part of the exploratory study described in Chapter Four, a more comprehensive model was needed including socio-technical aspects.
Task-Technology Fit (TTF)	Improves on previous models by recognising the importance of fit.	Does not include the alignment of users and tasks.	Does not include the assessment of fit between users and tasks which is considered an important aspect for the oncology EPR study.
Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability (NASSS) Greenhalgh et al. (2017)	Very comprehensive framework including seven different dimensions and accounts for adaptation over time.	Wide range of factors for consideration but without emphasis on their alignment or fit.	Offers a very comprehensive approach but one that it is relatively new and had not been applied and validated at the time of the present study.
Cornford's Evaluation Framework (1994)	Considers evaluation of systems from a more holistic viewpoint than just user acceptance.	Lack of emphasis on alignment of different dimensions.	Cornford's matrix offers a comprehensive model for evaluating both technical and human factors but does not place as much emphasis on the concept of alignment or fit.

Table 2.11-1 Assessment of acceptance models for the study

Numerous studies have been conducted to evaluate different variants of the original technology acceptance model and other specific frameworks that have emerged over recent decades. Additionally, studies have been conducted to compare and contrast the features and to establish the strengths and weaknesses of these models. The Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies (NASSS) framework, developed by Greenhalgh et al. (2017), is particularly helpful in establishing the FITT framework's position on the acceptance continuum, as it incorporates an evaluation of 28 different system implementation models used in previous studies. Importantly, NASSS positions non-adoption and abandonment within this continuum, covering several stages: **n**on-adoption, **a**bandonment, **s**cale-up, **s**pread and **s**ustainability. Recognising the continuum of concepts related to non-adoption and abandonment, Bhattacharjee and Hikmet (2007) refer specifically to "resistance" being the opposite of acceptance, explaining that the theories associated with resistance to change allow a dual-factor model of technology usage. In the same vein Samhan and Joshi (2015) described a spectrum of models, focussing on resistance, as opposed to acceptance, of technology solutions. Whilst some gaps in the existing research were highlighted, for example, the lack of investigation into patients as the ultimate end users of EPR systems, their study appeared to be limited by not really acknowledging that extensive research has been conducted in relation to technology acceptance, essentially the same issue (Samhan & Joshi, 2015). The conceptual model developed in this study, CICERO, follows a similar approach to Bhattacharjee and Hikmet's (2007) theoretical model, which combines elements of technology acceptance models with change management theory, providing more comprehensive coverage of the range of socio-technical factors that might affect adoption of new information systems.

The final NASSS model incorporated questions in seven areas: the condition or illness; the IT solution; the value proposition; the user community (including clinical staff, patients and carers, the organisation; the broader context (e.g. regional, national, society levels); and the interaction and reciprocated adaptation among the seven areas over time. As such, NASSS would appear to offer a very comprehensive approach incorporating all of the elements of a socio-technical perspective, although without a clear focus on clinical tasks. Like FITT, NASSS is a model developed for use specifically in a healthcare context. It includes the important element of the condition or illness that is relevant to the technology being evaluated, but arguably FITT allows for this contextualisation within each of its three domains and places more emphasis on the task component that was missing from other approaches.

As noted by Honekamp and Osterman (2011), the suitability of FITT for investigating technology adoption factors can be evaluated by highlighting its differences and similarities to other frameworks. Use of the original Technology Acceptance Model (TAM) for example, would likely have generated similar results with regards to the extent of alignment between oncologists and

EPR systems. However, the TAM does not facilitate analysis of the individual-task interface: in this case, the alignment of oncologists and their clinical work in cancer treatment centres.

Benbasat and Barki (2007) argued that there is a requirement for improved conceptualisation of system usage to incorporate a wider perspective on how end users operate. They also claimed that existing TAMs do not adequately cater for the dynamic interplay that often happens between different user behaviours related to system use at the time of a new system going live versus when it is stable, familiar, and fully embedded in operational practice. As such, they also recommended that multi-stage models should be developed with a comprehensive set of behaviours as consequences, as a replacement of the previous single, narrowly conceptualised usage behaviour. Whilst FITT does not specify the requirement for multi-stage evaluation, it does provide the flexibility for a comprehensive perspective on the individual domain, allowing the researcher to incorporate whatever particular characteristics are deemed appropriate for the study.

Another model that may have yielded similar results in all three dimensions is the Information Systems Success Model (ISSM). Had ISSM been applied in the present study, it would have potentially accounted for the broader range of socio-technical factors and those included within the IBM CUSQ, such as information quality, system use, and interface quality. However, a key feature that distinguishes FITT from ISSM - and arguably provides a further advantage - is that FITT illuminates the reasons why the same computerised information system (e.g. an EPR system) can be adopted and used in varying ways, and have contrasting effects, in different settings (Ammenwerth et al., 2006). In the case study reported by Honekamp and Osterman (2011), for example, the authors found that their prototype system fared better in a more a complicated healthcare scenario.

As the exploratory study presented in Chapter Four had already focussed on system quality issues via the CUSQ survey and other questions were used to investigate issues pertaining to actual system use, a concern with ISSM (Delone, 1992) was that it might not be able to assist in further, more detailed investigation into why the same EPR systems were being adopted to varying extents in different staff groups and hospital sites. It was therefore deemed to not be the most suitable model to adopt for the purposes of framing the main qualitative study described in Chapter Five.

The FITT theoretical position can be summarised as one which recognises the broad and subjective nature of each of the three dimensions within the framework, aligned with a socio-technical perspective. The model therefore lends itself well to qualitative research, as it assumes a position whereby the factors affecting adoption use are complex and multi-faceted and go beyond those which are isolated and deemed to be the predominant ones. In this regard FITT

has a different focus than TAM, as its aim is not to predict levels of acceptance based on user characteristics alone; rather, FITT recognises the importance of the type of technology being used and the tasks that it is intended to support.

Honekamp and Osterman (2011) demonstrated how FITT can be used to evaluate an information system in healthcare, using a case study related to headache patients. The study involved the development of a prototype clinical system, and the FITT model was used to determine the “deltas” (or disparities) between dimensions, rather than trying to predict the likelihood of adoption and acceptance by end users based on the conventional TAM factors. The study analysed three different bilateral relationships between the FITT dimensions: the task-technology fit, the individual-task fit, and the individual-technology fit.

The FITT framework (Ammenwerth et al., 2006), shown in Figure 2.11.1, is one of the most recent models developed specifically for use in a clinical environment. In this sense, the FITT framework answers the call for specifically contextualised models described in the previous section (e.g., Bath et al., 2012). It comprises three critical determinants of information systems adoption: the fit between individual, task, and technology. The “delta,” which refers to the disparity between intention and reality, can be established through the application of the framework. A small delta depicts a significant degree of acceptance of the system, whereas a large delta indicates a misalignment between two or more of the dimensions. The model is founded on the idea that ICT adoption and use in clinical environments depends upon alignment between the characteristics of system users (e.g. fear of technology, ICT literacy, interest), key features of the ICT system (e.g., access, speed, functions), and factors relating to the users’ clinical activities and working practices (e.g., structure, task intricacy). The interaction of user and task is the critical new factor in this approach, which had not been an area of focus in previous approaches to evaluating user acceptance. The user-task interaction is a novel aspect as it considers not only whether the technology solution has been optimally configured for specific tasks, but also whether end users feel optimum usability and efficiency when executing procedures on the system. Application of the framework makes it possible to explain and analyse disconnects between the three FITT dimensions in order to predict future problems or analyse existing ones.

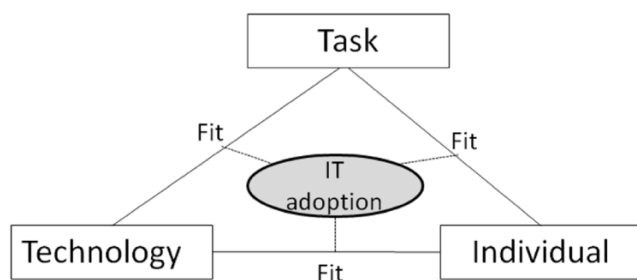


Figure 2.11.1 The FITT model

(Reproduced pending permission from Ammenwerth, 2006)

Based on the researcher's critical review of the alternative frameworks described above, FITT was identified as the most appropriate theoretical model for this study, as it aligns with the researcher's interest in exploring the relationship not only between users and technology, but also between oncologists and the specific clinical tasks that they need to perform. The incorporation of the relationship between user and task is particularly meaningful as it highlights the organisational issues involved in system deployments that are often neglected (Tsiknakis & Kouroubali, 2009).

The introduction of new ICT systems is often accompanied by organisational changes, which can lead to low user satisfaction and resistance to change. The resistance is often blamed on the usability or performance of the ICT solution, suggesting a poor fit between the system and user or between the system and task. In fact, however, resistance is mainly caused by users' reluctance to take on additional or changed tasks; hence, it actually reflects a poor alignment of user and task (Tsiknakis & Kouroubali, 2009).

Whilst studies using the FITT model are fairly limited in number, those that have applied it have found that it is a helpful model to establish and comprehend perceived barriers and facilitators to system deployment and use, and to elucidate the potential reasons for acceptance or rejection. The relevance of the FITT framework can also be evaluated through comparison with alternative frameworks. Use of the TAM, for example, would identify the deltas in fit between system users and technology, although the TAM has no ability to establish the deltas in alignment of users and the tasks they undertake. If the Information Systems Success Model was used for the study, it could be assumed that this model would generate results consistent with TAM since it focuses on the interactions among factors, such as system performance, data quality, and user satisfaction. The benefit of the FITT model is that it can help to understand and articulate why the same electronic information systems can be accepted and used in a different manner, and with differing impacts, across various contexts and environments (Honekamp & Ostermann, 2011).

The FITT framework (see Figure 2.10.1) is considered particularly suitable for this research study due to the specialised nature of both the technology and the clinical tasks that it is being developed and implemented to support. For example, oncologists routinely use established computer system technology for some clinical tasks, such as radiotherapy planning, but based on the findings of the literature review, EPR technology has been much less widely adopted or accepted for other oncology-specific tasks, such as prescribing chemotherapy.

FITT was therefore used to group themes and questions relating to the evaluation of the current EPR systems, to explore the three interrelated dimensions of the model and the fit between them, and to determine whether there may be any particular individual task that deltas should be worked on in future developments of oncology information systems, in addition to improving

the technology. In Section 2.13, a conceptual model that was used in conjunction with FITT is presented, along with an explanation of how it was developed to define the scope of the study at its outset. Later chapters then describe how it was adapted following the empirical phases of the study.

2.12 Limitations of the existing research

Several limitations were identified during the review of existing literature across the three main subject areas covered in this chapter: the background and policy context for development and implementation of EPRs; the functions, capabilities and evaluation of oncology-specific EPR systems; and the socio-technical theoretical frameworks and approaches to assist in the investigation and improved understanding of the factors that affect adoption and use of EPRs.

There were four main areas where limitations were identified. Firstly, the existing literature did not include any studies where a comprehensive evaluation of user experience had been conducted in the context of the full range of oncology-specific EPR functionality. With only two notable exceptions (Galligioni et al., 2009; Sicotte et al., 2016), almost all of the studies identified through the literature search were focussed exclusively either on systems used in a radiotherapy department, or systems used for SACT. The second limitation was that none of the oncology-EPR related studies had used an in-depth qualitative approach such as phenomenography as the primary research approach, in order to investigate issues related to the adoption and use of the systems with a focus on end users' lived experiences. The third limitation identified was that all previous studies were conducted in a single organisation setting, usually focussed on a particular sub-specialty of oncology, rather than in a comprehensive cancer centre setting.

The fourth limitation identified was that there was very little evidence of established technology acceptance models being applied in oncology-specific studies, to evaluate the factors affecting adoption and use of IT systems. As noted in Section 2.10, the only exception to this was a study to assess clinician's acceptance of a tele-oncology solution, a video-conferencing facility for online consultations (Allen et al., 1995). This type of IT solution is obviously different from the EPR system and was used for a particular purpose, distinct from recording medical record information.

Within the literature, the only example of a comprehensive study that investigated users' attitudes towards a comprehensive EPR system in oncology, covering both SACT and radiation therapy, was a case study at a cancer treatment centre in Montreal, Canada, was reported by Sicotte et al. (2016). In this longitudinal study, clinical staff working in the cancer centre were asked to complete questionnaires before and after an EPR system replacement project to

ascertain their attitudes and expectations. Next, the pre- and post-survey results were compared. Purposive sampling was then used to select end user representatives for qualitative interviews. Whilst Sicotte et al.'s study (2016) was similar to the one described in this thesis, only eight oncologists were interviewed for the qualitative aspect, and it was not conducted within the UK NHS, which, as explained earlier, has its own unique characteristics and information system requirements.

2.13 Synthesis of the literature and development of the CICERO model

To elaborate on the rationale for this study explained in Chapter One, it is now widely accepted that the implementation of information systems is a significant real-world problem that presents distinctive challenges within specific healthcare environments and clinical specialities. As previously noted, oncology is a very complex, multi-organisational, and information-dependent clinical speciality; this means it is well-positioned for the potential benefits of EPR systems (Snyder et al., 2011) but also presents a complex set of challenges for technology solutions. This potential paradox is exemplified at the case study site for this research, The Clatterbridge Cancer Centre NHS Foundation Trust, where consultant oncologists increasingly depend upon EPR systems and are required to perform a wide range of complex clinical tasks using a combination of paper-based and multiple, often disparate, electronic information systems across organisational boundaries and from remote locations. This makes The Clatterbridge Cancer Centre challenging as a case study for research, but it also provides a good opportunity to undertake research in a real-world situation and thereby deepen understanding of the diverse factors affecting EPR acceptance and use.

Although scholars recognise that there are particular technology challenges associated with system functionality and integration, a general agreement is emerging that difficulties with healthcare technology projects, as in other industries, are often caused by socio-technical and finance-related issues; in other words, these difficulties are often more user-centred than technical. For several years now, it has been acknowledged that successful system implementation involves a blend of organisational, behavioural, cognitive, and social factors (Kaplan & Harris-Salamone, 2009).

Within the socio-technical systems domain of information systems research, areas such as human factors engineering, usability, human-computer interaction, and technology acceptance and adoption have been studied extensively (Coiera, 2003). However, although the phenomena of technology acceptance and adoption have been researched within numerous healthcare environments over many years, technology adoption studies within the specific field of oncology remain very limited, as demonstrated in Section 2.10. This study aimed to help fill this gap in

research and add knowledge to the socio-technical systems research tradition by exploring the relationships between individuals (oncology clinicians), technology (complex oncology EPRs), and tasks (clinical tasks that are unique to the oncology domain, e.g., radiotherapy planning and chemotherapy prescribing), using an application of Ammenwerth et al.'s (2006) FITT model to identify the socio-technical factors that influence ICT acceptance and use in the cancer treatment setting.

The FITT framework, as explained in Section 2.11, is founded on the notion that ICT acceptance in a healthcare setting depends upon alignment of the characteristics of system users (e.g., fear of technology, ICT literacy, interest), key features of the ICT system (e.g. access, speed, functions), and factors relating to clinical activities and working practices (e.g., structure, task intricacy). The inclusion of the user-task dimension, which is not included any of the other frameworks discussed above, makes the FITT model a highly appropriate framework (Tsiknakis & Kouroubali, 2008) for analysing the adoption of EPR systems in a cancer treatment centre.

In summary, the researcher sought to contribute to an improved comprehension of clinical end users' information system needs in oncology services. Specifically, the study was designed to establish whether or not there are significant relationships among oncologists, the clinical tasks they perform, and the technology systems that they use, which may not have been identified in previous research studies. In doing so, this study aimed to contribute to the existing body of research about the acceptance and use of clinical information systems. These contributions are described in Chapter Six, sections 6.7 and 6.8.

In addition to learning about and evaluating established theoretical frameworks relevant to this field of research, in parallel with conducting the literature review, the researcher began considering whether a model could be produced to incorporate all of the key features and aspects of oncology EPRs in a relatively simple visual format. A basic model was developed in the form of a "rich picture" diagram, initially to help with scope definition and structure of the research area. The model, termed "CICERO," was intended as a preliminary model to guide this research study; in effect, the model can now be viewed as an inductive theoretical phase of the study, followed by an enhancement and finalisation phase using the final study results.

CICERO is an acronym for "comprehensive, integrated, customised, electronic records for oncology." CICERO does not describe a toolset or system solution; rather, it is a conceptual model designed to support further research in this area, from which practical guidelines for practitioners and commercial technology providers could potentially emerge. The intention is that the final published version will be recognised by researchers, oncology informaticians, clinicians, and managers as a useful reference model that encapsulates the existing body of research on the subject of oncology EPRs, integrates the research findings in a clear format, and expands the model to incorporate the findings from this PhD study. It could also potentially

take on broader interest and value as an approach to health informatics in general. In this regard, the purpose of CICERO is similar to that of other models that have been developed in response to the implementation of ICT systems and were then subjected to validation and empirical study. The initial version of the model is shown in diagram format in figure 2.12.1 below.

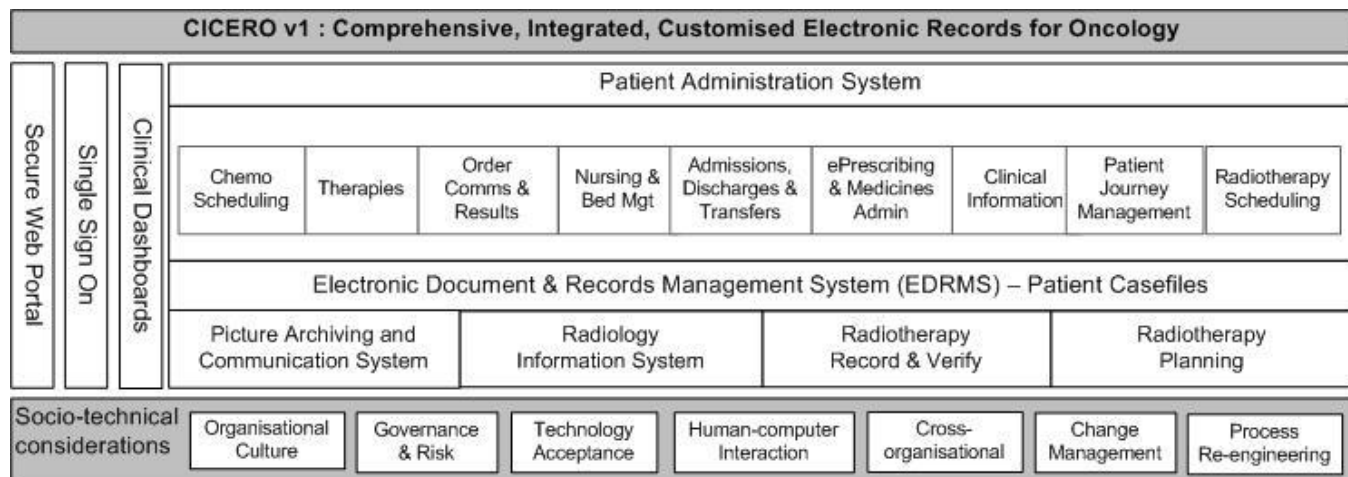


Figure 2.12.1 CICERO v1 – a conceptual model for oncology EPRs

At the time when the first literature review was conducted for this research, the functional modules specified for inclusion in the initial version of CICERO were at various stages of development and implementation at the primary study site (The Clatterbridge Cancer Centre NHS Foundation Trust, UK). These modules included:

- an integrated PAS;
- order communications and results reporting for pathology and radiology;
- electronic scheduling,
- prescribing and drug administration for complex chemotherapy regimens;
- radiotherapy action sheets,
- scheduling and pre-treatment workflow;
- messaging integration with radiotherapy treatment systems;
- integration with picture archiving and communication systems;
- an electronic document and records management system for unstructured data;
- nursing assessments and care planning forms;
- a patient journey management module;
- bed management;
- consultant and patient level dashboards, providing work lists and personalised views of the system.

As a conceptual model CICERO incorporates all of the above areas of functionality into logical “blocks,” each of which may be referred to as a component or sub-system of the overall socio-technical system for electronic patient records in oncology. Each component or sub-system has a range of further prompts and recommendations based on empirical evidence from EPR studies reported in the literatures and added to through the fieldwork presented in this thesis.

In line with recommendations made by Silsand and Ellingsen (2016), teams using the CICERO model to prompt planning and evaluation of different aspects of EPR implementation in oncology are strongly encouraged to do so in the context of the principles of openEHR and other relevant open standards-based initiatives that encourage the development of clinical informatics standards via professional collaboration groups.

As depicted in the research methodology overview diagram in Section 3.10 of the thesis, the researcher's intention was to further develop and update the model following completion of the Phase Two data analysis and again following analysis of and triangulation with the Phase Two results. The final updated versions of CICERO are presented in Chapter Six.

2.14 Conclusion

Following the background and contextual information provided in Chapter One, this chapter has described the research subject areas for this study in more detail, providing a critical evaluation of the literature about the history of information system developments in cancer services, the functions and capabilities of EPR systems in oncology and the challenges associated with implementation projects. Socio-technical theoretical frameworks and technology acceptance models were presented, and the FITT model (Ammenwerth et al., 2006), adopted for this study, was explained. In the previous section, the CICERO model was introduced as a conceptual framework for positioning the scope and guiding the research process for the study presented in this thesis.

Overall, the evidence in the literature regarding the impact of ICT on the delivery of oncology care is limited; thus, there are strong grounds for supporting future research to examine how ICT systems contribute to improved cancer care (Hains, Ward, & Pearson, 2012). Following a literature review conducted by Hains et al. (2012), particular areas of inquiry that were suggested included how, to what extent, and in what ways ICT systems have: changed clinical practices and healthcare delivery; improved processes; supported best practice; reduced errors or adverse events; and enabled better decision-making, teamwork, and communication within provider groups and between providers and patients. The literature review confirmed that gaps exist in the existing body of research, and no comprehensive study of the acceptance and use of EPR systems in oncology has been published before. Very few studies covering the full range of information systems used in oncology (i.e., covering both chemotherapy and radiotherapy functionality) were identified, and no studies have investigated the experiences of end users in the context of this full scope of EPR system functionality.

These gaps in the literature warrant more extensive, rigorous research designs to examine the implementation and usage of ICT in the delivery of cancer care. According to Hains et al. (2012), a purpose-designed, advanced framework and a model of evaluation are needed, in addition to more traditional empirical research, such as clinical trials, conducted in the healthcare domain. Based on the findings of previous studies, longitudinal data mapping changes in ICT use over time may also be an important future research requirement. This study therefore aimed to address the research gaps outlined above by investigating and analysing factors that affect EPR technology acceptance and adoption in cancer services.

Now that this chapter has summarised the literature, identified gaps in research, and proposed how this research may address those gaps, the next chapter discusses the research design and methodology adopted and developed to address the research question and objectives that were presented in Chapter One.

Chapter Three: Design and Methodology

3.1 Introduction

Having explained the background to the research (Chapter One) and provided a review of the relevant literature (Chapter Two), this chapter describes the research methodology and design that have been developed for the study. First, a brief overview of research methodology is provided in Section 3.2; next, the overall research design is described in Section 3.3. The philosophical assumptions, including the ontological and epistemological perspectives which informed the research design, are then considered (3.4), followed by a brief explanation of the three main methodologies for conducting research: qualitative, quantitative, and mixed methods (3.5). The rationale for adopting interpretive phenomenography and a mixed methods approach for this research is then elucidated (3.6). The data gathering and analysis methods adopted in this research, including a survey questionnaire and semi-structured interviews, are then explained in sections 3.7 to 3.9. The ethics issues related to undertaking the research are then presented (3.10), and in the final section of this chapter (3.11), issues relating to the quality of research are discussed.

3.2 Research methodology

According to Silverman (2006, p. 88), “methodology is concerned with the choices that researchers make about cases to study, models, methods of data gathering, forms of data analysis etc., in planning and conducting a research study.” According to Teddlie and Tashakkori (2009, p. 21), this includes consideration of the researcher’s view of the world, their overall preferred approach to design, research samples, data gathering and strategy for analyses, method of determining inferences, and criteria for quality evaluation and improvement. Holloway (1997, p. 105) defined research methodology as “the principles and philosophy on which researchers base their procedures and strategies, and to the assumptions that they hold about the nature of the research they carry out.”

By way of further explanation, research methodology is the empirical framework for undertaking the research, incorporating particular methods and instruments that the investigator has selected to enable them to answer the research questions. Establishing the research question is normally considered to be the initial step in research (Bryman, 2007, p. 5). In this research, however, the development of research questions and the selection of research methods was an iterative process, continuously evolving throughout the preliminary stages of the research project. Multiple factors informed the selection of the research subject and, therefore, the research methods to be applied.

3.3 Research paradigms

D. L. Morgan (2007) explained that paradigms have emerged as a core concept in social science research methodology. However, the term *paradigm* often takes on a different meaning in this context to that in other areas of scientific research. In order to explain the distinction between numerous meanings and applications of the term, Morgan identified four versions most commonly used within the social sciences: “paradigms as worldviews; paradigms as epistemological stances (e.g. realism and constructivism); paradigms as shared beliefs among members of a specialty area; and paradigms as model examples of research” (Morgan, D. L., 2007, p. 51).

The first and widest of these versions views paradigms as worldviews or all-inclusive ways of comprehending and experiencing the world, including values, aesthetics, and beliefs about morals. Rossman and Rollis (2003) define paradigms as shared understandings of reality, and they recognise four alternative paradigms, the two main ones being positivism and interpretivism.

Positivism is often related to quantitative research. It uses the development and testing of hypotheses to find “objective” truth. It may also be utilised as an approach for predicting future events and developments relating to given phenomena. Critical realism is a form of positivism which includes value assumptions made by the researcher. It can incorporate perspectives on power in society, for example, for which researchers mainly use quantitative data.

In comparison, advocates of qualitative methods are often interpretivists, who postulate that reality is subjective and indeterminate. In an interpretivist epistemology, knowledge is created via social interactions. Interpretivism is applied to gain a comprehension of the world from an individual perspective. Critical Humanism is a sub-category within the interpretive paradigm, a perspective where the researcher includes the people being studied in the research process.

The philosophical perspective adopted for this study is interpretive, as the aim is not only to explore the functional and technological requirements for EPR systems, but also to explore the socio-technical aspects of the whole information system within a specific clinical service context. The underlying assumption is that the reality of information system adoption and use in oncology (or any other business, clinical or social domain) can only be reliably established through social constructions such as language, consciousness, and shared meaning.

While positivism looks at reality as being static at any given point in time, an interpretivist perspective is more dynamic. Implementing an IT solution is an intervention in a social system, which will alter its state. To understanding the intervention and its antecedents, as well as its

consequences, practitioners and system designers must necessarily account for the complex and dynamic interactions and shared meanings and constructs among stakeholders working within the organisation(s).

Clinicians construct their own sphere of reality as to how EPR systems are useful to them, and they have their own expectations that may be incompatible with those of other users and stakeholders. This study uses an interpretive epistemological perspective, which views information technology as embedded in a social context, because it is usually this social situation that raises the most intriguing and challenging aspects of implementing IT solutions. One argument for adopting an interpretivist case study approach is that it may enable researchers to distil participants' experiences and facilitate the development of theories that are both grounded and relevant (Galliers, 1992).

3.4 Overview of research design

According to Mason (2002), it is very important for researchers to have a clear understanding of the essence of their enquiry. In common with Silverman (2000), Mason (2002) described the pursuit of this understanding as an "intellectual puzzle." To help with formulating and resolving this puzzle, Mason proposes five important questions that can help researchers to develop a clear focus for a study.

First, the social "reality," or ontological perspective, needs to be defined, with reference to the fundamental question, "what is the nature of the phenomena, or entities, or social 'reality,' to be investigated?" (Mason, 2002, p. 14). In this research study, the ontological properties, or elements of interest, include the social actors' (oncology clinicians') individual motivations, perceptions, attitudes, beliefs, experiences, interactions, understandings, and interpretations of EPR systems. The EPR systems used by the social actors in this study are "man-made" objects that are subjective in nature, with various ontological features such as their organisation, structure and presentation. These features are ontological in nature due to the wide variation in the way that the EPR systems are constructed, with different workflows, screens and processes to fulfil similar tasks.

Mason's second question relates to knowledge, evidence, and the researcher's epistemological position: "what represents knowledge or evidence of the social 'reality' to be investigated?" (p. 16). Epistemology refers to the researcher's theory of knowledge (Mason, 2002). In this study, the researcher's epistemological stance is that the most effective and appropriate way to generate knowledge about the phenomenon of EPR systems in cancer services is to extract

information about the subject from the experts working in the clinical speciality, who are the users of the information systems that are being investigated (i.e., the oncologists themselves). Various epistemological positions could be adopted in line with this approach, but the overarching philosophy is that the most robust and reliable way to generate knowledge about the factors influencing the adoption and use of oncology EPRs is to view the issues from oncologists' perspective. The specific approach adopted to achieve this, "phenomenography," is explained further in Section 3.7 of this chapter.

Mason's (2002) third question is concerned with defining the broad research area: "what topic, or broad substantive area, is the research concerned with?" Following on from this, in the fourth stage, the specific research questions are defined. Mason's final question concerns the aims and purpose of the research, i.e., what is it about and why is the researcher doing it? Mason emphasised the importance of formulating the research puzzle in sequence, explaining that the broad area of research can only be defined properly once the researcher has established their ontological and epistemological position. The flow diagram shown in Figure 3.4.1 below shows the high-level research design with reference to Mason's (2002) five questions, briefly summarizing how each question is applied to this research study.

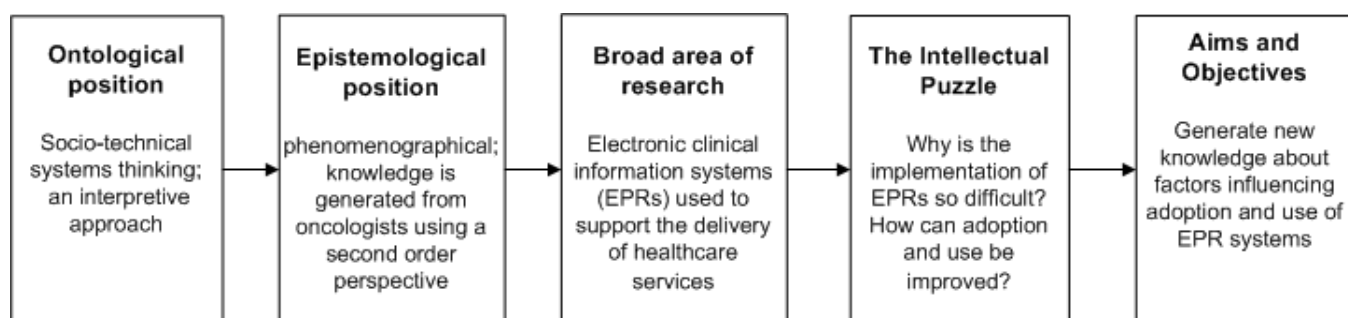


Figure 3.4.1 Basic overview of research design

The following narrative explains the relationships between the different components of this study's overall research process. These relationships are visually illustrated in Figure 3.4.2 and are outlined with reference to these components below.

1. The research objectives were originally stated in the PhD proposal but were refined during the initial phase of research and the literature review. The objectives were stated in Chapter One of the thesis, but to reiterate here with reference to the overall research process, they are to:
 - Establish the most important factors that affect the adoption and use of EPR systems by oncologists working in comprehensive cancer centres.

- Establish the different ways that oncologists think about and experience the use of EPR systems and identify their perceptions of the barriers to successful implementation.
 - Develop and refine a model for a customised, integrated, comprehensive electronic record system for oncology (“CICERO”) and to provide associated implementation guidance for use of this system in cancer services.
 - Make recommendations for how oncology EPR systems are designed and developed, based on the requirements of oncologists.
2. The working title of the thesis and the research objectives were used to devise a search strategy and conduct a literature review, which was presented in Chapter Two of the thesis.
 3. Following the initial literature review, a survey questionnaire was developed to conduct preliminary research about the current use of EPR systems at the cancer treatment centre and to gather data about oncology clinicians’ views on tasks, information systems, user satisfaction, and the perceived impact of electronic records; these issues relate directly to perceived potential benefits and the facilitators and barriers to adoption of EPR systems.
 4. In parallel with the literature review about oncology EPR systems, a review of relevant theoretical models and frameworks was conducted, and the most appropriate theoretical tool was selected. The Fit between Individuals, Technology and Tasks (FITT) model was selected due to its design for use specifically in a clinical environment (Ammenwerth et al., 2006) and its alignment with the issues identified in the literature review. In particular, the FITT model’s individual-task dimension is especially relevant to the case study site and was not adequately incorporated into other established technology acceptance models, such as the original Technology Acceptance Model, or TAM (Davis et al., 1989), and the unified theory of acceptance and use of technology, or UTAUT (Venkatesh et al., 2003).
 5. The literature review, initial survey questionnaire, and FITT framework combined to inform the development of the conceptual model for the study, CICERO, which served as a reference point and scope definition for the study.
 6. To inform the final research design, the approach to conducting in-depth interviews, and the development of an interview guide, the data gathered in step 3 above were analysed to identify prominent themes relating to the use of EPR systems at the study site that required further investigation.
 7. Semi-structured interviews were conducted using a phenomenographical approach, in which the key questions were grouped by the three dimensions of the FITT model and were designed to elucidate detailed information about oncologists, the clinical tasks they perform, and their perspectives on the EPR technology they use.
 8. Interview data were analysed using phenomenographical analysis techniques to identify the themes, categories of description, and the outcome space.

9. The data from the initial phase of research (which identified 10 themes) were re-visited, re-analysed, and compared against the results of the data analysis in step 8.
10. Once the data analysis had been triangulated, the final results were used to update the CICERO model. This involved adjusting the scope of the model and/or extending the model to incorporate key themes and findings from the “outcome space,” to reflect the overall results of this study.
11. In the final stage of the overall research design, the triangulated results were written up in a comprehensive form with an application of the FITT model to explain any findings in relation to “fit” between oncologists, the clinical tasks they perform, and their use of technology. These relationships were analysed from a phenomenographical perspective, i.e., from the “second order” perspective of the oncologists, in order to explain whether there may be different types or groups of oncologists with different worldviews of their work, the tasks they perform, and their acceptance and adoption of EPRs.

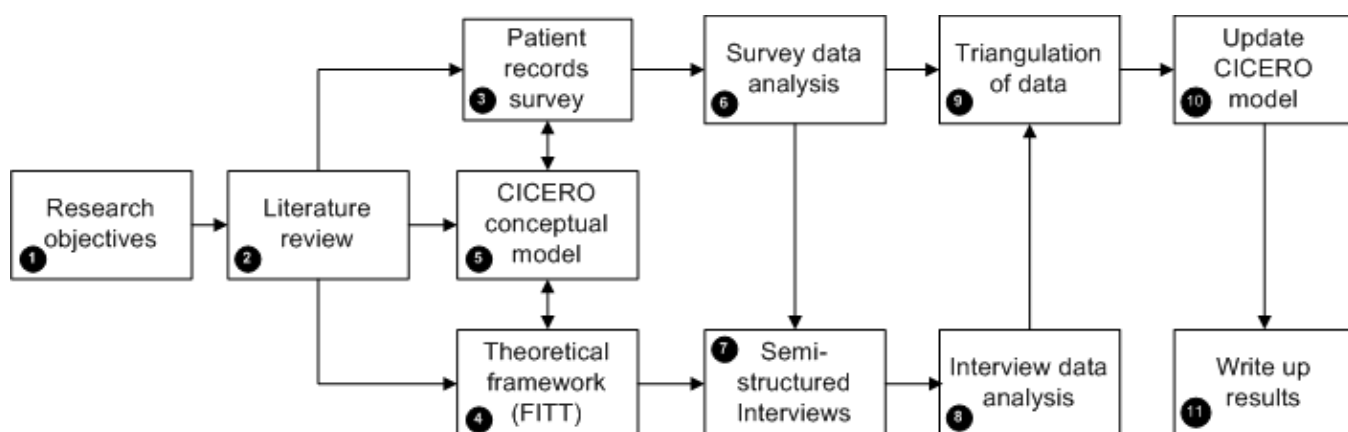


Figure 3.4.2 Stages of the research process

3.5 Ontological and epistemological assumptions of the study

To elaborate on the brief overview provided in Section 3.2, ontology refers to the assumptions that researchers make about the nature of the phenomenon under investigation, while epistemology represents generic assumptions about the optimum methods for understanding that phenomenon (Van de Ven, 2007). Ontology is "the study of being" and is about the nature of existence and therefore the structure of reality (Crotty, 1998, p. 10). Blaikie (1993, p. 6) defined ontology as "the claims or assumptions that a particular approach to social enquiry makes about the nature of social reality." The relationship between data and theory is an integral part of any scientific study. Failure to consider philosophical issues like this can seriously affect the quality of a particular research study (Easterby-Smith, 2002). Before they start thinking about which research method is most appropriate to use, researchers have to clarify whether the

phenomenon under study is assumed to be objective (and hence exists independent of human agents) or subjective (and hence exists only in and through human actions) (Guba & Lincoln, 1982).

In this study, the use of EPR systems by individuals was assumed to be a subjective experience, and this assumption influenced the research paradigm applied, as explained in the following sections. The researcher's own ontological position stemmed from a background in learning about and working in more traditionally scientific disciplines within a social sciences context (e.g. modelling/designing, developing, and implementing information technology solutions within organisations that are made up of complex social systems). For the researcher, one of the most influential and thought-provoking experiences as an undergraduate was studying *The Fifth Discipline* (Senge, 1992) and learning about systems thinking. *The Fifth Discipline* is a book that combines science, spiritual values, psychology, and management theory and explains five dimensions that make up the "art and practice of the learning organisation." One of the five dimensions is "systems thinking." Systems thinking suggests that you can only understand a system properly by contemplating the whole, not just one individual part of a pattern. Systems exist at a global, ecological, biological, physical, and social level and within industries, countries, cities, economies, etc. Systems thinking recognises that all systems are "bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other" (Senge, 1992). Senge explained that because people are part of that "lacework" themselves, it is even more difficult to visualise the entire pattern of change. Consequently, we often focus on snapshots of isolated parts of system and remain confused as to why some of our most difficult problems do not get resolved.

Although their work is focussed on biology education, Verhoeff et al (2018) explained the generally applicable theoretical and abstract inherent features of systems thinking. The authors assert that systems thinking has an important role in various areas of research, including sociological, psychological, technological and scientific disciplines. They argued that systems thinking is not just about a comprehensive understanding of complex phenomena, but that it is an approach to learning via theoretical ideas that can be used to investigate and explain natural phenomena. The authors elaborate on this point by suggesting that systems thinking is not just a skillset or knowledge base that can be learned incrementally, but rather propose that researchers should give consideration to the wider system features and attributes and the theoretical concepts they are determined from.

To further explain the some of the key concepts and features, three different areas of systems thinking can be summarised as follows. Firstly, General Systems Theory is focussed on hierarchical (e.g. nested) open systems. Its key concepts include: identity; system boundary; levels of organisation; inputs and outputs. A second type of systems thinking is Cybernetics,

focussed on self-regulating closed network. The key concepts here include feedback, self-regulation and equilibrium. The third example is Dynamical systems theory, concerned with complex self-organising systems. The core concepts in this field are self-organisation, emergence, non-linearity and equilibrium states (Verhoeff et al., 2018).

The present study is position primarily in relation to General Systems Theory as it views the socio-technical system as an open system with numerous components including the EPR systems, the system users and a wide range of other variables, processes and sub-systems that interact with system boundary that is defined, for the purposes of this study, by the scope of the CICERO model.

3.6 Research approaches

3.6.1 Qualitative approach

Qualitative research enables the exploration of a broad range of features of the social world, incorporating the “texture and weave” of human existence. Qualitative research emphasises the conceptions, experiences, and perspectives of research subjects; the ways that social mechanisms, organisations, discourses and relationships operate; and the relevance of the meanings that they create for study participants (Mason, 2002). According to Holloway (1997), qualitative inquiry focuses on how individuals interpret and understand their experiences.

Qualitative research encompasses a wide range of strategies and techniques, but there are some common features that define a given approach as qualitative. Mason (2002) proposed three key criteria for defining a qualitative approach:

- a) It is grounded in a philosophical perspective that is mainly interpretivist, meaning that it is interested in how the social world is construed, comprehended, lived, generated, or formed. While various types of qualitative research may understand or interpret these aspects differently (for example, focusing on social connotations, understandings, or experiences), all will view these aspects as meaningful components of a complicated and multifaceted social ecosystem.
- b) It uses data production methods that are both adaptable and perceptive to the social environment in which data are generated (as opposed to inflexibly consistent or regulated methods where data generation is completely abstracted from real-world settings).
- c) It utilises techniques for analyses, description, clarification, and reasoning that require comprehension of intricacy and perspective. Qualitative research aspires to generate

comprehensive and contextualised comprehension of phenomena, based on in-depth, subtle, and detailed information. In qualitative research, the focus is on comprehensive analyses, description, and clarification, rather than on recording superficial or external outlines, trends, and relationships in data. This is not to be dismissive of quantitative analysis, but to recognise its limitations for explaining complex phenomena in a social science subject area. Qualitative research frequently uses some type of quantitative methods or techniques, but statistical analyses are not viewed as essential to the overall approach.

Strauss (1998) also identified three fundamental elements of qualitative research:

- a) Data: that can be generated from various sources such as interviews, surveys, focus groups and observations.
- b) Procedures for data analysis that are used to help interpret data such as coding, non-statistical sampling, and memo writing.
- c) Written and verbal reports.

While this study used a mixed methods design, the predominantly qualitative approach to conducting this investigation was based on two philosophical foundations: first, an interpretivist epistemological stance that focussed on understanding the social reality through the participants' thoughts and perceptions; and second, an inductive approach, according to which the theory developed is the main outcome of the research. That is to say that, with *inductive reasoning*, theoretical propositions are developed from the data analyses (Mason, 2002). In the present study, this means that the investigation did not start with a hypothesis about which factors were the most important in affecting the adoption and use of EPR systems; rather, the analyses of survey data and subsequent in-depth qualitative examination of the key issues would reveal the answer to the research questions, following analyses of the data. This approach was chosen for the study due to the researcher's focus on the research questions being answered by the views and experiences of the clinical end users of EPR systems, rather than a theory being proposed based only on previous research findings or the experience-based views of the researcher.

3.6.2 Quantitative approach

A quantitative approach is concerned with the systematic process that is dependent on a positive, objective, and direct method. In quantitative studies, researchers use statistical analysis to facilitate the description, testing, examination, and measurement of causes and influences to identify relationships within data about a given phenomenon (Neumann, 2006).

Broadly speaking, a quantitative research approach is founded on testing a hypothesis against a sizeable volume of respondents; this sample should be representative of the whole population of the study, in order to explicate phenomena via statistical analyses. Bryman (2008) identified five principal methods applied in the social sciences: “social survey; experiment; official statistics; structured observation; and content analysis” (Bryman, 2008, p. 11). Others have proposed that there are four main methods used in a quantitative approach: correlational; quasi-experimental; experimental; and descriptive (Burns, 2005).

In this research, a quantitative approach was applied primarily via a patient records survey questionnaire devised for Phase 1 of the study. Section 3.8.1 explains how the survey was developed and conducted, and Section 3.9.1 describes the approach to quantitative analyses of the data.

3.6.3 Differences between qualitative and quantitative approaches

A high volume of literature has discussed different aspects of qualitative and quantitative research methodologies. In broad terms, quantitative research is empirical research in which the data are calculated or processed using pre-defined rules, in contrast with qualitative research, which considers the signification, conceptions, definitions, attributes, metaphors, symbols, and descriptions of textual and other data. Qualitative approaches suggest that experiences are challenging to measure, whereas a quantitative method treats experiences as measurable or quantifiable (Berg, 2001; Blaxter, 2010; Punch, 2005).

Leedy (2010, p. 94) commented on the distinction between quantitative and qualitative research, stating that:

In general, quantitative research is used to answer questions about relationships among measured variables with the purpose of explaining, predicting, and controlling phenomena. This approach is sometimes called the *traditional*, *experimental*, or *positivist* approach. In contrast, qualitative research is typically used to answer questions about the complex nature of phenomena, often with the purpose of describing and understanding the phenomena from the participant’s point of view. The qualitative approach is also referred to as the *interpretative*, *constructivist*, or *post-positivist* approach.

Whilst broadly in alignment with Leedy’s description, Silverman (2006) also argued that qualitative research encompasses a wide scope of various, sometimes even conflicting, undertakings. The choice between qualitative and quantitative approaches depends on the aspect to be analysed; both approaches are relevant to the study presented in this thesis. Another earlier proponent of qualitative methods, Marsh (1982), explained that the approaches

used by qualitative investigators are based on a common belief that these can provide a more in-depth comprehension of social phenomena than would be achieved with quantitative methods alone.

3.6.4 Rationale for adopting a mixed methods approach

This study also incorporated mixed methods research. The term *mixed methods* refers to the use of a combination of qualitative and quantitative techniques to explore a common phenomenon (Johnson & Onwuegbuzie, 2004). Usually, the researcher triangulates these two methods in order to verify the accuracy of the data gathered by each method, to reduce weaknesses in a study, and to answer a wider scope of research questions (Denscombe, 2014; Mason, 2002; McNeill, 2005).

From a philosophical viewpoint, a mixed methods approach is founded on pragmatism (Creswell, 2014). Onwuegbuzie and Johnson (2006, p. 54) construed pragmatism as “a search for workable solutions through the practice of research to help answer questions that we value and to provide workable improvements in our world.” Their statement follows a practical perspective, where taking this viewpoint branches from securing an answer to particular research questions to enable improvements to society. Pragmatism is thought to provide the benefit of integrating qualitative and quantitative approaches, enabling researchers to exploit the advantages of both tactics (Johnson & Onwuegbuzie, 2004).

The application of mixed methods is sometimes justified by the complexity of the research questions (Bryman, 2006). Mixed methods research may be utilised when the research questions require assimilation of both qualitative and quantitative information (Teddlie & Tashakkori, 2009, p. 129). Another benefit of mixed methods approaches, as identified by Creswell and Miller (2000), is that they aid in the validation of research outcomes.

In mixed methods research, there are two distinct designs which can be used for data gathering and analysis: either sequential or concurrent (Teddlie & Tashakkori, 2009). The sequential mixed methods process integrates methods in a consecutive manner, in which the use of one method is followed by the application of another. In contrast, the concurrent, or parallel, design applies the two methods in the same phase of research; for example, both interviews and surveys may be conducted concurrently during the same phase of research.

In this study, the researcher adopted a sequential mixed design, in which qualitative data collection (Chapter Five) was used following analyses of quantitative data (Chapter Four) obtained from a survey questionnaire. Using a between-methods triangulation (i.e. survey data results and interview data results), the findings were integrated at the end of the study (Chapter

Six) in order to update the initial conceptual model and to answer the research questions (Teddlie & Tashakkori, 2009).

3.7 Phenomenography, the approach to the qualitative study

Having assumed an interpretivist approach to the study, the epistemological stance and philosophical thinking adopted by the researcher can be explained further with reference to the overarching design of the main phase of empirical study.

3.7.1 Overview

Phenomenography is a method of qualitative research and analysis that is distinctive in its ideologies, application, processes, and results (Alsop & Tompsett, 2006). It has been described as:

the empirical study of the different ways in which people think of the world. In other words, its aim is to discover the qualitatively different ways in which people experience, conceptualise, realise and understand various aspects of phenomena in the world around them. (Marton, 1981, p. 177)

In phenomenography, the investigator explores how people experience a particular phenomenon, rather than just studying the phenomenon itself. Walker (1998) articulated phenomenography as follows:

Phenomenography is focused on the ways of experiencing different phenomena, ways of seeing them, knowing about them and having skills related to them. The aim is, however, not to find the singular essence, but the variation and the architecture of this variation by different aspects that define the phenomena. (Walker, 1998, p. 110)

Walker's definition complements Marton's original work in the development of phenomenography by highlighting an important point relevant to the present study: having knowledge of and skills related to the phenomena in question. In this research, the oncologists' knowledge of and skills related to EPRs were both important aspects that could influence their level of adoption, use, and acceptance of computerised clinical information systems.

3.7.2 Origins and history of phenomenography

Larsson and Holmstrom (2007) explained that phenomenography was conceived as a research philosophy in the 1970s by Ference Marton and colleagues at Goteborg University in Sweden. According to Richardson (1999), the first research to be described as "phenomenographical" was a series of studies conducted by Marton and his co-researchers, in which they investigated

the qualitative variations between individual pupils with regards to the process and outcomes of learning. The researchers asked participants to read an article of text within a certain time limit and then to explain to the researchers, in their own words, what they thought the text was about. Following this, the participants attended a structured interview in which they were asked about how they approached the task and their general approach to studying. To summarise the findings of the early research, Marton et al. (1981) found that learning processes and outcomes could be consistently categorised and that the categories could be logically linked in a hierarchical structure (Richardson, 1999). Following several other studies, Marton and Dahlgren (1976) established that the logical relations between the various categories of outcome could be used collectively to produce a comprehensive description, or “outcome space,” of the phenomenon under investigation (Richardson, 1999).

Further studies in the late 1970s and early 1980s led Marton to generate an appropriate description of different levels of processing used in student learning, defining two types: “surface-level processing” and “deep-level processing.” The distinction between these deep and surface approaches to learning was subsequently replicated and supported by studies in other countries. With regards to conceptions of learning, a comprehensive study conducted by Saljo (1979) resulted in five qualitatively distinct conceptions of learning: “(1) the increase of knowledge; (2) memorizing; (3) the acquisition of facts, procedures, etc.; (4) the abstraction of meaning; and (5) an interpretive process aimed at the understanding of reality” (Saljo, 1979, p. 1).

The three main findings of early phenomenographical research emerging from the education research domain can be summarised as follows: firstly, when different pupils review a piece of text, their efforts to recall the essence of the article can be defined in a hierarchical structure of different learning outcomes; secondly, pupils display qualitatively distinctive approaches to learning which depend on how they perceive the task and their conceptions of themselves as learners; and finally, different pupils demonstrate several alternative conceptions of learning which seem to represent a developmental hierarchy, partly influenced by involvement in higher education (Richardson, 1999). Whilst this thesis is not concerned with education, Richardson’s findings (1999) are relevant to explain the origins of the main approach adopted for the present study.

Although the early phenomenographical research was almost exclusively focused on education and learning, during the last two decades the approach has been developed and applied more widely, particularly within the healthcare domain. As of October 2014, a basic search on the Web of Science research database, using the term “phenomenograph*” in the title field, returned a list of 177 research papers that apply or comment on the approach. Re-running this search in December 2018 found a significant increase with 306 articles being listed, with 90 of them also

including the term “health*” in the topic field. Section 3.7.4 summarises how the approach has been used in various healthcare studies, then explains how phenomenographical concepts were applied in this study.

3.7.3 The distinction between phenomenography and phenomenology

Before explaining how phenomenography has been used in healthcare and how it was applied in this particular research study, it may be helpful to explain the difference between phenomenography and phenomenology. Several publications about phenomenographical research have attempted to explain the distinction; according to Richardson (1999), Marton deliberately set out to exploit the relationship between phenomenography and the more established phenomenological approach, which was developed by several German philosophers during the period 1913-1931. Table 3.7-1 provides an overview of the differences between phenomenography and phenomenology, with reference to various publications that have explained this distinction.

With regards to how phenomenography is positioned within the wider methodological landscape, it may be helpful to think of it as a variant of interpretivism, which is founded on naturalistic methods of data gathering, usually interviews and observations. In interpretive studies the results often emerge towards the completion of the investigation process. There are three prominent variations of interpretivism: hermeneutics; symbolic interactionism; and phenomenology (Interpretivism, n.d.). Hermeneutics is concerned with the philosophy of interpretation and comprehension, usually focussing on religious manuscripts and philosophy literature, and is therefore not a variant of interpretivism that is relevant to the present study. Symbolic interactionism is a theoretical perspective about behaviour and interaction, focussing on how people interact with others and derive meanings based on how they view those interactions. Whilst some aspects of symbolic interaction may be relevant to the present study, this variant of interpretivism is concerned with the behaviour of individuals rather than the communal behaviour of a group of people e.g. oncologists working in hospitals. The third prominent variation is phenomenology, which aims to gain an understanding of the world through investigating the direct experience of the phenomenon of interest.

Although several authors have explained the characteristics of phenomenography by comparing it with phenomenology, as stated above, a critical review of the literature published in 2016 clarified that from a methodological perspective, phenomenography can actually be viewed as a sub-category of phenomenology (Cibangu & Hepworth, 2016). In terms of its place in the wider methodological backdrop, phenomenography can therefore be positioned as variant of interpretivism and, from a hierarchical perspective, as a sub-type or variant of phenomenology. However, Svensson (1997) describes phenomenography as an empirical

research tradition rather than a system of philosophical beliefs. As such, there is not a clear and simplistic association between broad ontological and epistemological suppositions and the traits of an empirical research tradition (Svensson, 1997).

Phenomenography is more appropriate for use in this study due to the complex nature of the EPR phenomenon and the need to gain an in-depth, evidence-based, and collective understanding of this phenomenon in order to respond to the research questions. It is acknowledged that phenomenology could alternatively have been applied in this study in order to better understand the phenomena of EPR systems. However, due to the choice of a subjectivist paradigm and the desire to understand the views and experiences of a cohort of oncologists, phenomenography was felt to be a better fit because, principally, the research is to investigate clinicians' perspectives and experiences, rather than the phenomenon of the EPR system itself.

	Phenomenography	Phenomenology
1	"The researcher investigates how a group of individuals perceive or understand the phenomenon."	"The phenomenon itself is investigated."
2	"The researcher looks for the variation of people's ways of understanding or conceptualising the phenomenon."	"The essence (meaning structure) of the phenomenon under study is sought."
3	"The structure and meaning of a phenomenon as experienced can be located in both pre-reflective and conceptual thought."	"A detachment is claimed between pre-reflective experience and conceptual thought."
4	"The aim is to describe variation in understanding from a perspective that views ways of experiencing phenomena as closed, but not finite."	"The aim is to clarify experiential foundations in the form of a singular essence."
5	"The researcher emphasises collective meaning and aims to investigate the range of meanings within a sample group, as a group, not the range of meanings for each individual within the group."	"The researcher emphasises individual experience."
6	"A second-order perspective in which experience remains at the descriptive level of participants' understanding, and research is presented in a distinctive, empirical manner."	"A first-order perspective."
7	"Analysis leads to the identification of conceptions and outcome space."	"Analysis leads to the identification of meaning units."

Table 3.7-1 A comparison of phenomenography and phenomenology

(adapted from Barnard, McCosker, & Gerber, 1999; Larsson & Holstrom, 2007; Dahlberg, 2006; Akerlind, 2012)

In addition to comparing phenomenology, other qualitative research methodologies could also have been adopted for use in the overall design and methodology for the study. One such methodology is grounded theory, which is widely used in qualitative research. Glaser and Strauss (1967) originally defined this theory in their publication *The Discovery of Grounded Theory* in 1967. The authors explained that the intention of grounded theory is to produce new theory, rather than to validate existing theory. They emphasised that grounded theory is not just about the generation of theory, but it also "grounds" the theory in data that has been methodically

collected and analysed to produce an inductive theory related to a substantive topic or phenomenon (Glaser, 1992; Corbin, 2008).

Grounded theory looks at experiences and as many other data sources as possible to develop a more objective understanding of the subject of the investigation. The aim is for the researcher to develop their own model or explanation of the meaning of the study. In comparison, phenomenography is primarily interested in the "lived experiences" of the subjects of the study, meaning subjective understandings of their own experiences. The aim is to answer specific research questions about the experiences of the participants. Whilst grounded theory could have been used in this research, it is because of this focus on "lived experiences" that phenomenography was selected as the preferred approach.

In phenomenography, two associated features characterise the data collection process: single-pass data collection and the separation of data generation for data analyses. Single-pass data generation, producing all of the data for the study in advance of analyses commencing, is uncommon in qualitative analysis from which a grounded theory is generated. The methodology used in the grounded theory approach is the most obvious contrast to the single-pass model, as single-pass interprets any interaction with participants through the conceptions of the researcher, meaning that analysis is intrinsic within the data collection phase.

In most other approaches to qualitative research, data generation and analyses are undertaken as iterative processes; consequently, the researcher should develop and maintain self-awareness, recording the open-ended interactions between their individual comprehension and the phenomenon being studied. In contrast, in phenomenography, data are gathered as impartial descriptions, with no intention of undertaking successive or follow-up data collection activities (Alsop & Tompsett, 2006). To clarify, whilst some of the data analyses processes can be iterative in phenomenography, the point made here by Alsop and Tompsett (2006) is that further interviews or surveys were not conducted with the same participants to follow up, clarify, or expand on the data collected during the first interview; hence the term "single-pass."

Furthermore, alternative approaches to qualitative research (founded on other principles) share a common interest in unfolding the means by which people comprehend their experiences of a phenomenon in a shared "outer world," but phenomenography differentiates itself from all of these other approaches via at least one of the following features: the assumed objective nature of the data collection process; the format and presentation of the outcome space as a hierarchical structure; and the portrayal of the hierarchal presentation of results as a boundary to the experience of any person (Alsop & Tompsett, 2006). To clarify, whilst the overall phenomenographical approach follows a subjectivist paradigm, the data collection process is assumed to be objective in nature, in the sense that the interviewer avoids introducing their own

views and experiences as far as possible, to remain objective in the facilitation of participant responses.

3.7.4 Phenomenographical research in healthcare

As noted in sub-Section 3.7.2, although it originated in the study of education, phenomenography is increasingly being used as a qualitative approach in healthcare research. For example, studies have explored how surgical nurses understand their interactions with patients (Jangland, Larsson, & Gunningberg, 2011); how patients perceive drug information provided by rheumatology nurses (Larsson, Arvidsson, Bergman, & Arvidsson, 2010); conceptions of physiotherapy knowledge among Swedish physiotherapists (Larsson & Gard, 2006); information literacy in nursing practice (Forster, 2013); and information behaviour of people diagnosed with dementia and their carers (Harland & Bath, 2008; Harland, Bath, Wainwright, & Seymour, 2017).

In phenomenography, an important differentiation is made between two perspectives. From the first-order perspective, the aim of phenomenography is to describe different aspects of the world (in this research, oncology-focused EPR systems), as per the focus of phenomenology, and from the second-order perspective, the intention is to describe people's experiences of different aspects of the world (in this research, oncologists' experiences of using EPR systems to perform clinical tasks). This second-order perspective is the focus of phenomenographical research.

Given the professional role of the researcher, the interpretive and subjective approach to the study, and the desire to understand how oncologists think about and experience EPR systems, a phenomenographical approach was considered appropriate for this study. This approach was applied in conjunction with the FITT framework, explained earlier in the thesis (Chapter 2.12). The practical application of phenomenography in relation to analysis of the data gathered via semi-structured interviews is explained in sub-Section 3.9.2.

3.7.5 Phenomenographical research in information systems

Phenomenography has also been used to investigate information systems research. In their report about the collective consciousness of information systems (IS) research, Bruce, Pham, and Stoodley (2002) analysed information systems and technology research, its entities and areas, as they are established by IS researchers related to the various topics in the domain of information science, systems, and technology. A phenomenographical method was used to generate data from a varied group of IS researchers using semi-structured interviews. The data analyses demonstrated the deviation in meaning related to the concept of IS research and the

consciousness structures via which the respondents experience differences in ways of viewing the objects and areas of IS research. An “outcome space” was developed to explain the interrelationships among various modes of viewing the research area (Bruce et al., 2002).

Eight ways of viewing information technology IS research were identified: “The Technology Conception, The Information Conception, The Information and Technology Conception, The Communication Conception, The Ubiquitous Conception, The Sanctioned Conception, The Dialectic Conception and The Constructed Conception” (Bruce et al., 2002).

According to the authors, the first five categories reflect the perspectives of traditional IS research over recent decades, where the primary focus had been on the researcher’s interaction with technology. In the outcome space diagram, they were grouped together under the heading *historical development*. The final three categories indicate where researchers had an incrementally increasing awareness of how IS researchers relate to IT research with regards to the level of control over the research territory and the extent to which they were responsible for its construction.

Bruce et al.’s study (2002) not only demonstrates the application of phenomenography in the field of information systems research; it also provides an opportunity to reflect on and consider the positioning of the present study, from the researcher’s perspective. Because the current study was intended to be holistic in its scope of a socio-technical information system in oncology, and is focussed on the views and experiences of others, it also includes the development of a conceptual reference model for presenting the results, and it is assumed that, for the current study, the researcher would be included in the “sanctioned conception” category. This is due to the researcher’s focus on using established IS research definitions, theories, concepts, models, tools, and techniques, but also due to the intention to contribute novel ideas and developments. Whilst researchers in this category largely respond to definitions provided by others, they see the research community as a specific group and see other stakeholders outside of this community as having an important role to play in defining IT. The involvement of oncologists as participants in this research (and the member-checking process used to confirm findings with them) is an example of how this study would fall into the “sanctioned conception” category.

3.7.6 Key concepts in phenomenography and their application in this study

Table 3.7-2 provides a basic overview of the various conceptual tools used in phenomenographic research with a brief explanation of how they were applied in this study.

Conceptual Tool	Description	Application to this study
Phenomenon	A fact or situation that is observed to exist or happen (Oxford Dictionary, 2014). With regards to awareness, it is anything that people can perceive or think about. It is the abstraction of experience of situations which enables sense to be made in different contexts, e.g. the concept of “chair” in a lounge, waiting room, meeting room, etc. In phenomenography, a phenomenon is represented as an <i>outcome space</i> .	In this study, the phenomenon of interest is “the adoption and use of EPR systems in oncology.” The approach to data gathering, analysis, and description of findings is defined by the relationship between the research subjects (oncologists) and the phenomenon being investigated.
Variation	The aim of phenomenographic research is to discover and explain how members of a given group experience a given phenomenon in different ways. Any significant variation has the potential to help to describe the experience in a more comprehensive manner, i.e. to provide improved understanding of the phenomenon and its meanings.	In this study, the data gathering tools assisted with the requirement to represent variation by ensuring that data was collected from a range of individual oncology clinicians, who were asked about their personal experiences of working with EPR systems. Oncology clinicians were expected to have varied conceptions of EPR systems due to a range of factors, some of which may be explained by the theoretical framework adopted for the study.
Conception (experience)	Conception is how people comprehend, view, and understand a phenomenon. The completeness of an individual’s conception is determined by the number of aspects of it that they are aware of at the same time. This experience is the relationship between the person and the phenomenon they are experiencing. In phenomenography, conceptions are represented as <i>categories of description</i> .	In this study, the relationships between the subjects (i.e. oncology clinicians) and the phenomenon of EPR systems were carefully considered in the context of the FITT theoretical framework, which acknowledges the links between individuals, the tasks they perform, and their use of electronic information systems. The categories of description represent the different ways that oncologists think about EPR systems.
Second-order perspective	The line of thinking taken by the investigator throughout the study, to establish and explain the relationships of the subject group experiencing the phenomenon. The researcher must consciously remove personal views and experiences to observe the phenomenon from the subject’s perspective. The researcher must focus on the relationships between the subject and the phenomenon, rather than attributes of the subjects and features of the phenomenon. In essence, it is this focus on the relationships that distinguishes the deeper second-order perspective from a more superficial perspective.	In this study, the researcher deliberately assumed the role of an independent and objective researcher, detaching from their own views of the issues, as well as the participants’ views. The FITT model is particularly useful in this aspect of a phenomenographical study, as this model foregrounds the relationship between clinicians and the EPR technology.
Theme (focus)	The key feature of a category, it is the focal point of the respondents’ thoughts when experiencing the phenomenon in the way described by the category. Every category has a unique theme as its focus. To clarify, a category has a specific meaning in phenomenography as explained above; a theme is a more generic term often also used in other qualitative research methods.	As above, the key categories in this research were similar to the themes that were identified during the preliminary research phase, i.e. integration, safety, security, accessibility, training, etc. Through the phenomenographical analyses the themes were grouped and developed into categories of description.
Thematic field	The background situation of the theme that is directly relevant to the phenomenon being investigated.	The thematic fields for each of the categories included clinics, wards, radiotherapy treatment sets, other hospital sites, etc.

Table 3.7-2 Key concepts in phenomenographic research
(Adapted from Stoodley, 2012)

Conceptual Tool	Description	Application to this study
Outcome space	A universal representation of a given phenomenon, explaining its component parts (categories of description) and the relationships between them. The correlation and variances between the categories provide the structure for the phenomenographical description of the experience. The categories are rationally related and are usually ordered in a hierarchy according to complexity. The outcome space should represent all of the experiences of the phenomenon for the subject group investigated	In this research study, the scope of the phenomenon was partially pre-defined by a combination of the FITT framework and CICERO model, but the outcome space was not constrained by them and included the full range of discussions with oncologists about their experiences. Presentation of the outcome space for this research included a visual, hierarchical representation of the categories of description (described below) and also the final version of the CICERO model.
Category of description	Categories are how conceptions are represented in phenomenography. A category is one particular way that the subject group experiences a phenomenon. It is established with reference to other categories identified within the data. It is differentiated from other categories, although multiple categories can have a common margin. Each category is derived from evidence in the data. However, a category does not represent a single subject (person) and can be created from pieces of evidence in several respondents' transcripts. An individual's understanding of a phenomenon can change in accordance with the focus of their attention (thematic) and what is marginal, defined by how relevant they view issues to be in a particular context. Therefore, there is a bi-directional "one to many" relationship between participants and categories of description.	In this study, the categories of description included different ways in which the participants viewed EPRs: <ul style="list-style-type: none"> • EPRs as a basic activity log and legal record • EPRs as a communication aide • EPRs as a clinical decision support system
Margin	Margins are not the focal point of awareness in a particular category, but are loosely associated with, or peripheral to, the central theme of a category. Common margins can affect multiple categories.	In this study, margins included organisational issues that affect the way the oncologists think about EPRs, as well as general trends in society and the use of information technology, and organisational strategies. A common margin was oncology as a clinical specialty and this context for EPR.
Awareness	This is determined by the ever-changing nature of experience, in which theme, thematic field, and margin are continually changing, causing both participants and the researcher to re-constitute experiences.	The changing nature of awareness among the subjects in this study is important, as the case study site, the wider healthcare system (NHS) and society as a whole are undergoing changes which may be viewed as margins for some participants, and themes or thematic fields for others. For example, some may view oncology service developments as a margin, whereas others may see this as a theme.

Table 3.7-2 Key concepts in phenomenographic research (continued)

(Adapted from Stoodley, 2012)

3.7.7 Rationale for adopting phenomenography in this study

Following the exploratory quantitative research phase, the researcher came to adopt phenomenography for the qualitative, second and main phase of the overall study. The rationale for employing phenomenography in this research was founded on four key premises. Firstly, the researcher was particularly intrigued about how oncology clinicians viewed the EPR systems, in contrast to whether they comprehended or shared the researcher's perspective. Several approaches could have been selected, but phenomenography appeared to be well-matched for the study and appropriate due to the time constraints for data collection during phase 2 of the study. An additional benefit was phenomenography's potential to produce outputs more rapidly compared to alternative approaches to qualitative analysis (Alsop & Tompsett, 2006).

Secondly, due to the researcher's role in the organisation at the study site, an approach which emphasised and ensured maximum objectivity was particularly important. One of the distinct features of phenomenography, i.e., the single-pass procedures involving separation of collection and analyses, aided in this effort to ensure objectivity. Thirdly, one of the main advantages of phenomenography lies in its sensitivity to varied, contextual experiences. Experience of the EPR systems phenomenon varies depending on the individual clinician and the role he or she is performing. At the same time, the notion of limited variation, the key aspect that differentiates phenomenography from other approaches, enabled the researcher to develop a structured representation of the experience of the group of oncology clinicians. Phenomenography is a useful approach to any study that is interested in how professionals experience a phenomenon in its varying contexts and subjective meanings and roles, with the aim of developing a comprehensive picture of those experiences and exploring the relationships between them (Bruce, 2002).

3.8 Case study site: The Clatterbridge Cancer Centre NHS Trust

As described in Chapter One (Section 1.4), the case study selected for this research is The Clatterbridge Cancer Centre NHS Foundation Trust (CCC), a regional cancer treatment centre located in the Merseyside and Cheshire region of North West England, UK.

Clinical services at CCC are organised within a directorate structure. The Directorates are Radiotherapy, Chemotherapy, Diagnostic Imaging, and Patient Services. The centre employs just under 1,000 staff, including approximately 50 Consultant medical staff, predominantly Consultant Oncologists but also a small number of Consultant Radiologists and posts in Palliative Care and Liaison Psychiatry (CCC, 2015).

Radiotherapy is delivered from the CCC main site on the Wirral, Merseyside, and a satellite centre at the Aintree University Hospitals site in Liverpool, which opened in February 2011. Radiotherapy treatment is predominantly administered by means of external sources of ionizing radiation delivered by linear accelerator machines. In addition, the Trust provides the only Proton Therapy treatment facility in the UK, which is used for ocular treatments. A range of brachytherapy (i.e., contact radiotherapy) is also provided by the Trust. The vast majority (over four fifths) of radiotherapy is delivered as an outpatient treatment.

As explained in Chapter One, chemotherapy (the term used to represent systemic anti-cancer therapy) is the treatment of cancer using chemicals, and it is predominantly delivered as an outpatient treatment via a network of clinics across Merseyside and Cheshire, from seven different peripheral clinical locations at district general hospitals. Chemotherapy is delivered (and measured) in “cycles” and attendances. All inpatient chemotherapy, complex day case therapy, and additional chemotherapy services for Wirral and West Cheshire patients are provided at the CCC main site.

The Diagnostic Imaging directorate provides imaging services to patients who are referred to CCC for treatment. The imaging modalities available include: plain film x-ray, Computerised Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine³, and Positron Emission Tomography (PET). Diagnostic imaging services are provided to a number of other organisations, including a direct access service provided for CT/MRI for Primary Care and the nuclear medicine service provided to the Wirral University Teaching Hospital. Almost 20,000 diagnostic examinations are undertaken each year.

Patient Services are responsible for providing nursing and rehabilitation services; there are three inpatient wards, a day case unit for chemotherapy treatments, an outpatient department, and a theatre for delivery of brachytherapy. This division is also responsible for the Cancer Rehabilitation and Support Team (CReST), a large multidisciplinary team made up of allied healthcare professionals, specialist nurses, and non-clinical support staff. CReST also includes the Specialist Palliative Care Team, which comprises a Consultant in Specialist Palliative Care, a Macmillan Clinical Nurse Specialist and Clinical Nurse Specialist in Palliative Care. The CReST Team provides rehabilitation, physical, psychological, social, and spiritual care services and also provides expertise in a wide range of cancer information and advice within the Centre.

³ A branch of medical imaging that uses small amounts of radioactive material to diagnose and determine the severity of or treat a variety of diseases, including many types of cancers.

3.9 Data collection methods

Following the data collected and analysed via the literature search, the phases of empirical research employed two main data collection methods: a survey questionnaire and semi-structured interviews. These are frequently used methods in sociological research as they are known to be effective in gathering information about how people view and experience different phenomena.

3.9.1 Phase 1: Quantitative study

Data collection is a critically important activity in all research studies. If data are not accurate, reliable, and managed appropriately, they will negatively affect the outcomes of a piece of research and ultimately produce invalid results. Quantitative data collection techniques utilise random sampling and structured data-gathering instruments, such as survey questionnaires that are used to collate a wide range of information into pre-specified response groups. They generate outcomes results that are straightforward and enable researchers to make comparisons, draw conclusions, and generalise to the wider population. Qualitative data can be gathered via a wide range of alternative methods, including interviews, participant observation, and audio or visual media (Creswell, 2014). The aim is to generate findings that are transferable, rather than generalisable.

The data collection instruments employed in the first phase of this study were questionnaires and interviews. A detailed description of how the data collection instrument was developed for the first phase of the study is summarised below. In the second phase of the study, semi-structured interviews were used as the data collection method.

3.9.1.1 Survey questionnaire

A questionnaire is a type of instrument that is used to collect data (Castle, Brown, Hepner, & Hays, 2005). Questionnaires have many different formats and types of questions, e.g. closed questioning (fixed choice answers) and open questioning (free text answers). They can also be used to collect quantitative data in many ways.

3.9.2 Phase 2: Qualitative study

For the second phase of the mixed methods study, data were obtained via a series of interviews with oncologists. Interviews are one of the main methods used to obtain data for qualitative studies, as they allow the opportunity to engage in meaningful discussions with participants, to

hear how they have lived experience of the phenomena being investigated. The following subsection provides an overview of how interviews are used in qualitative research studies, such as the one presented in this thesis.

3.9.2.1 Semi-structured interviews

Kvale (2009) referred to research interviews as “professional conversations,” in which the interaction between the respondent and the researcher is the foundation for constructing knowledge. The reason for undertaking interviews is to gain insights and understanding of participants’ perspectives, experiences, and conceptions and to establish the reasoning behind them (Patton, 2002). The interviewer’s aim is to “gather participants’ stories” (Patton, 2002, p. 341) in order to appreciate and comprehend their worldviews. Interviews can be undertaken in person with a single individual, or with a group of participants as a focus group. Interviews can also be conducted by telephone, video-conferencing, or using other electronic methods, such as email or interactive websites (Kumar, 2014).

There are three main formats for research interviews: structured, semi-structured, and unstructured. A structured interview has a schedule and pre-defined list of questions which are used consistently throughout the study to ensure that all respondents answer exactly the same questions. Semi-structured interviews also have a pre-defined list of questions, but they allow the interviewer to vary the order in which questions are asked, opening up more flexibility for the researcher to interact with the respondent and ask follow-up questions, if appropriate, depending on interviewee’s responses (Bryman, 2008, p. 96). The unstructured interview, in contrast, allows much more flexibility with regards to content and format (Kumar, 2014, p. 23), and more fluid interplay between the researcher and the interviewee. With only a list of subjects to investigate in the interview, the interviewer’s aim is to stimulate the respondent to continue explaining their “story” with minimal interference.

Yates, Partridge, and Bruce (2012) referred to phenomenographical interviews as a specialised type of qualitative interview and listed a number of features shared with other types of qualitative interviews. Unlike other types of interviews, phenomenographic interviews investigate the variation in the way that different individuals and groups of interviewees experience or perceive the phenomenon of interest (Yates et al., 2012). Consequently, the focus of the interview is on the relationship between the interviewees and the phenomenon of interest, rather than the phenomenon itself (Bruce, 1997).

In phenomenography, interviews are semi-structured in nature and involve exploring the participant’s thoughts about the phenomenon in question at increasingly greater depths, but without being led by the interviewer (Prosser, Trigwell, Hazel, & Waterhouse, 2000). According

to Prosser et al. (2000), when participants are describing their experiences, they should be afforded time to reflect. In addition, the questions asked of them should not be influenced by presumptions about the respondents or the phenomenon being investigated but should instead emerge as the interviewee explains their experiences in more detail.

The investigator's interviewing skills should be continually evaluated during the study and adjusted when needed. For example, oratorical traits or body language that may prevent or limit a respondent from providing a full description should be identified and then avoided in future interviews (Prosser et al., 2000).

3.10 Data analysis

The following sub-sections provide an overview of the approach to conducting different types of data analyses, a critical stage in the research process. As a mixed methods approach was adopted, it was important to plan the data analyses activities for both quantitative and qualitative data types, bearing in mind the need for triangulation.

3.10.1 Phase 1: Quantitative data analysis

To conduct statistical analyses, it is necessary to consider the analyses prior to data collection and either learn the underlying formula for each technique and apply this to the study's data or use a computer software package to perform it. To analyse the data collected during the first phase of research, a computer software package, International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS), was selected. SPSS is the most widely used software package for undertaking this type of quantitative data analysis (Bryman, 2011).

Before data analysis could be performed, the data were imported from a comma-separated file format (.csv), which was generated from the web-based survey questionnaire variables, into SPSS. The data then had to be named, labelled, and recoded appropriately within SPSS to ensure the data were prepared for accurate analyses. A range of different statistical tests were performed including frequency analysis, descriptive statistics, regression and correlation tests. The analyses and results are presented in Chapter Four.

3.10.2 Phase 2: Qualitative data analysis

There is a wide range of approaches to data analysis in qualitative research, and the role and activities of the researcher are defined quite differently across the spectrum (Green & Thorogood, 2013). A common approach to analysing qualitative research is to identify themes in the data (Boyatzis, 1998; Bryman, 2008). Thematic analysis has been defined as “a method for identifying, analysing, and reporting patterns (themes) within data” (Braun & Clarke, 2006, p. 79). The identification of themes comprises the creation of “core meaning” within the data (Patton, 2002, p. 453). Thematic analysis is thought to be a straightforward and flexible procedure for data analysis (Braun & Clarke, 2006) that may be used within different theoretical frameworks (Braun & Clarke, 2006), and in all stages of research (Boyatzis, 1998), to give improved acuity of data content (Braun & Clarke, 2006, p. 78).

Other approaches frequently used in qualitative analysis include grounded theory (as explained in Section 3.7.3) and framework analysis. Where grounded theory is concerned with the generation of theory, framework analysis, devised by the National Centre for Social Research, is specifically aimed at producing policy and practice-based outcomes (Ritchie & Spencer, 1994; Green & Thorogood, 2013).

In this research, however, as explained in Section 3.7.6, phenomenography was adopted as the overarching approach. As part of the data analysis process in phenomenographic research, the researcher established qualitatively distinct categories, which described the manner in which distinct individuals or groups experienced particular concepts. There can be a restricted amount of classifications for each concept in the research. These categories can be identified in interview transcripts (Marton & Booth, 1997). Sjöström and Dahlgren’s study (2002) explained that the analysis should be undertaken in stages. These stages are explained in Table 3.10-1 below.

Forster (2019) explained that the thematic approach to data analyses divides outcomes into small experiential stories, or aspects of variation, drawn from multiple transcripts, grouping them together within themes of increasing awareness (Åkerlind, 2005). The themes are the various meanings of how the particular phenomenon is experienced from the groups’ perspective; in the present study, the lived experience of using EPR systems. Other related aspects are positioned with their relevant theme in levels of complexity, or awareness of the sophistication of lived experience of the phenomenon. In thematic phenomenography, the categories of description are the combination of the narratives from each theme at the same level of sophistication (Forster, 2019).

Stage	Summary	Description / procedure
1.	Familiarisation	The researcher read the whole text to become familiar with the material by means of reading through the transcripts. This step was important for making corrections to the transcripts. In this study, this step involved reading through 36 interview transcripts.
2.	Compilation of answers	Compilation of answers from participants to a certain question. The researcher identified the most significant elements in answers given by participants and grouped "similar" transcripts together based on general themes or contexts of described experiences of the EPR phenomenon.
3.	Condensation, or reduction, of the individual answers	Condensation, or reduction, of the individual answers to find the central parts of a dialogue. In these passages, the researcher looked for the focus of the oncologist's attention and considered how the oncologist described her/his way of working. A preliminary description of each oncologist's predominant way of understanding EPR systems was determined by looking for dimensions of variation within the groups.
4.	Preliminary grouping or classification of similar answers	Descriptions were grouped into categories based on similarities and differences, and categories of description were formulated. These are contexts, such as "interoperability" or "information access," in which EPR systems are experienced, that featured throughout the complete collection of transcripts. The groups from Stage 2 above were used as a foundation for these. Each theme connected a set of alternative dimensions of variation that appeared to be present within that grouping.
5.	Preliminary comparison of categories	The researcher looked for non-dominant ways of understanding the categories and arranged them into groups where the key issues and emerging themes seemed to be linked.
6.	Naming of categories	Find a structure in the outcome space.
7.	Assign a metaphor to each category of description	Contrastive comparison of categories. This includes a description of the character of each category and similarities between categories. Each category is an archetype and does not describe an individual oncologist or oncologists but can rather be articulated as a "persona."

Table 3.10-1 The stages of phenomenographic data analysis

(adapted from Ornek, 2008; Larsson & Holmstrom, 2007; Forster, 2013)

In another approach to phenomenographical data analysis explained by Ornek (2008), the investigator assesses the transcripts from respondent interviews, with the aim of identifying both similarities and distinctions between them. Throughout this procedure, the investigator creates initial classifications to group different participants' experiences of the phenomena being studied. Once all of the different aspects of the phenomenon have been established, the investigator specifies categories to help explain any types of variation in the data. Next, with reference to the first set of categories, the investigator re-examines the transcripts to establish whether the original categories are descriptive enough and whether they relate clearly to the full set of information. This follow-up review of the data amends category descriptions, and the following assessment of the data is then re-examined for intramural consistency of the categories of description. This iterative procedure of re-examination and amendment goes on until the amended categories appear to be fully compatible with the interview transcripts (Ornek, 2008).

3.10.2.1 NVivo

A range of computer-assisted qualitative data analysis software applications are available to researchers working in the social sciences, abbreviated as CAQDAS by Leech and Onwuegbuzie (2011). Nvivo, developed by QSR International Pty Ltd., is a software application for managing qualitative research projects. For this research, Nvivo 10 for Mac was used to create a project and design a filing structure to store the audio files, transcripts, and interview notes produced during the main phase of empirical research. Nvivo was then used to create nodes for the collection of all references related to themes identified during the phenomenographical analysis and coding of the interview transcripts.

Within the context of the phenomenographical approach to the data analyses, Nvivo can be used to perform a range of different qualitative data analyses. Leech and Onwuegbuzie (2011) explained the procedures for conducting seven types: “constant comparison analysis, classical content analysis, keyword-in-context, word count, domain analysis, taxonomic analysis, and componential analysis” (Leech & Onwuegbuzie, 2011, p. 70). Section 5.5 in Chapter Five explains the results of the various qualitative analyses conducted using Nvivo 10.

3.11 Ethical issues

Research ethics is concerned with investigations being conducted in conformance to moral principles and values of appropriate behaviour with regards to others, according to high scientific principles, and in a manner that safeguards participants’ health and wellbeing (Bryman, 2008). Due to the involvement of human participants, ethical issues are deemed to be critical in social science research. As noted by Berg (2007), social science researchers have an ethical duty to other researchers, their study population, and society as a whole, as their research often delves into the lives of other people. Various publications have proposed common criteria for research to be classed as “ethical” (Bryman, 2008). Patton (2002) provided a checklist of the ethical considerations that researchers should deal with before initiating a study that includes participation of people. These are categorised as follows: “explaining purpose, promises and reciprocity, risk assessment, and confidentiality” (Patton, 2002, p. 408).

In addition to following the good practice guidance relating to ethics for the overall PhD project, in this research the different phases of the study required separate consideration of ethical issues. The first phase of this study was developed using data obtained from a survey questionnaire which was originally conducted as part of the coursework for a module (Quantitative Research Methods) of the MSc Health and Social Care Research distance learning programme, delivered by the School of Health and Related Research (SchARR) at the University of Sheffield. Further details of the ethics application process are provided in Chapter Four.

For the second phase of this study, the semi-structured interviews with oncology clinicians, the NHS Health Research Authority (HRA) guidance on ethics approval was reviewed, and the HRA decision tool was used to determine whether NHS ethics approval was required. Because the study did not include any patient data and was not concerned with clinical trials, the outcome of the decision tool was that NHS approval for the research was not required. An application for ethics approval was submitted to the University, and approval was awarded in January 2015 (documentation is provided in Appendix C). Further details of the ethics application process are provided in Chapter Five.

3.12 Research quality

The criteria for assessing the quality of research can change within various research paradigms and across alternative research methodologies. In an extensive study concerned with defining quality in social policy research, Becker and Bryman (2004) defined the traditional criteria for research quality in relation to validity, reliability, replicability, and generalisability. Validity (or truthfulness) is the degree of correlation between information and the concept it relates to; reliability, sometimes referred to as consistency, is the degree to which observations are made consistently when a research instrument is used more than once; replicability is the degree to which an investigation can be accurately recreated; and generalisability is the extent to which findings can be applied to comparable cases which have not been examined before (Becker & Bryman, 2004).

Whereas quantitative research seeks to generalise the findings to the wider population, qualitative research seeks to achieve “transferability,” which specifies the extent to which research outcomes can be applied to other cases or contexts. Arguably, the unique attributes of any context or case and the essence of changes occurring within it may prohibit direct transferability; nevertheless, it is feasible for hypotheses to evolve that could be transferred to other contexts with common features. In this research study, transferability was concerned with whether the results of the first two phases of research were transferable to other cancer treatment services within the UK National Health Service.

During the next phase of research, a detailed plan to test and confirm the validity, replicability, and reliability of the data collection instruments and methods of analysis was developed. Following Phase Two data collection and analysis, data triangulation was conducted to validate the research findings, helping to achieve deeper insights and surmounting some of the limitations of each individual method. The purpose of using triangulation is to establish consistency among the data, that is, to establish credibility (Guba & Lincoln, 1982). A number of researchers have proposed definitions of triangulation in mixed methods research. Teddlie

and Tashakkori (2009), for example, proposed that triangulation can be accomplished via the integration of alternative methods in the accumulation and analysis of data during the whole of the research process.

It is acknowledged that there are some subjective factors relating to the researcher's role in the study (due to the researcher working as a senior manager within the primary study site), but every effort was made to represent the details of the study accurately as reported by the participants. Research findings were checked and discussed with the research supervisor on an ongoing basis; these discussions were helpful in stimulating further analysis of the Phase 1 data and providing alternative perspectives on the research.

3.12.1 Reliability

Green and Thorogood (2013, p. 193) explained that reliability is concerned with "repeatability" of interpretation. In qualitative research, repeatability is usually defined as the likelihood that a similar study would generate similar results from thematic analyses. It should be noted, though, that whilst this type of reliability is important, it is not expected that different researchers would necessarily identify exactly the same codes in the data, as this may be affected by their individual interests, epistemological perspectives, and assumptions (Green & Thorogood, 2013). To ensure reliability in this study, a summary of the initial analyses was firstly shared with participants via member-checking, allowing the opportunity for any significant discrepancies or misunderstandings to be highlighted. Following this, throughout the data analyses the emerging themes and categories of description were discussed with the research supervisor and fellow PhD students, to sense check application of codes, the suitability of labels and the grouping of related concepts into categories. As noted by Green and Thorogood (2013), this does not mean that other researchers or other methods would not have generated slightly different results, but it served to minimise the likelihood of unreliable findings by sense-checking the analyses on an iterative basis.

3.12.2 Validity

Validity is generally thought of as the extent to which a research investigation is focused on what it intended to investigate, or the degree to which the study outcomes accurately represent the phenomenon being investigated. Although the notions of validity and reliability stem from a positivist approach to research, qualitative investigators are still expected to demonstrate compliance within the context of the ontological and epistemological perspectives of the study (Akerlind, 2012).

Phenomenography has many similarities with other qualitative research approaches and therefore utilises their processes for demonstrating validity, but also has variations that require its own set of procedures. Kvale (2009) refers to two main forms of validity check undertaken in phenomenography: *communicative validity* and *pragmatic validity*. Communicative validity is concerned with ensuring that the research methodology and interpretation of the data analyses are considered to be appropriate by the relevant research community (Akerlind, 2012). However, while research symposiums and peer-reviewed publications can be used to help establish the validity of the overall research design, it can also be useful to include the research participants, other representatives of the research subjects, and the intended audience for the research outcomes (Kvale, 2009). In this research, in addition to peer-reviewed publication of initial results (as noted in the previous section), member-checking was used to check that the researcher's interpretation of the results was relevant to the oncology research community, of which many of the participants are active representatives.

Pragmatic validity checks are concerned with the usefulness and meaningfulness of the research findings. In performing this type of validity check, the extent to which the research provides useful knowledge is assessed; in this context, knowledge is described as the ability to undertake effective actions (Kvale, 2009).

3.12.3 Generalisability and Transferability

Research outcomes are only transferable or generalisable if they can apply to new contexts beyond the context of the study in question. Transferability is equivalent to external validity (that is, the degree to which findings can be generalised). *Generalisability*, which is different from transferability, refers more specifically to the extent to which an account of a particular context, scenario, or population can be applied to other studies with different respondents, times, or settings than those directly studied (Maxwell, 2013).

Transferability is regarded as a problematic issue in qualitative research due to the subjective nature of the researcher acting as the main instrument and the risk of invalid inferences being made from data (Marshall & Rossman, 2011). Nonetheless, a qualitative investigator can augment transferability by specifying the research methods, contexts, and assumptions that underpin the research. Becker and Bryman (2004) stated that transferability is attained by producing detailed, rich accounts of the culture in the setting being studied to provide others with *thick descriptions*, enabling judgments to be made about potential transferability to other milieus (p. 275).

As this research was conducted at a single case study site, the process of generalisation that appositely aligns with it is “inferential generalisation,” which refers to generalisation from the context of the research study itself to other similar settings or scenarios (Ritchie, 2014). Consequently, it is necessary to provide comprehensive documentation and justification of the methodological approach, describing in detail the specific processes and procedures that informed the construction, shape, and meanings associated with the EPR phenomena. Moreover, during the course of this study, the researcher was sensitive to potential biases in the study by maintaining consciousness of the potential for numerous interpretations of reality. In qualitative research, generalisability is occasionally overlooked due to the focus on improving the local understanding of a particular scenario (e.g. the use of EPR systems at Clatterbridge Cancer Centre). However, in Chapter Four, a rich, detailed, and *thick description* of the study site is provided to allow readers to appraise the significance of the meanings applied to the findings and make their own judgments regarding the transferability of the research findings.

The thesis provided a comprehensive description of the organisational context of The Clatterbridge Cancer Centre in the Introduction (Section 1.4) and Methodology (Section 3.8) chapters to aid readers who are interested in making use of the study outcomes in different settings. Therefore, the question of generalisability has to be answered by the reader of the thesis based on how similar the author’s and the reader’s contexts are. Thinking about which findings are context-specific and which could be more broadly applicable, readers should ask: are these research outcomes applicable to my treatment clinic, to my cancer hospital, to my information system, or to my clinical speciality? (Green & Thorogood, 2013). It is an issue of judgement about the particular setting and the phenomena being studied that enables others to evaluate the transferability of the research outcomes to other contexts (Ritchie, 2014).

3.13 Conclusion

This chapter of the thesis has explained the research methodology and design that were applied in the study. The pragmatic, interpretive phenomenographic approach has been explained, along with the main approaches to research and the reasoning for utilising a mixed methods approach. A brief overview of the data collection and analysis methods chosen for this research was given, explaining that the study used a survey questionnaire and semi-structured interviews to achieve its objectives by providing opportunities for the provision of detailed information from clinical stakeholders. Quantitative and qualitative approaches to analysis were explained with reference to researchers including Krueger (2009) and Teddlie and Tashakkori (2009), who recognised the importance and benefits of combining quantitative and qualitative procedures in strengthening the research design. The ethical, quality, validity, and reliability issues associated with the study were also summarised.

The following chapter (Chapter Four) describes the first exploratory phase of the study, presents the results of this phase, and explains how these results informed the development of the second and main phase of qualitative research.

Chapter Four: Exploratory Research (Quantitative Study)

4.1 Introduction

The literature review (Chapter Two) highlighted several factors that could affect users' attitudes towards, and the actual use of, electronic patient record systems in cancer services. The main factors identified in the original technology acceptance model (Davis, 1989) were those that could influence the perceived usefulness (PU) and perceived ease-of-use (PEOU) of an information system. Subsequent work on developing and expanding the model has incorporated additional external variables with the intention of investigating their impact on end users' attitudes, behaviours, and actual use of information systems.

As reported in Chapter Two, various studies have highlighted user and task characteristics and environmental factors as having an influence on PU and PEOU. In order to explore these factors and to identify others that may affect healthcare workers' attitudes towards electronic patient record systems in cancer services, an exploratory quantitative study was undertaken.

In this chapter, the research questions and approach to developing a survey questionnaire are explained in sections 4.2 and 4.3. Section 4.4 describes a pilot exercise and how the results were used to finalise the questionnaire. The design, development, sampling, and other information relating to undertaking the survey study are discussed in sections 4.5 and 4.6. The coding method, data analyses, and the validity and reliability of the data collection instrument are described in sections 4.7 to 4.9. The key findings from analyses of the survey questionnaire are reported in Section 4.10 and discussed further in Section 4.11. The limitations of the survey are discussed in Section 4.12, and the conclusion of this chapter is provided in Section 4.13.

4.2 Research questions

Whilst the literature review identified a number of factors, such as perceived usefulness, that might influence clinicians' attitudes towards using EPR systems in oncology, an exploratory study was required to establish the extent to which they were present within, and relevant to, a cancer services setting. The key research questions were specified to establish the associations among various factors that were reported in previous studies included the literature review, to identify the most significant factors that could influence oncology clinicians' attitudes, and to identify the alignment or "fit" between individuals, technology and tasks. The main questions were:

1. What are the key issues relating to oncology workers, EPR systems, and clinical tasks?
What are the relationships between oncology workers, EPR systems and clinical tasks

and what is their impact on users' attitudes towards using clinical information systems in cancer services?

2. What are the most significant factors that influence oncology EPR users' attitudes towards using computerised information systems in cancer services?
3. What is the relationship between users' characteristics and their perspectives on ease of use and usefulness of EPR systems in cancer services, as well as their perspectives on the impact of moving to fully electronic records?

Having determined the key research questions for first phase of the mixed methods study, the following section provides an overview of the methods that were used to design and conduct the exploratory survey questionnaire.

4.3 Methods

Following on from the detail of the overall mixed methods approach and study methodology described in Chapter Three, this section provides details of the specific methods used in the initial, exploratory phase of the research, including the design and development of the survey questionnaire and techniques used for data analyses.

4.3.1 Questionnaire design and development

In this exploratory study, all employees at the primary research site were invited, via email, to complete an online patient records survey questionnaire (May 2011). The questionnaire requested qualitative data about respondents' use of paper medical notes, use of current EPR systems at the centre, and perceptions of the impact of moving to fully electronic patient records. Questions related to the use of EPRs were derived from previous studies using task-oriented EPR questionnaires (e.g. Lærum, Ellingsen, & Faxvaag, 2001), and system usability questions were based on an established IBM Computer Usability Satisfaction Questionnaire (CUSQ) (Lewis, 1995).

Lewis (1995) explained that the majority of usability assessors will assemble both subjective and objective data. Examples of objective usability measures are use case (i.e. a procedure usually specifying the interactions between an end user and an IT system to accomplish a particular task) completion time, use case completion rate, and the amount of time expended dealing with system errors (Happ, 1994). Subjective usability metrics are often responses to Likert-scale questions that evaluate user attitudes in relation to issues such as system ease-of-use and interface friendliness (Alty, 1992). Whether subjective or objective measures are most

appropriate depends the aim of the assessment or research. If the aim of evaluating a computerised information system is to use the results to improve productivity, then objective measures are the main focus. However, if the aim is to gain an understanding of the level of user satisfaction with a system, as was the case with this exploratory patient records survey, then subjective measures are more important.

Table 4.3-1 provides an overview of the different sections of the survey questionnaire and the questions within each section, explaining the question/data types and the rationale for each question.

System usability and user satisfaction are related to the technology acceptance and information systems adoption issues referred to in the research objectives. A number of instruments have been developed to measure user perceptions related to system usability. Some of these instruments have been assessed for reliability and validity, including the IBM CUSQ (Lewis, 1995). While the CUSQ may be somewhat dated, it is still frequently used and cited as a classic usability instrument. In a study measuring the validity and reliability of usability instruments, the CUSQ was reported to have both content and construct validity, and it scored highest for reliability ($r = 0.91-0.96$) out of eight established instruments that were evaluated (Columbia University, 2014).

The CUSQ was selected for use in a sub-section of the patient records survey in the preliminary research phase of this study, and it was used for three of the 20 questions in the survey overall. There were three main reasons for using the CUSQ. First, the CUSQ was identified during the early stages of the study and was selected as an established and proven tool for measuring user satisfaction in relation to the use of any computerised information system. The use of “generic” questions in this sub-section of the survey would potentially facilitate comparison of results against other studies in future research. Secondly, because the patient records survey was concerned with several IT systems, collectively referred to as the EPR systems in the hospital, user satisfaction levels were being sought at the overall system level. Finally, the CUSQ was used because it includes free-text fields to collect respondents’ views on the most beneficial and problematic aspects of the systems.

A copy of the survey questionnaire, showing all of the data items that were collected, is provided in Appendix B, along with a copy of the covering e-mail sent to all staff at the case study site.

Section		Question	Question Type (response type)	Rationale
1.	Survey Eligibility	User of medical records?	Closed (binary)	To ensure eligibility of respondents
2.	About You	Staff group?	Closed (multiple-choice)	For describing the sample
		Time worked at Trust?	Closed (multiple-choice)	For describing the sample
3.	Using Paper Medical Records	How frequently do you deal with paper-based patient medical notes to undertake your work?	Closed (multiple-choice)	To establish the extent to which paper systems and processes are still used at the case study site, in conjunction with EPR systems
		What tasks do you use paper format patient medical notes for?	Closed (multiple-choice)	To gather initial data on clinical tasks undertaken by oncologists, using paper-based systems
		Do you always have access to a patient's medical notes file whenever you need it?	Closed (polar/binary)	To establish whether or not access to information might be a relevant theme for the study
		If a patient's file that you need is not readily available, how long on average do you have to wait to be able to see it?	Closed (multiple-choice)	
		On average how long do you keep patient's medical notes files in your possession?	Closed (multiple-choice)	
		Do you ever suspect that a patient's medical notes that you are working with are not fully up to date?	Closed (binary)	To potentially establish whether the currency of information is a relevant theme for the study
		How frequently do you suspect that you are working with a patient's medical notes that aren't fully up to date?	Closed (multiple-choice)	
		What do you do if a patient's medical notes are not available when you need them?	Open (free-text)	To establish whether or not availability of information might be a relevant theme
4.	Using the Electronic Patient Record (EPR) system	Do you use the current version of the MAXIMS Electronic Patient Record system at CCO?	Closed (binary)	To ensure eligibility of respondents
		How frequently do you use the EPR system to perform the following tasks?	Closed (multiple-choice)	To establish which clinical tasks are performed using EPRs
		Please tell us what you think about the overall EPR system by indicating the extent to which you agree or disagree with the statements below.	19 Closed (multiple-choice) questions / statements	Based on IBM CUSQ, to determine current levels of user satisfaction with EPR systems
		Please list the most negative aspect(s) of the current EPR system	3 Open (free-text) response fields	Based on IBM CUSQ, to establish experiences, issues and themes associated with use of EPRs
		Please list the most positive aspect(s) of the current EPR system	3 Open (free-text) response fields	

Section		Question	Question Type (response type)	Rationale
5.	IT Training Needs	Please tell us how competent you feel in using computer systems	Closed (multiple-choice)	To gather basic data which may indicate whether training and competence is related to current use of EPR systems
		Would you like to have the option to complete some clinical systems training courses via eLearning?	Closed (binary)	
6.	The impact of moving to fully Electronic Patient Records	How do you think it will affect your work when all paper-based medical notes are replaced with a fully electronic patient record system?	8 Closed (multiple-choice) questions / statements plus an open (free-text) field for comments	To establish the views of system users in relation to whether EPR systems will have a positive or negative affect on their clinical work and patient care
7.	General Comments	Any comments about the use of patient case-files or development of the Trust's Electronic Patient Record system	Open (free-text)	To obtain qualitative data which may be used to identify issues and themes which might inform the design of the main phase of the study

Table 4.3-1 Overview of survey questionnaire and rationale for questions

Development of the questionnaire was undertaken using a free online survey questionnaire system called SurveyMonkey. The system was used to create a series of webpages in which the questions were grouped into sections with appropriate response fields including check boxes, radio buttons, and drop-down lists. Where possible, question interdependencies were built into the functionality so that, for example, if a respondent selected an answer to the eligibility question that meant they were not eligible to participate in the survey, they would automatically be routed to an “end of survey” screen, rather than to the next question.

4.3.2 Ethics approval and pilot study

The survey questionnaire was originally developed as part of the coursework for a module (Quantitative Research Methods) of the University’s “MSc Health and Social Care Research” distance learning programme, delivered by the School of Health and Related Research (SchARR) at The University of Sheffield and completed by the researcher as part of PhD research training.

Although the SchARR teaching staff indicated that ethics approval was not necessary for the coursework for the MSc module (HAR6071) at the time (Spring semester 2011), as it was concerned with designing a questionnaire and conducting a pilot study only, in line with correct procedures, approval was sought from the NHS National Research Ethics Service (NRES) for the questionnaire to be issued and the data to be used. The intention at the time was that the survey questionnaire would be used for research training purposes and also to inform the study

site's (i.e. Clatterbridge Cancer Centre's) strategic planning for information management and technology. A letter from the NHS NRES is provided in Appendix A, which indicated that ethics approval was not required because in their view, this constituted service evaluation.

Following the initial analysis of the survey data and discussion with the research supervisor, it became clear that the data collected had potential to inform the core PhD study. In the preparation of the MPhil to PhD transfer report it was realised that, with hindsight, it might have been appropriate to seek further clarification from the University as to whether research ethics approval should have been obtained prior to carrying out the survey. In May 2014, this question was referred to the University Research Ethics Committee (UREC), and it was queried whether the data could be used for the thesis, given that ethics approval had not been obtained in 2011. The UREC response was that because the study was regarded as a service evaluation by a recognised ethics committee, i.e., within the NHS, and was being performed by a member of staff who was responsible for the service being evaluated, then the University would regard it as service evaluation; therefore, the study did not require ethics approval for that reason. This was indicated in an email from the then Chair of UREC, Professor Newman. It was deemed by Professor Newman that it was acceptable and appropriate to include the data in the thesis, as it had informed the development of the research, and the fact that research ethics approval was not obtained should not prevent its use within the thesis.

As noted by Prosser et al. (2004), the initial version of a questionnaire requires testing and evaluation, piloting, and potential amendments and finalisation prior to being administered to the full target group. After securing the approval to proceed from the local NHS research ethics committee (Appendix A) as noted above, the researcher undertook a pilot exercise with 23 staff members working within the Information Management and Technology Department, Medical Records Department, and Medical staff group at the study site. The pilot participants were recruited using convenience sampling, identified as a sample that was available by virtue of its accessibility (Bryman, 2008) at the study site; this sample constituted a small group of individuals with knowledge of, and an interest in, the development and implementation of EPRs.

The sample in the pilot study was asked to complete the online survey questionnaire, answering as though they were an end-user of the EPR systems used at the study site. They were asked to note any problems with the instructions, layout, navigation, and type of answer fields used in the questionnaire and to suggest any amendments that might be required. For the purposes of the pilot study, participant demographics were not collected, although the group included male and female participants who were in different age groups and job roles at the study site. Time permitting, they were asked to complete the web-based survey more than once, selecting different job roles and responses, to ensure the questionnaire was tested thoroughly and to ensure that sufficient response data were available to test for analysis.

A total of 14 replies were received from the pilot group, a response rate of 61%. Feedback from the pilot group led to some minor changes to the wording of two of the questions to make them clearer and easier to understand. One of the respondents recommended that when referring to patient medical records, the paper-based records should be referred to as “patient case notes” and the electronic records as “electronic medical records.” Some of the pilot group members reported that the instructions for completing the survey were clear and straight forward to understand and that the structure and flow of the online questionnaire worked well. All participants advised that the range of questions was comprehensive and covered the various topics of interest that they would expect to be included. The participants were asked to record the elapsed time for completion of the questionnaire, and the mean time reported was seven minutes.

4.3.3 Setting, population and sampling method

As explained in Chapter One, the setting for this research was The Clatterbridge Cancer Centre NHS Foundation Trust, a specialist cancer treatment hospital in the North West of England. As noted by Black (1999, p. 111), the primary interest of the social sciences is people; if a study focuses on a particular organisation, it is the people within that organisation that are of principal interest to the researcher. In this case, the characteristics, attitudes, and opinions of healthcare workers at the cancer centre, in relation to EPR systems, was the focus of interest, and the population was defined as healthcare workers who use patient records to undertake their job roles.

At the time of conducting the survey, the population was 863 relevant staff members, including doctors, nurses, radiographers, pharmacists, physicists, other allied health professionals, and administrative staff. To ensure that the potential research participants were given equal opportunity to participate in the study, and to maximise the response rate, the entire population of staff at the cancer centre was invited to complete the survey questionnaire. The survey included an initial question to determine eligibility to participate based on whether or not the respondent used patient medical records in their job role. This basic inclusion criterion ensured that only respondents who could provide relevant and useful information completed the questionnaire (Fink, 2003). Details of the sample characteristics are provided in the results section of this chapter, 4.4.

4.3.4 Recruitment of participants

Following the pilot study, a link to the online questionnaire was e-mailed to an “all staff” distribution list at the study site (Appendix B). Participants were asked to use the web link to access the survey and to complete it by a set deadline. Using the SurveyMonkey system, the

researcher was able to monitor the number of completed questionnaires, which was helpful to inform the timing of reminder e-mails to encourage staff to participate, with a view to maximising the response rate. The survey took place during the period 6th to 13th May 2011.

4.3.5 Coding process

Coding involves translating written or chosen responses to questions into numbers using an established coding scheme (Albuam, 1993; Fink, 2003). For the survey questionnaire, each respondent was automatically given a unique reference number via the SurveyMonkey system, which was labelled as participant ID in SPSS, to be used for tracking question responses in the original questionnaire, if required. Prior to coding the response data, the variables were configured with appropriate labels in SPSS. All question responses were then coded numerically. For example, all “yes/no” questions were coded as yes (1) and no (2). For the Likert scale questions, each of the available responses were coded from one to five. For responses where the participant selected “don’t know,” the data were coded as 99.

4.3.6 Data analyses

Competent researchers must be purposeful in their approach to the completion of a survey analysis task. A poorly designed approach to analysis may produce erroneous or unreliable outputs and results that are not applied or utilised appropriately. Problematic data outputs may also cause important findings to be unidentified or omitted and a lack of identification and extraction of subsets of the data where useful information may have otherwise been evident. To ensure a robust process, it is helpful to break the analysis activities into three main phases: exploratory data analysis (EDA); deriving the main findings; and archiving (Statistical Services Centre, The University of Reading, 2001).

An initial analysis of the survey questionnaire was undertaken using tools and techniques for statistical analysis via the Statistical Package for the Social Sciences (SPSS) software, now co-branded as PASW or SPSS-IBM. During the EDA phase, the survey data, which were originally collected via an online web form, were viewed in a series of standard reports available on the online survey website used. It is a usual practice in the EDA phase to review the data files; on some occasions it is appropriate to do this prior to the completion of data collection and entry, to check on response rates and the format and type of data being generated. This may result in further data collection, if required, or it may reduce lost time by halting data collection when outcomes are already clear or there are obvious problems with the data. It is not expected that information from the EDA phase will be ready to publish as study findings or outcomes (Statistical Services Centre, The University of Reading, 2001).

In the next stage of the process, a comma-separated values (CSV) file, which stores tabular data (numbers and text) in plain-text form, was exported from the online survey database. The CSV file was then opened with SPSS, and the data were prepared for analysis. Using IBM-SPSS, the data were coded appropriately for the different variables. Some of the variables are "categorical" (nominal) in nature, while others represent "quantitative" measurements (for these variables, the values that can be obtained are qualitatively different from each other, and arithmetic functions cannot be performed on them). Within the variable view of SPSS, the variable types were configured appropriately as nominal or ordinal, string or numeric, discrete or continuous, etc.; then, as mentioned above, a coding frame was established for all closed/scalar questions.

Once the data had been prepared appropriately, a range of descriptive statistical queries were performed against the data set, including frequency analysis and parametric and non-parametric tests. To attempt to answer the questions set out earlier in Section 4.1, multiple regression analyses were used to investigate the significance of each independent variable to key dependant variables in the data set. A coding framework was devised for the thematic grouping of the free-text responses to the CUSQ questions. The results of the survey data analyses are provided in the Section 4.10.

4.3.7 Instrument reliability and validity

In the previous chapter, an overview of issues relating to reliability and validity in both qualitative and quantitative studies was presented. In relation to quantitative studies such as the patient records survey, according to Black (1999), construct validity aims to "maximise the consistency between concept, construct and operational definition" (Black, 1999, p. 192). Other types of validity, such as criterion, predictive, and content validity, are viewed as complementary to construct validity and are used for more specific validity tests.

4.3.7.1 Internal reliability

Black (1999) explained that the simplest way of estimating the internal consistency of a questionnaire is to use a coefficient that accounts for the average correlation among the relevant questions and the number of questions. For questions using a scale for responses, such as Likert scales, Cronbach's alpha coefficient (α) serves this function.

In order to measure the reliability of the Likert scale questions in the patient records survey questionnaire, the internal consistency was calculated using Cronbach's alpha coefficient (α). By applying this statistical calculation to the set of CUSQ and "impact of EPR" questions, it was possible to determine whether the questions in the relevant sections of the survey questionnaire

reliably measured the same latent variables: for the CUSQ, usability and user satisfaction with the EPR systems; for the impact of EPR, user attitudes towards electronic patient records. As mentioned in Section 4.3, the CUSQ has previously been found to have an excellent level of internal consistency. With reference to the patient records survey data collected using the CUSQ section of the questionnaire, the α value was calculated to be .951 using SPSS, which is in line with the findings in other studies. According to DeVellis (2012), this α value indicates that the questions in this section had a high level of internal consistency.

Pipan, Arh, and Blažič (2010) explained that the CUSQ can be used to measure three aspects of satisfaction: system usefulness (SYSUSE), information quality (INFOQUAL), and interface quality (INTERQUAL), with respective coefficient alphas of 0.96, 0.91, and 0.91. However, in calculating Cronbach’s alpha for the sub-scales in the patient records survey, slightly different results were found, as presented in Table 4.3-2 below. This may be because a 5-point Likert scale was used in the adapted version of the survey, instead of the original 7-point scale. While the SYSUSE coefficient alpha was very similar to that reported in other studies, the results for INFOQUAL and INTERQUAL were lower, although still within a range considered to be “good,” in terms of the level of internal consistency of the sub-scale.

Sub-scale	CUSQ Questions		Cronbach’s alpha for the sub-scale
System Usefulness (SYSUSE)	Q1	Overall, I am satisfied with how easy it is to use this system	0.937
	Q2	It is simple to use this system	
	Q3	I can effectively complete my work using this system	
	Q4	I am able to complete my work quickly using this system	
	Q5	I am able to efficiently complete my work using this system	
	Q6	I feel comfortable using this system	
	Q7	It was easy to learn to use this system	
	Q8	I believe I became productive quickly using this system	
Information Quality (INFOQUAL)	Q9	The system gives error messages that clearly tell me how to fix problems	0.876
	Q10	Whenever I make a mistake using the system, I recover easily and quickly	
	Q11	The information (such as on-line help, on-screen messages and other documentation) provided with this system is clear	
	Q12	It is easy to find the information I need	
	Q13	The information provided with the system is easy to understand	
	Q14	The information is effective in helping me complete my work	
	Q15	The organization of information on the system screens is clear	
Interface Quality (INTERQUAL)	Q16	The interface of this system is pleasant	0.858
	Q17	I like using the interface of this system	
	Q18	This system has all the functions and capabilities I expect it to have	

Table 4.3-2 Cronbach’s alpha co-efficient for CUSQ constructs

However, when applied to the “impact of implementing fully electronic records” set of questions, the result was .347, indicating that this group of questions was not internally consistent; each question was measuring something different.

According to Black (1999), the most appropriate indicator for assessing the reliability of individual questions is the *item-total correlation*, defined as “the correlation between individual response scores for the item and the total score on the instrument” (Black, 1999). This shows how consistently each question is measuring the same thing as the overall instrument; therefore, a high item-total correlation is desirable. In investigating the apparently low level of internal consistency among the questions pertaining to the impact of implementing fully electronic records, the item-total statistics presented in Table 4.3-3 show that one of the questions in particular, relating to the impact of EPR systems on interaction with patients, has negative value due to a negative average covariance among items. According to SPSS, this value violates reliability model assumptions and indicates a need to check item coding. However, a further review of the data and coding did not identify any anomalies.

Question	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
I will be more concerned about the security of patient information	55.62	4130.299	.064	.144	.353
It will have a negative impact on how I interact with patients	39.86	1619.732	.441	.256	-.001 ^a
I will not be able to work as efficiently as I do now	55.65	4126.188	.095	.513	.352
Clinical information will be more up-to-date	56.60	4149.665	-.080	.402	.356
It will improve patient care	56.21	4131.222	.083	.556	.353
I will make clinical decisions that are more informed	36.49	1519.572	.362	.314	.120
It will take longer to complete some tasks	56.28	4126.243	.104	.406	.352
I will spend less time waiting or searching for patient information	55.57	3926.619	.096	.156	.339

Table 4.3-3 Item-Total Statistics: Impact of EPR

4.3.8 Validity

According to Golafshani (2003), validity establishes whether the study really measures what it was aiming to measure, or how true the research outcomes are. In simple terms, it is concerned with whether the study instrument enables the researcher to clearly address their core research objective. Investigators usually determine validity by posing a sequence of questions, and they frequently seek answers from studies undertaken by others.

In this exploratory phase of the research, the validity of the survey questionnaire was tested by applying content and face validity. To enhance the content validity, the relevant literature was evaluated, and key concepts and questions were specified with reference to previous, similar studies. The content of the questionnaire was also discussed with the PhD supervisor and expert colleagues at the cancer centre case study site. To ensure face validity, the supervisor’s advice and the views of the pilot study participants were used to improve the wording, presentation, flow, and format of the questions in the web-based questionnaire. The pilot study also assisted in improving face validity by verifying that the participants had clearly understood the meaning of each question.

4.4 Results

This section presents the results of the exploratory quantitative study, the patient records survey questionnaire. In the first sub-sections, descriptive analysis of the sample characteristics is provided.

4.4.1 Descriptive analyses

The following sections firstly presents the survey response rate and then a range of descriptive statistics are used to explain the results of the patient records survey.

4.4.1.1 Response rate

The overall response was 130 completed surveys, representing 21% of staff members that were eligible to participate. Table 4.4-1 provides the numbers of respondents and the response rates for each staff group.

Staff Group	Total Staff	Eligible for Survey	Responses Received	Response Rate (%)
Medical	59	59	20	34
Nursing	243	179	22	12
Radiographers	191	180	13	7
Allied Health Professionals	22	22	8	36
Administration	252	139	52	37
Pharmacy	34	18	2	11
Physicists	33	20	8	40
Senior Management	29	10	5	50
Total	863	627	130	21

Table 4.4-1 Survey response rates (n)

It can be seen from Table 4.4-1 that the largest number of responses came from administrative staff ($n = 52$), followed by nursing ($n = 22$) and medical ($n = 20$) staff. The response rate differed across the staff groups, the highest being among senior management (50%) followed by physicists (40%) and administrative staff (37%).

4.4.1.2 Sample Characteristics

To facilitate data analysis, radiographers, allied health professionals, pharmacists and physicists were merged into a single category (“Allied and other health professions”), and senior management and administrative staff were merged into a separate single category (“administration and management”). Overall, 51 respondents (39.2%) had been working the Trust for more than 10 years, 32 (24.6%) for 6-10 years, 35 (26.9%) for 1-5 years, and 12 (9.2%) for less than 1 year.

Analysis of the survey results is focused on the relationship between different staff groups; their access to, and use of, paper-based medical notes; their views on the current EPR systems at the Trust; and their perspectives on the potential impact of implementing fully electronic patient record systems.

4.4.1.3 Use of paper-based medical notes

Overall, 98% ($n = 127$) of respondents used paper-based medical notes in their work roles. Of these, 98 respondents reported using paper-based notes on a daily basis (77%), 17 respondents (13%) used them occasionally (e.g. on weekly basis) and 12 respondents (9%) reported using paper-based notes rarely (e.g., for audits). There was a significant association between staff group and the frequency of using paper-based notes ($\chi^2 = 21.10$; $df = 2$; $p < 0.001$). Of the 42 clinical staff (nursing and medical), 40 used paper-based notes on a daily basis (98%), whereas only 15 of the 31 allied and other professions used paper-based notes on a daily basis (48%), and 43 of the 57 administrative/management staff (75.4%) used paper-based notes on a daily basis. There was no association between length of time working in the Trust and frequency of using paper-based notes ($\chi^2 = 4.235$; $df = 2$; $p = 0.237$).

4.4.1.4 Access to patient medical notes

More than half of respondents ($n = 66$; 52.8%) reported that they did not always have access to a patient's medical notes file when they needed it. There was no statistically significant association between staff group and whether respondents always had access to a patient's medical notes file when they needed it ($\chi^2 = 2.63$; $df = 2$; $p = 0.268$). Of the 42 clinical staff, 20

(47.6%) reported that they always had access to a patient's medical notes file when they needed it, compared to 11 of the 31 allied and other health professionals (35.5%) and 28 of the 52 administrative/managerial staff (53.8%).

When respondents who said that files were not readily available were asked how long they had to wait for access, 27% ($n = 23$) said they had to wait for a whole day or longer. When asked how long they kept files in their possession, 22% ($n = 29$) of respondents selected “three days or more.” Table 4.4-2 below shows the number of participants who reported the usual duration of time that they would keep a patient’s paper-based medical record with them (during which time that record is unavailable to other clinical staff). Of the 127 respondents that said they used paper-based medical records, responses to this question were received from 116 participants (91% of paper-based medical records users).

Staff Group	Length of time that medical records are kept n (%)						Total
	Less than an hour	1-2 hours	3-7 hours	1 day	2 days	3 Days+	
Clinical	11 (28%)	6 (14%)	8 (20%)	5 (13%)	2 (5%)	8 (20%)	40 (100%)
Admin/mgmt.	7 (14%)	4 (7%)	5 (10%)	14 (29%)	2 (4%)	17 (36%)	49 (100%)
AHPs	17 (63%)	3 (11%)	0 (-)	1 (4%)	2 (7%)	4 (15%)	27 (100%)
Total	36 (30%)	13 (11%)	13 (11%)	20 (17%)	6 (5%)	29 (25%)	116 (100%)

Table 4.4-2 Length of time that paper-based medical records are kept by staff group

When asked what action they would take in an event where a patient’s file was not available, more than half of medical staff respondents ($n = 12$) stated that they would locate the last clinical letter in order to proceed with a consultation. Other medics responded that they would “continue without notes” or “piece information together from memory.” Other clinical staff indicated they were less likely to continue working with a patient, with both nurses and radiographers reporting that they “cannot work without the complete record” and “cannot treat [the] patient” or that they would “defer seeing that patient and treat another patient instead.”

Participants reported that a variety of different tasks were carried out using the medical notes. All medical staff respondents reported using the medical notes to review the patient’s problems and seek out specific information, with 80% ($n = 16$) using them to obtain the results from tests or investigations. Ninety-five percent ($n = 19$) reported using the medical notes file to record daily notes about the patient. Eighty percent ($n = 16$) of medical staff reported using the notes for clinical audits, and 70% ($n = 14$) used them for research purposes. Fifteen percent ($n = 3$) stated that they used the notes to facilitate subject access requests. Administration staff reported using the notes for a variety of other purposes including clinical coding (15%, $n = 8$), filing Trust

documents (63%, $n = 33$), and filing documents originating from referring hospitals (46%, $n = 24$).

Perhaps the most concerning finding was that 65% ($n = 84$) of all respondents said they suspected that the patient's medical notes file that they are working with was not fully up to date (e.g., some clinical letters were not present, or recent documents had not yet been filed). In the medical staff group, 85% reported that they suspect patient records were not fully up to date and a chi-squared test indicated that there was a statistically significant association between staff group and concerns about currency of information ($\chi^2=7.618$; $df = 2$; $p = 0.022$). Seventy-one percent of allied health professionals, and just over half (54%) of the respondents in the administrative and management staff group, suspected that patient records were not fully up to date.

4.4.1.5 Tasks supported by EPR systems

Overall, 86% ($n = 112$) of participants reported using the Trust's existing EPR systems (in this case defined as several computer systems currently used to record patient information including appointments; admissions, discharges and transfers; clinical documentation; scheduling; and prescribing). Ninety-eight percent of these EPR system users indicated the type and frequency of tasks that they undertook using the systems.

The highest frequency daily task supported by the electronic patient record system was tracking the paper-based patient record ($n = 48$; 43%). Other, relatively high-frequency tasks relate to order communications and results reporting (more commonly referred to as Computerised Physician Order Entry [CPOE] in the USA) for pathology, recording contacts with patients, and tracking the status of a patient in relation to their planned clinical pathway. Entering clinical information into the EPR and performing some clinically focussed tasks such as prescribing chemotherapy had relatively low (electronic) activity levels at the time of the survey.

4.4.1.6 Reported uses of EPR

A range of reported uses were indicated within each staff group. Highlighting the wide range of views on EPR systems, when asked what other tasks they used the EPR for, in addition to those pre-defined for selection in the questionnaire, one doctor responded to say that they used the system "to check clinic appointments to plan my work, patient details and phone numbers, radiotherapy schedules and diary to plan when I'm seeing patients and keep track of their treatment. I read last letters etc. when calling patients to save getting notes." However, another doctor reported, "I try to avoid using the EPR system if at all possible; it takes too much time

and wastes valuable clinic time; it is not best use of my expertise to make me slowly type in patient numbers.” Other clinicians indicated that they used the system to check the details of the most recent clinical letter when the paper file of medical notes was not available.

Additional tasks undertaken by administrative staff respondents included checking a patient’s clinical trial details, identifying a GP contact and foreign hospitals, and validating statutory reports. A radiographer responded that they used the system to view clinic lists and schedule workloads. Management respondents stated that they used the EPR system to “review for audit / investigation of complaints / incidents” and to review nursing documentation.

4.4.1.7 Self-reported levels of IT literacy and preference for eLearning

The 112 participants who reported using the electronic patient record systems in addition to paper medical notes were asked how competent they felt in using information technology and the EPR systems. Within this group, 77% of respondents said they felt they were either very competent or competent in using the systems. Only eight participants stated that they were unsure about their level of IT competency or needed further training. Within this group, there were four clinical staff, three allied health professionals, and one member of administrative staff. A chi-square test indicated that there was no statistically significant association between self-reported level of IT literacy and overall satisfaction with the EPR systems in use ($\chi^2 = 12.287$; $df = 6$; $p = 0.056$). Additionally, there was no statistically significant association between different staff groups and level of IT literacy ($\chi^2 = 17.881$; $df = 12$; $p = 0.269$).

The other question in this section of the questionnaire was whether the respondents would be happy to learn how to use the EPR systems via eLearning products. This was considered to be a relevant question due to potential changes in the way that EPR system training was to be provided at the study site in the future. Table 4.4-3 below presents the responses to this question. Interestingly, the responses seemed to be fairly balanced within the clinical staff group, with a slight preference overall for eLearning systems to be introduced. Within the Allied Health Professionals group, twice as many respondents stated a preference than those who said they would not like to use this method of training in the use of EPR systems. However, a chi-square test identified that there was no statistically relevant association between staff groups and a preference for eLearning ($\chi^2 = 2.381$; $df = 5$; $p = 0.794$).

Staff Group	Would you like EPR system training courses via eLearning?			
	No/blank		Yes	
	n	%	n	%
Clinical	14	42	19	58
Admin/management	15	37	25	63
AHPs	6	33	12	67
Total	35	38	56	62

Table 4.4-3 Preference for eLearning for EPR systems

4.4.2 User satisfaction with current EPR systems

Using an adapted version of the CUSQ, respondents were asked 19 questions to obtain feedback on user satisfaction, using a 5-point Likert scale rating for each statement (Strongly Disagree to Strongly Agree). Ninety-three of the EPR user respondents answered this section of the questionnaire.

Seventy-four percent of respondents ($n = 69$) in this section either agreed or strongly agreed that the systems were easy to use. A similar result was seen in relation to users' indicating whether they could complete their work effectively using the systems, with just under 74% agreeing that they could ($n = 69$), and 26% ($n = 24$) either undecided, disagreeing, or strongly disagreeing. Over half of respondents (55%; $n = 51$) agreed or strongly agreed that they could complete their work quickly using the systems, with 62% agreeing they could complete their work efficiently. Eighty-four percent of respondents ($n = 78$) agreed or strongly agreed that they felt comfortable using the systems, with similar numbers (81%; $n = 75$) agreeing that it was easy to learn to use the systems.

The majority of respondents indicated that information provided with the systems (e.g. training manuals, user guides) was clear (72%; $n = 67$), it was easy to find information on the system (75%; $n=70$) and it was easy to understand (70%; $n = 65$). Sixty-eight percent ($n = 63$) felt that the information provided by the system was helpful in enabling them to complete tasks, and 65% ($n = 60$) agreed that the organisation of information on screens was clear. When asked whether the user interface was pleasant and if they enjoyed using it, over half of the participants responded positively.

However, less than half (44%; $n = 41$) of respondents agreed that the systems had all the functionality and capabilities that they expected. When the usability questions were analysed by specific staff groups, medical staff had the highest percentage of respondents who did not agree

that all functions and capabilities were provided (71%; $n = 66$). The statement with which the fewest respondents agreed was “when I make a mistake using the system, I recover easily and quickly” ($n = 39$; 42%).

Table 4.4-4 presents the number and percentage of each staff group and their overall level of satisfaction with the EPR systems in use at the time of the survey. In total, 90 of the respondents answered this question about overall level of satisfaction.

Staff groups	Overall, I am satisfied with the EPR systems										Total	
	Strongly Agree		Agree		Don't Know		Disagree		Strongly Disagree			
	n	%	n	%	n	%	n	%	n	%	N	%
Clinical	0	0	18	55	1	3	12	36	2	6	33	37
Admin/mgt.	2	5	29	74	3	8	2	5	3	8	39	43
AHPs	1	5	9	50	3	17	2	11	3	17	18	20
Total	3	3	56	62	7	8	16	18	8	9	90	100

Table 4.4-4 Overall satisfaction with EPR systems by user group

As indicated in Table 4.4-4, no clinical staff members agreed strongly that they were satisfied overall with the EPR systems in use, and only one AHP selected this response. However, the overall profile of responses to the CUSQ questions indicated that almost two thirds of respondents (65%; $n=59$) were satisfied with the EPR systems, 7 respondents did not know whether they were or not, and 27% ($n=24$) were not satisfied.

With reference to the CUSQ instructions for use, Lewis (1993) explained that overall user satisfaction scores should be calculated using the average (mean) score of responses to questions one to 19. To calculate the mean response to this sub-scale, a new variable was created and calculated in the SPSS dataset. Table 4.4-5 shows the mean score for each staff group, indicating that there was not a clear level of overall satisfaction or dissatisfaction with the EPR systems in any of the staff groups. The mean scores suggest that the clinical staff group were marginally less satisfied with the systems than allied health professionals, whose average score leans slightly towards satisfaction.

Staff Group	N	Mean	Std. Deviation	Mean Rank	% of Total N
Clinical	34	2.8072	.70098	54.78	36.6%
AHPs	41	2.4089	.65566	37.91	44.1%
Admin./management	18	2.7261	.76981	53.00	19.4%
Total	93	2.6159	.71251		100.0%

Table 4.4-5 Overall CUSQ scores

A Kruskal-Wallis test calculated (at $\alpha = 0.05$) giving a result of 8.373 ($df=2$) with a p value of 0.015, meaning that there was significant variance in Mean Rank scores for CUSQ between different staff groups. Most notably the AHPs group had a significantly lower mean rank CUSQ than both Clinical and Admin./management groups.

System Usefulness

With reference to the CUSQ instructions for use, the 19 questions within this section of the questionnaire were grouped into three different sub-scales related to system usefulness (SYSUSE), information quality (INFQUAL), and interface quality (INTERQUAL). Firstly, to calculate SYSUSE, a new variable was created to calculate the mean average of the answers to questions 1-8 within the CUSQ. The mean of this variable was then calculated for each staff group, as presented in Table 4.4-6 below.

Staff Groups	n (%)	Mean	Std. Deviation	Mean Rank
Clinical	34 (37)	2.63	.7717	54.00
AHPs	41 (44)	2.18	.6488	39.27
Admin/Management	18 (19)	2.59	.8658	51.39
Overall	93 (100)	2.42	.7641	

Table 4.4-6 SYSUSE scores

With reference to the 5-point Likert scale, where 1 = strongly agree and 5 = strongly disagree, a higher mean score indicates more disagreement with the groups of statements, and a lower score indicates a higher level of agreement with the relevant statements. All of the mean scores were within the range of 2.1 to 2.7, with a total of 2.42, indicating that overall there was not a strong agreement or disagreement with the statements in any of the staff groups, but overall responses tended marginally closer to agreement. However, the clinical staff group had the highest score overall, indicating an overall tendency toward disagreement with the statements, followed by admin/management and then allied health professionals. This outcome suggests that medical and nursing staff found the current EPR systems to be less useful than other allied health professionals working at the cancer centre.

A Kruskal-Wallis test was performed to determine the level of variation in SYSUSE groups among the different staff groups. The result indicated that there was a statistically relevant association between staff group and SYSUSE with a figure of 6.480 ($df = 2$; $p = 0.39$).

Information Quality

As with the instructions for calculating SYSUSE, the same process was followed to create a new variable in SPSS and to calculate the mean score from participant responses to the Likert-scale questions. For INFQUAL, one less question was included in the subscale than for SYSUSE, those numbered from 9 to 15 in the CUSQ. Table 4.4-7 shows the mean scores of the overall INFQUAL responses. Overall, similar to the results of SYSUSE, the overall mean of 2.73 for INFQUAL indicates that there was no strong agreement or disagreement in any of the user groups, although a marginal weight towards disagreement with the statements was evident. The relative level of disagreement was also similar to SYSUSE, with clinical staff disagreeing more strongly than the other groups that the current EPR systems had a good level of information quality.

Staff Groups	n (%)	Mean	Std. Deviation	Mean Rank
Clinical	34 (37)	2.88	.63667	55.32
AHPs	41 (44)	2.58	.71985	38.61
Admin./Management	18 (19)	2.77	.68694	50.39
Total	93 (100)	2.73	.69049	

Table 4.4-7 INFQUAL scores

A Kruskal-Wallis test indicated a statistically relevant association between staff groups and their mean INFQUAL scores, with a result of 7.533 ($df = 2$; $p = 0.023$).

Interface Quality

INTERQUAL is the sub-scale with the lowest number of items included, only three questions. The mean INTERQUAL variable was created in SPSS, and Table 4.4-8 below sets out the results for each staff group. The results show that whilst the total was again not giving any strong indication of overall agreement or disagreement with the statements, in this subscale the mean result for clinical staff is >3 , meaning that there is a clear tendency towards disagreement with the interface quality statements in this user group. Of the three different sub-scales within the CUSQ, interface quality was the construct that the users were least likely to agree with positive statements about.

Staff Group	n (%)	Mean	Std. Deviation	Mean Rank
Clinical	34 (37)	3.08	.98151	51.68
AHPs	40 (43)	2.67	.89951	39.95
Admin./Management	18 (20)	2.97	.92576	51.28
Total	92 (100)	2.88	.94478	

Table 4.4-8 INTERQUAL scores

A Kruskal-Wallis test was also used for the INFQUAL subscale, to determine whether or not there was a statistically relevant association between staff groups and the responses related to the interface quality of the EPR systems. Unlike SYSUSE and INFQUAL, for the INTERQUAL subscale it was found that there was not a statistically significant association between the staff groups and their ranked mean responses. The Kruskal-Wallis result was 4.385 and the Asymptotic Significance was 0.112.

4.4.3 Perceived impact of fully electronic patient records

In order to establish their views on the potential impact of patient records becoming fully electronic, participants were asked to respond to eight questions using a Likert scale rating. Table 4.4-9 provides a summary of the results from four positive statements used for this question; these were balanced in the questionnaire with similar negative statements about the impact of fully electronic records, to avoid response bias arising from respondents ticking the same category across a set of positive statements.

	Percentage responding favourably to positive statements (agree or strongly agree)							
	Clinical information will be more up-to-date		It will improve patient care		I will make clinical decisions that are more informed		I will spend less time waiting or searching for patient information	
	n	%	n	%	n	%	n	%
All respondents	64	49	41	32	31	24	56	43
Participant Groups :								
Medical	10	50	5	25	4	20	4	20
Nursing	11	50	6	27	7	32	14	64
Radiography	6	46	4	31	4	31	3	23
Allied HCPs	4	50	3	38	3	38	4	50
Administration	29	56	21	40	10	19	28	54
Pharmacy	2	100	1	50	0	0	2	100
Physicists	4	50	2	25	1	13	4	50
Management	2	40	2	40	3	60	3	60

Table 4.4-9 Perceived impact of fully electronic records: positive statements

Analysis of these responses indicates a good case for implementing fully electronic patient records, with just under half (43%) of respondents reporting that they think they would spend less time waiting or searching for patient information and half (49%) expecting that clinical information would be more up-to-date.

	Percentage response to negative comments (agree or strongly agree)							
	I will be more concerned about the security of patient records		I will not be able to work as efficiently as I do now		There will be a negative impact on how I interact with patients		It will take longer to complete some clinical tasks	
	n	%	n	%	n	%	n	%
All respondents	32	25	26	20	16	12	46	35
Participant Groups :								
Medical	4	20	9	60	8	53	13	87
Nursing	6	32	6	32	3	16	12	63
Radiography	4	50	1	14	0	0	5	63
Allied HCPs	5	31	3	19	3	19	7	44
Administration	13	32	7	17	2	5	7	18
Management	0	0	0	0	0	0	2	50

Table 4.4-10 Perceived impact of fully electronic records: negative statements

A quarter of respondents stated that they would be more concerned about the security of patient records when they are fully electronic. Overall, respondents seemed to be more concerned about the security of records than about the impact on interactions with patients, which only 12% of respondents were worried about. The most widely shared concern for respondents was that the implementation of fully electronic records would have an adverse impact on the time it took to complete tasks, with over a third either agreeing or strongly agreeing that tasks would take longer. However, in contrast with this, 17% of respondents either disagreed or strongly disagreed with the statement, expecting that full implementation of EPR systems would result in more efficient clinical workflows.

4.4.4 Positive and negative aspects of the current EPR systems

With regards to the reported positive and negative aspects of the current systems, a total of 203 comments were made (these were coded as being 59% negative and 41% positive). Themes that emerged from analyses of the qualitative data were grouped into nine categories: integration; accessibility and availability; usability; patient safety; efficiency; security; reliability; functionality; and training and support.

Tables 4.4-11 to 4.4-15 set out the positive and negative statements made by respondents in each staff group, categorised by each of the different themes that emerged. With reference to Table 4.4-11 below, the medical staff group made more negative than positive statements. The themes with the most comments overall were 1) availability and accessibility, and 2) usability.

Theme	Most Negative Aspects	Most Positive Aspects
Efficiency	<ul style="list-style-type: none"> • Time taken to do work • Time-consuming • It takes far longer to order bloods than it ever did using paper • I find PAS a bit slow and can't print from it 	
Integration	<ul style="list-style-type: none"> • Does not tie up to PACS • Not joined up to other e-systems • Disparate applications rather than a single EPR module 	
Usability	<ul style="list-style-type: none"> • A lot of fields to navigate and not able to have more than one on screen at a time • Poor user interface • Too many different screens for the same job e.g. Ordering chemo • Help button not useful • Not intuitive • Not always easy to find some information • Links from one system to another often slow and complicated • Not interactive for clinicians • Sometimes difficult to pinpoint information 	<ul style="list-style-type: none"> • Fairly quick to move between screens • Simple to review for clinic letters
Accessibility and availability	<ul style="list-style-type: none"> • When the computers go down/ freeze/ crash etc there is no way of getting to anything • Need for computer access • No relevant information from outside trust, so I have to use the paper and maxims which adds to wasted time • Can't access results in peripheral hospital clinics • Backup if computers crash • Password changes • Repeated time out and the need to login frequently 	<ul style="list-style-type: none"> • Single point of access for info • Single sign on - but not available everywhere • Allows access to most salient aspects of a patient's history • Easily accessible patient letters • Remote access • All info available • The fact it is finally getting rolled out • Holds a lot of information • Allows one to do some work without case notes
Patient Safety		<ul style="list-style-type: none"> • Abnormal results don't slip through the net so easily • Definitely safer for chemo prescribing and administration
Functionality	<ul style="list-style-type: none"> • I would like to be able to enter new note when patient contacted for example by the phone • Lack of functionality • Would like to find a way to track all of my patients (i.e. have a list) - on treatment also • I would like to be able to see if chemotherapy given or not on particular date 	<ul style="list-style-type: none"> • Good for tracking case notes
Training and Support	<ul style="list-style-type: none"> • Knowing where to ask for help when the system appears to fail 	

Table 4.4-11 Medical staff comments

Theme	Most Negative Aspects	Most Positive Aspects
Efficiency	<ul style="list-style-type: none"> • Sometimes a bit slow • Repetitive information • It should be able to give us more • Speed is sometimes quite slow • Timely to get to information 	<ul style="list-style-type: none"> • Blood results are quickly available
Integration	<ul style="list-style-type: none"> • Cannot access results from all the hospital that I need to 	<ul style="list-style-type: none"> • Enables access to some of the other hospitals in the area for results that I need e.g. scan results • CT etc. results available from other hospitals
Usability	<ul style="list-style-type: none"> • Slow to change between screens • It's just not user-friendly • Limited patient pathway information • No flexibility • Outdated information is not removed • Maxims not detailing information from a long time period • Can be time consuming having to go in to numerous areas to get different results • Incomplete clinical records • Information is not always accurate 	<ul style="list-style-type: none"> • Easy to use
Accessibility and availability	<ul style="list-style-type: none"> • Cannot view at patient bedside • Not able to access blood results from other hospitals • Having access to a PC • When the system goes down it directly stops work/ affective work 	<ul style="list-style-type: none"> • Much improved since single log in has been introduced • Can be viewed from all over trust • Live access to up-to-date information about patients • Accessible from any pc • Don't need to have the case notes all the time. • Viewing clinical letters easily
Training and Support	<ul style="list-style-type: none"> • Poor computer skills can directly slow down care • Complex to learn 	<ul style="list-style-type: none"> • Once you have mastered the skills it's okay, but the older generation don't always have the skills and it can take a long time, I know from personal experience

Table 4.4-12 Nursing staff comments

Nursing staff did not make any comments relating to patient safety but, in common with medical staff, the themes with the most comments were accessibility and availability, and usability.

Theme	Most Negative Aspects	Most Positive Aspects
Efficiency	<ul style="list-style-type: none"> • Slow (x 9 comments) • Delays to timeliness of data entry 	<ul style="list-style-type: none"> • Quick (x 3 comments) • I am satisfied with the system It is great as a supplement to the paper record, or the paper record is great as a supplement to this system Overall okay
Reliability	<ul style="list-style-type: none"> • Error messages and bugs • When it breaks it disrupts work • The error messages make no sense to non-IT people • Any downtime, not often • Freezes • Frequently crashes 	<ul style="list-style-type: none"> • Reliable
Integration	<ul style="list-style-type: none"> • Whilst it has this hospital's letters on the system, it does not have letters from GP's or other hospitals • Not everything shown in the one system 	
Functionality	<ul style="list-style-type: none"> • It does not give you all the information you need e.g. it says what the regime is but not the dose prescribed or the dose given. • Doesn't keep up with past appointments • Up to date patient records • Staff cannot run reports if needed • Finding case notes • Lack of character space to track files etc. • Clinician input not available 	
Usability	<p>Does not show previous cancelled appt, only the rebooked date</p> <ul style="list-style-type: none"> • Not able to increase text size easily • Not enough info as to current conditions, i.e. why patient has cancelled appoint, why has appt been rearranged • Sometimes lose letters that have been typed and not able to recover them • Drop down lists not reviewed frequently enough <p>Enter button is sensitive and jumps screens sometimes Boxes not relevant to my box should be not available</p> <ul style="list-style-type: none"> • Un-user-friendly • Infill boxes far apart and jump in PAS • Navigation could be slicker • Very old fashioned • Disjointed • On line help sometimes not always easy to understand • It looks dated, old fashioned screens • It doesn't show cancelled outpatient appointments in Maxims • Unclear 	<ul style="list-style-type: none"> • User friendly • Easy access • Easy (x3) • Simple to use • Easy access to records • Easy to use • It does the job • Does the job • Simple to navigate round • Easy to use system • All information in one place • Can't think of any • Easy access to a large volume of key data • Overall, I am satisfied with how easy it is to use this system • It is fairly easy to get to grips with • Easy to rectify problems • Comfortable • When the information is there it is great • Multiple tracking to update location is easy • Easy to use • Enhances validation
Accessibility and availability	<ul style="list-style-type: none"> • It is not available to everyone who needs access to it. I.e. Other staff in other hospitals, whilst linked to CCO one way or another and who need to write into these notes, cannot access this system to do so. 	<ul style="list-style-type: none"> • Access to information at any location • Accurate information available 24/7 • Accessible
Training and Support		<ul style="list-style-type: none"> • It is easy to use once trained I can effectively complete my work using this system

Table 4.4-13 Administrative staff comments

Nine of the Administrative users of the EPR systems stated that the system was “slow.” However, in the positive comments section of the questionnaire, three respondents stated it was “quick” or “fast.” Similarly, within the comments coded to the usability theme, there seemed to be a mixture of responses that indicated contrasting user perspectives.

The most important theme to emerge from the comments from this staff group was usability, with 14 respondents stating that the system was either “easy” or “simple” to use. Within the senior management group of respondents, there were three negative comments, which were all categorised as relating to functionality: the EPR does not facilitate good care planning or patient assessment; and the assessment tab lacks detail. The positive comments were also functionality-related: “ease of pulling audit data” and “single nurse management system.”

Theme	Most Negative Aspects	Most Positive Aspects
Reliability	<ul style="list-style-type: none"> • Timeouts • Crashes • Downtime 	
Efficiency	<ul style="list-style-type: none"> • Too slow 	
Accessibility and availability	<ul style="list-style-type: none"> • Can't access Wirral University Teaching Hospital lab results 	<ul style="list-style-type: none"> • Access to nursing notes • Access to CCO lab results • Access to patient correspondence
Usability	<ul style="list-style-type: none"> • Screens too busy to look at 	<ul style="list-style-type: none"> • Clear • Easy to use • Paperless
Functionality	<ul style="list-style-type: none"> • One-way transfer of info between PAS and CRIS e.g. update of patient demographics 	

Table 4.4-14 Radiographer staff comments

As shown in Table 4.4-14 above, a limited number of comments were made by Radiographers, with positive statements about accessibility and usability of the current EPR systems.

Theme	Most Negative Aspects	Most Positive Aspects
Efficiency	<ul style="list-style-type: none"> • It generates work • Waiting for screens to swap can slow me down • Speed (2) • Hasn't improved my efficiency 	<ul style="list-style-type: none"> • Reduces the need to carry reams of paper work but as Drs do not use it, I still have to find and read case notes as well. This means I am duplicating my entries in both maxims and in the case notes, which is not efficient
Reliability	<ul style="list-style-type: none"> • Timed out with Microsoft message sometimes • Errors can only be corrected e.g. in documents, by contacting the maxims team, and even then this cannot always be done. Additionally, on many occasions the system has crashed and I have been unable to access patient notes so I have been unable to treat the patients who have attended to be seen. 	
Functionality	<ul style="list-style-type: none"> • It requires other supplementary systems • No chemo scheduling • It does not allow physiotherapy treatment notes to be recorded on a body map using nationally and internationally agreed symbols for treatment techniques and grading • duplication of information • Doesn't allow me to be paper free and probably never will 	<ul style="list-style-type: none"> • It should assist workload planning • only as good as the info put in Comprehensive
Accessibility and availability	<ul style="list-style-type: none"> • lack of access to computers • Occasional users always find that their password has expired 	<ul style="list-style-type: none"> • Access to information instantly • It should make data more accessible • Patient Records available from anywhere
Usability	<ul style="list-style-type: none"> • Appointment lists are not intuitive • No user-friendly part for specific profession • It requires switching screens multiple times to find what you need 	<ul style="list-style-type: none"> • patient treatment plan available • Easy to use, when you know how • Easy to use on a 1 basis • It should ensure consistency of data • Clear • Able to monitor patient appointments and co-ordinate my outpatients using the clinic system • Enables audit to be easy • No paperwork or filing etc. • Easily negotiated around
Training and support	<ul style="list-style-type: none"> • My poor IT skills - sometimes don't know where to find things 	

Table 4.4-15 Allied Health Professional Comments

4.5 Discussion

Having presented the results of the patient records survey in the previous section, this section now discusses the results in further detail, with reference to the literature about previous, similar studies. As reported in Chapter Two (2.7), the most notable studies to have investigated users'

views and experiences using EPR systems in oncology were those conducted by Galligioni et al. (2009) in Italy and Sicotte et al. (2016) in Canada. It was reported in both of these previous studies that levels of user satisfaction with the EPR systems were neither strongly negative nor strongly positive, although Sicotte's et al.'s (2016) research highlighted that overall ease of use was more positive than all of the other features assessed and with an average score of 3.89 on a Likert scale, compared to 2.42 in this study. This suggests that there were clearly higher levels of satisfaction with the system used in Canada, compared with the EPR systems at The Clatterbridge Cancer Centre. With reference to other features that scored a higher level of satisfaction, those with the highest average scores also featured in the "perceived system quality" section of the survey, with the most notably high average score being for accuracy (3.92), although other items in this category scored relatively low (e.g. data entry errors, lost and incomplete orders). The comparable section of the CUSQ survey used in this study was INFOQUAL, which again found noticeably overall lower levels of satisfaction among the EPR users at The Clatterbridge Cancer Centre, compared to those at the Canadian cancer centre. Similarly, Galligioni et al.'s (2009) Italian study found a good level of user satisfaction with EOPR system rolled out and evaluated over the course of several years.

One possible reason for this higher level of satisfaction relative to previous studies is the extent to which the study site is self-contained. Although Sicotte et al.'s (2016) study was eventually extended to include six peripheral clinical locations, there was little indication in the studies by Galligioni et al. (2009) or Sicotte et al. (2016) that cross-organisational working and interoperability with external systems was an issue of concern.

The preliminary analysis indicated that "usefulness" was more of a problem than usability, in the sense that, from the end user's perspective, the systems appeared to work reasonably well for the tasks that they were designed to support, but they did not appear to offer the necessary range of functionality to support all tasks required of them.

Following the review of literature about previous studies, this exploratory phase of the research highlighted a number of areas requiring more in-depth investigation in order to establish the reasons behind the inclusive statistical analyses; the apparent lower levels of satisfaction reported in comparison with other, similar studies; and the range of different comments made about use of the systems. In particular, it was clear that further research was required to explore in-depth with the medical staff group, given that participants in this group made more negative comments and were exposed to the widest range of functionality provided by the systems.

The previous studies conducted by Galligioni et al. (2009) and Sicotte et al. (2016) only included a small group of medical staff within a wider sample of healthcare workers, and the results of

their user satisfaction surveys were based on a limited number of participants representing a range of different professional roles. This wider cross-section of staff may have prevented more detailed insights from being obtained via an in-depth study focussed on a specific category of clinical end user; in the case of medical staff, the most advanced users of EPR functionality, exposed to workflow processes such as complex oncology order sets and SACT that only this group is qualified, trained and authorised to use.

4.6 Limitations

It should be acknowledged that the survey results were only relevant to the case study site at a particular point in time, and it is not suggested, especially at this exploratory stage of the research, that they were entirely representative of the use of EPR systems in other cancer centres. For example, at the time of the patient records survey, the implementation of electronic prescribing of chemotherapy was in the early stages, with only 10% of prescriptions prescribed electronically, a figure which increased to >60% in the subsequent 6 months and reached 100% compliance beginning in April 2015. However, despite many years of EPR projects, it is not an unusual situation for a leading cancer centre to still be at this relatively early stage of development of its clinical IT systems, and some of the systems used at the centre are the same as, or very similar to, those used at other UK cancer treatment centres. Therefore, the findings from this study might be of interest and relevance to other specialist centres starting to develop clinical IT systems.

It is also acknowledged that the findings may not be reliably representative of all EPR system users at Clatterbridge Cancer Centre. The survey response rate was relatively low in some staff groups and therefore the results may have provided varying degrees of representation of those entire groups. Only a small number of specialist non-medical cancer roles completed the survey questionnaire, such as Pharmacists and Physicists, for example, and therefore it would not be appropriate to assume that their responses were representative of the entire staff groups that they were members of.

4.7 Conclusion

This chapter of the thesis has explained the results of data analysis from the first exploratory phase of the study. The results have identified the importance of the accessibility and currency of oncology patient records as well as the usability of EPR systems. Various EPR themes emerged from end user feedback about existing patient record systems. In the next chapter, the next phase of the research programme is explained, including a description of how semi-structured interviews were conducted with oncology clinicians to obtain more detailed qualitative

data for analysis, with the overall study being conducted in line with the Guidelines for Good Evaluation Practice in Health Informatics (GEP-HI) framework (Nykanen et al., 2011).

In conclusion, the exploratory research phase highlighted the need for further progress in implementing effective IT systems to support day-to-day clinical practice in cancer treatment services and a requirement for more in-depth qualitative information about oncology EPR end users' views and experiences. In the next section of the thesis, the methods, analyses, and results of the second and main phase of research are presented.

Chapter Five: Qualitative study

5.1 Introduction

In the previous chapter, the exploratory study was described. As explained in Chapter Three, the mixed methods study described in this thesis comprised two main phases conducted in an oncology setting: first, the exploratory study, based on quantitative research that was presented in the previous chapter; and then the in-depth qualitative study that was conducted to explore the factors impacting oncologists' adoption and use of EPR systems. This chapter presents the methods, analyses, and results of the main study of this thesis, a qualitative study, in which data were obtained using semi-structured interviews and analysed using a phenomenographical method. The aim of this study was to examine the issues related to the adoption and use of EPR systems in more detail, based on the findings of the exploratory study carried out in Chapter Four.

This chapter comprises nine sections to describe the details of the study and the main results. Section 5.2 revisits the overall research aims and questions and clarifies the particular areas of focus for the main qualitative study. In Section 5.3, which focuses on the qualitative study design, the research setting and procedures for identifying and recruiting participants are explained. This section is followed by a description of the methods used for data collection, a pilot exercise, the approach to semi-structured interviews, the method of data analyses, and the validation of results. Section 5.4 provides an overview of the findings of the main qualitative study before these results are analysed in more detail in Section 5.5. The patterns of conceptions presented are then summarised in Section 5.6. The limitations of the study are discussed in Section 5.7, identifying aspects that require further investigation in the future. Finally, sections 5.8 and 5.9 respectively conclude the chapter by identifying directions for further research and describe implications for the triangulation and comparison of the results with the findings from the preliminary research presented in Chapter Four. The application of the FITT theoretical framework (Ammenwerth et al., 2006) and finalisation of the CICERO model are discussed in the following chapter, Chapter Six.

5.2 Qualitative study research aims

As presented in Chapter One (Section 1.7), this study investigated the following over-arching research question: "What are the factors that influence the adoption and use of EPR systems by clinicians in cancer services?" It was anticipated that answering this question would provide theoretical, methodological, and practical research contributions to the field of health

informatics. Specifically, as proposed in Section 1.7, this study's findings may inform recommendations for future developments in cancer treatment services, with a view to improving healthcare services for both clinicians and patients. The extent to which these aims were achieved by the study is described in Chapter Seven.

This Chapter describes the second and main phase of research, in which the researcher built upon the findings of the exploratory phase by designing and conducting a more in-depth study to investigate the factors that affect adoption and use of EPRs with medical end users, as one of the key professional roles using the full range of functionality provided by the systems.

This phase of the study aimed to answer the research questions about adoption, acceptance, and use by exploring the issues related to the key themes of usability, accessibility, interoperability that emerged from the patient records survey. By interviewing a number of clinical end users, the issues were investigated in detail to establish whether or not the areas identified by the survey are confirmed as the most important problem areas limited increased adoption and user satisfaction.

5.3 Research methods

Further to the details of the overall methodology for this research described in Chapter Three, this section describes the specifics of the main phase of qualitative research, including the study design, research setting, and method of enrolling participants and data generation. This description is followed by an explanation of the preparatory work required for undertaking the interviews, the pilot study, the methods used to collect and analyse data, and the methods used to test the reliability and validity of the results.

5.3.1 Qualitative study design

As previously mentioned (Section 1.7), the main aim of the study was to investigate the factors that could influence the adoption and use of EPR systems in oncology. These factors were established by exploring users' conceptions of working with EPR systems in oncology, an approach that was essential to understand the key factors that affect adoption and use of these systems. A qualitative approach was selected for the main phase of the research, as this approach could build upon the results of the exploratory patient records survey, presented in Chapter Four, to provide a more in-depth understanding of the issues affecting adoption and use of EPR systems from a user's perspective. This approach is also in keeping with the interpretivist paradigm discussed in Chapter Three (Section 3.5). As explained in Section 3.7, the particular qualitative approach used in this main phase of the study was

phenomenography, an approach in which the researcher considers the phenomena under study from the perspective of the research participants and analyses differences in those perspectives.

5.3.2 Research setting and EPR systems used by oncologists

As explained in Chapter One (Section 1.4), the main study site for this research was The Clatterbridge Cancer Centre NHS Foundation Trust (CCC), one of three comprehensive cancer centres in the NHS in England. The CCC employs approximately 1,000 staff and operates from ten hospital sites across Merseyside and Cheshire, treating over 30,000 patients a year via systemic anti-cancer drugs, radiotherapy, and proton therapy treatment modalities (CCC Annual Report, 2013).

At the time of the main qualitative study (March to May 2015), a project to digitise paper-based patient records was in progress at CCC, with 45% of active patient records being stored and accessed by clinicians in “electronic only” format. The main EPR system in use, IMS Maxims, was due to be replaced with a new integrated hospital-wide EPR system in 2016 (MEDITECH). In addition to IMS Maxims, several other clinical information systems were in use at the cancer centre and at the various host hospital sites from which CCC runs outpatient and chemotherapy treatment clinics. Table 5.3-1 provides an overview of the range of systems used by oncologists.

System	Description	Internal or external system
Carestream PACS	Picture archive and communications system (PACS) used by most NHS hospitals in Cheshire and Merseyside. Trusts in the PACS consortium are able to share diagnostic imaging studies electronically via a “global work list.” PACS is used to store and provide access to CT scans, MRI scans, and X-rays.	Internal and external
IMS Maxims	The “core” EPR system used for recording details of diagnosis including cancer staging; radiotherapy action sheets (orders); inpatient/nursing assessments and care plans; clinical correspondence; laboratory orders and results (for inpatients and outpatients from the Wirral only); and chemotherapy treatment plans.	Internal
IMS Hearts PAS	Patient administration system used for patient registration, booking outpatient clinic appointments, admissions, discharges and transfers, and cancer waiting times. Provides the master patient index for all other CCC clinical systems.	Internal

System	Description	Internal or external system
Sunquest Integrated Clinical Environment (ICE)	Used for requesting diagnostic tests (pathology and radiology) and reviewing their results. Different instances of ICE are used in several external host hospitals where CCC runs clinics.	External
Ascribe electronic prescribing and medicines administration system (ePMA)	Used to prescribe and administer cycles of chemotherapy treatment, the Ascribe ePMA system is accessed by oncologists, non-medical prescribers and nursing staff via the IMS Maxims system, launching the Ascribe user interface in patient context. This system also provides the patient medications record and is accessed directly (i.e. standalone, not via IMS Maxims) by staff working in the cytotoxic pharmacy production unit for pharmacy stock control and logistics.	Internal
Kainos Evolve	A "read only" electronic document and records management system (EDRMS) with sections of each patient's electronic medical record structured to reflect the format of the paper medical records folder. Approximately 45% of active patient medical records have been digitised (scanned) into Evolve and completed electronic clinical correspondence is automatically sent from IMS Maxims into the relevant section of a patient's case file in Evolve.	Internal
Varian ARIA	The radiotherapy information system used for radiotherapy prescribing, planning, and delivery. Medical physicists and therapeutic radiographers are the main users of ARIA, but clinical oncologists use some applications within the system for prescribing treatment and outlining dose/volume.	Internal
HSS clinical radiology information system (CRIS)	A shared instance of the CRIS is used by all hospitals in Cheshire and Merseyside for managing workflow processes associated with diagnostic imaging orders and results. CRIS is primarily used by diagnostic radiographers and radiologists who produce reports relating to imaging studies (e.g. CT, MRI, PET scans).	Internal
BigHand Digital Dictation	A digital dictation system used by oncologists to dictate clinical correspondence to GPs, referring surgeons, and patients. Generated using BigHand via a Blackberry device, the audio dictation files are sent wirelessly to a system at the main hospital site where medical secretaries transcribe them.	Internal

Table 5.3-1 Overview of clinical information systems used by CCC oncologists

5.3.3 Sampling and recruitment

Prior to arranging the interviews, a scoping exercise was conducted to establish different EPR user profiles and their clinical system access levels. This included a review of the various clinical roles set up on the EPR systems at the study site. The researcher considered including a wide range of different groups of oncology staff in terms of clinical roles, qualifications, professional experience and their use of different system functionality, as per the findings of the exploratory patient records survey. However, in order to gain a more in-depth understanding of users' conceptions within a particular clinical staff group, the researcher decided to use a type of purposive sampling method called *criterion-based sampling* (Palys, 2008), whereby only medically qualified individuals (i.e. doctors/clinicians) were invited to participate.

There were two main reasons for applying criteria to the sample of participants. Firstly, if maximum variation sampling had been used to include participants from a wider variety of roles in the survey study (Chapter Four), sufficient numbers of participants from each different role would have been required for phenomenography to be applied appropriately. This approach would have been taken in order to analyse the variation in conceptions about EPR systems among doctors, nurses, radiographers, pharmacists, physicists, and other allied healthcare professionals. However, while this approach could potentially provide useful and interesting insights into different perspectives on EPR systems, it may have proved difficult to derive meaningful and reliable findings due to the range of different systems and functionality used by a wide variety of staff in these different roles. Hence, in order to investigate the variation in conceptions within one particular study group, the researcher decided to focus attention on one group using criterion sampling, i.e., doctors. Ideally, a more diverse sample would have been preferable, but this was not a practical fit for the project, partly because of the decision to use phenomenography and for logistical reasons: a larger-scale study in the future, or one using a different analytical approach, could perhaps take a broader range of perspectives into account.

The second reason for the decision to focus on clinicians in this study is that medical users of EPR systems use the widest range of clinical functionality. In addition, due to their allocation to different hospital locations across the region, they also have greater exposure to EPR systems used at other hospital sites than other clinical staff groups working in oncology. The inclusion of only medically-qualified staff in the sample group enabled the researcher to investigate variations in perspective within a specific group of research participants who use the most wide-ranging and advanced EPR functionality in oncology.

Once clinicians had been identified as the user group to focus on in the qualitative study, and ethics approval had been obtained (as described in Section 5.3.4 below), the medical director at the study site was asked to send an invitation to participate to all oncologists to maximise the

response rate, as explained further in Section 5.3.5.

5.3.4 Ethics Approval

As noted in Chapter Three, research ethics approval was also secured for the study, including a review of the proposed methodology for data collection, analyses and dissemination of results. The application for ethics approval from The University of Sheffield is provided in Appendix C for reference. Following review of the application a formal letter of approval was received, which is also included in Appendix C.

5.3.5 Data collection

Semi-structured interviews were conducted as the primary method of data gathering for the study, as the researcher planned to explore users' conceptions about EPR systems. As mentioned in Chapter Three, several authors (e.g. Mason, 2002; Marshall & Rossman 2011; Green & Thorogood, 2013) have explained that qualitative interviewing is one of the primary methods for generating data that can be used to inform an improved understanding of the views, discernments, sentiments, practices, mind-sets, and conceptions of research subjects in different settings and scenarios.

Yates et al. (2012, p. 102) cited several authors who agree that, in phenomenography, the main method of data generation is face-to-face interviews. Ballantyne and Bruce (1994, p. 49) stated that phenomenographical interviews share several features in common with other qualitative research interviews:

- “They are focussed on the research subjects’ world-view
- They aim to comprehend the meaning of phenomena in the research subjects’ world-view
- They intend to describe the perspectives of the research participants qualitatively and accurately without pre-conceptions or assumptions
- They are concentrated on a particular phenomenon and topics or ideas related to it
- They are flexible, prone to vagaries, and subject to modification
- They are conducted through interactive, personal communication
- They can be an enjoyable experience for the researcher and interviewee”

Nonetheless, the key distinction between interviews in phenomenography and other qualitative interviews is that, in phenomenography, there is an increased focus on investigating *variation* in how the interviewees experience and comprehend the phenomenon of interest. In addition to

reviewing guidance on qualitative interviewing techniques (e.g. Marshall & Rossman, 2011; Mason, 2002; Green & Thorogood, 2013; Berg, 2007), the researcher assessed data collection methods used in similar previous studies (e.g. Barnard et al., 1999; Maun, Engstrom, Frantz, Bramberg, & Thorn, 2014) and considered specific guidance on phenomenographical data collection issues when developing this study's research design.

As described later in this chapter, the researcher achieved this continual evaluation by taking notes in the interview; asking for informal participant feedback; listening to each interview audio recording carefully after each was completed; and considering improvements that could be made to the style, trait, and body language for subsequent interviews.

With reference to the methodology explained in Chapter Three, it should be noted that this study's phenomenographical approach is rooted in an interpretivist standpoint. Interpretivism was deemed to be important for this study because this epistemological perspective enables the researcher to recognise the nuances and variation in oncologists' experiences of the social-technical world in which they use EPR systems; it also highlights the need to understand these clinicians' views and experiences in order to answer the main research question.

5.3.6 Planning and preparing for phenomenographical interviews

For the second phase of empirical research in this study, semi-structured interviews were designed with questions grouped into the three main factors of the FITT model: individual, task, and technology.

The specific questions asked were derived from a combination of the literature review, FITT theoretical framework, themes arising from the analysis of the survey questionnaire, and examples of types of questions used in other phenomenographical studies. The questions and approach to the interviews concentrated on solid experiences so that the focus would be maintained, averting phrases about how things should be, or ought to be. The interview schedule, including the interview questions, is presented in Appendix D.

Interviewees for the study were recruited via an invitation that was sent out by the Medical Director at the case study site, on behalf of the researcher. An information sheet and consent form was distributed (Appendix E), including an explanation of the research purpose and research methodology. It was made clear that participation in the study was optional and that retraction from the study at any time would be entirely the participants' own choice.

The information sheet also clarified the research methods to be applied and the types of questions that were to be asked. The plan for managing and processing the data gathered was explained, providing assurance that participants' anonymity and confidentiality would be protected. This would include data storage, analysis, and how the information would be used in future. Potential risks and benefits of the research were also explained.

Oncologists who agreed to participate were contacted by the researcher to schedule a convenient date and time for the interview, which was expected to take approximately 30-40 minutes. Interviews took place onsite at the cancer treatment centre, either in the interviewee's office, the researcher's office, or a meeting room. The researcher talked through the information sheet with the participant and offered them the opportunity to ask questions before both parties signed the consent form and the researcher initiated the interview. Interviewees were informed that the interview was to be audio-recorded (and that the recording would be stored securely and only used for research purposes) before being asked to indicate their agreement to this on the consent form. The participants were informed that ethical approval had been secured for the study via appropriate formal processes.

5.3.7 Pilot study

As explained in Chapter Three, the interview guide was developed to include questions that were deemed appropriate for exploring the views and experiences of the oncologists in relation to the three different domains of the FITT framework (Ammenwerth et al., 2006). These questions were included for the purpose of obtaining a rounded view of experiences that acknowledged the interrelationships between the oncologists, the EPR systems, and the clinical work undertaken in the cancer centre as a whole. In order to ensure that the interviews were structured appropriately, with a smooth flow of questions that would facilitate a conversational discussion with the participants, the first seven interviews were used as a pilot exercise. It was helpful, therefore, to evaluate the handling of the pilot stage interviews (Prosser et al., 2000).

In previous phenomenographical studies (e.g. Maun et al., 2014; Carlsson et al., 2016), analysis of interview techniques considered the different types of questions asked. The questions were categorised as follows: question asked from the prompt list, questions asked as a follow-up to what the individual had said, and confirmatory responses or expressions of interest. Analysis based on these categories can highlight researchers' propensities to dictate the interview or to not follow through sufficiently on the interviewees' responses. Furthermore, Prosser et al. (2000) reported that some questions just did not "work" in some studies; for example, certain questions might fail to generate a natural response from the oncologists, or their answers may seem forced or lacking conviction. These issues were carefully considered when reviewing the recordings and transcripts of the first seven interviews that constituted the pilot study. Whilst it can be

inherently difficult to measure accurately whether an answer lacks conviction and to know whether questions have been followed up and probed sufficiently, this skill can be developed through careful reflection on the interviews and the identification of similarities in responses, where the participants may appear hesitant or uncertain, for example.

The pilot study highlighted the requirement for the interview guide (Appendix D) to be modified to include additional questions, such as what participants think the ideal oncology EPR system would be and what they see as the main purpose of EPR systems. These questions proved to be very helpful in prompting the oncologists to consider their system requirements and their perspectives on EPRs. They assisted the participants in thinking about what they liked and disliked about the various information systems they currently used.

The pilot interviews also allowed the researcher to build confidence in his interviewing technique and to try different follow-up questions, ensuring that the questions elicited natural and relevant responses. The audio recordings and transcripts of the pilot interviews were analysed at a high level, and an initial assessment was completed to identify any adjustments needed to interviewing technique. Following the pilot study interviews, the questions were reviewed, and minor adjustments were made to the sequencing and potential follow-on questions. As a result of this pilot study, the interviews in the main study were conducted in a more confident and relaxed manner, both from the interviewer's perspective and based on feedback from participants, with a better flow of discussion between the researcher and interviewees. As no major adjustments were made, the pilot interviews were included in the subsequent data analyses and main part of the study.

5.3.8 Data analyses

The interviews were audio recorded using a MacBook Pro and Audacity, a free open-source digital software application for audio recording and editing. The use of open source software did not raise any particular data protection concerns, as the audio files were stored securely and backed up in a private offline storage facility. The interviews were then transcribed verbatim for analyses, with assistance from a contract transcriptionist. The participant demographic information collected for all participants was used to present the sample characteristics.

A phenomenographical approach was used to analyse the interview data (Marton, 1986). As explained in Chapter Three, this involved seven steps: familiarisation; compilation of responses; condensation or reduction of the individual responses; initial grouping or classification of analogous responses; preliminary comparison of categories; ascribing a name to each category; and then finally, assigning a metaphor to each category of description. This seven-stage process is explained further below and illustrated in Figure 5.3.1 at the end of this sub-section.

During the first stage of the process, familiarisation, the researcher listened to the audio recordings of the interviews several times and reviewed the transcripts carefully. Notes were made about any relevant thoughts, ideas, and background information, such as how well each interview went and any particularly memorable statements made by the participants. To prepare for the second step, the transcripts of all interviews were imported into QSR NVivo 10 for Mac and were coded via the software program, which, as mentioned earlier, is used for conducting qualitative data analyses. The software enabled the researcher to code excerpts from the transcripts into nodes and classify them accordingly against appropriate themes, sub-themes, categories and sub-categories.

A series of nodes were created for each interviewee and for each of the main interview questions. Each participant's answers to the interview questions were then coded appropriately so that the answers to each question were compiled and could be analysed in relation to the theme or topic the question addressed. These compiled answers were then reduced down to shortened sections of text that were of particular relevance or representative of a key issue or theme in the data. These themes were created as nodes so that other similar passages of text could be coded to them, allowing the preliminary classification of answers. This, in turn, led to the fifth stage of the phenomenographical analyses, the comparison of categories. Towards the end of the analyses, the categories of description were named, and then, in the final stage of the process, metaphors were created for them. As explained in Chapter Three, phenomenography requires the creation of categories of description, which collectively form a comprehensive mental model, using metaphoric representation. Using metaphors to illustrate the categories of description had been found to be particularly effective in previous studies, as it helped to identify shared understanding among researchers and participants (Willis, 2018).

Whilst the themes identified during the familiarisation stage were subsequently grouped together into categories of descriptions in later stages of the phenomenographical analyses, the initial themes were still relevant for the purposes of triangulation with the patient survey results and for further discussion in the context of the FITT framework. For example, accessibility was a clear theme emerging from the thematic analyses of the interview transcripts, before it developed further into one of the features within the first category of description. One of the referential aspects of the first category of description was the reliance on other professionals and own memory for information contained within the EPR. This aspect developed from the basic theme of accessibility, in the sense that negative views and experiences of accessibility of the EPR systems encouraged oncologists in this group to place more reliance on other people and their own memory. The basic theme of accessibility is, however, still appropriate for use in further analyses, triangulation and further discussion in Chapter Six. The themes of usability and integration also both follow this logic, whereby they emerged as clear issues of interest or

concern from the initial review of the interview transcripts and coding during the familiarisation stage, but subsequently developed into more nuanced referential aspects within the categories of description. As a further example, the theme of usability is reflected in the second category of description in relation to the EPR design assumptions held by oncologists, several of whom felt the computerised system should reflect the structure of paper-format medical records. In summary this approach to analyses allows the principles of thematic phenomenography to be applied, as described in section 3.10.2 (Forster, 2019), but also supports the requirement for triangulation within a mixed methods study. The different types of triangulation, included data triangulation, are explained in Chapter Six.

To explain in further detail, each of the seven stages are described below with an example of how they were applied in practice using the “workarounds” referential aspect of the first category of description.

1. Familiarisation

Initially, the researcher listened carefully to all of the interviews before they were transcribed verbatim, with assistance from a contractor transcriptionist, into Microsoft Word documents. The process of translating the voice recordings into written text format was a vital part of familiarization, as it involved listening to each of the interview discussions several times and provided an opportunity to identify any subtleties relating to tone of voice, expression, hesitation, and flow of the conversations. This step proved to be helpful as it instilled a deeper level of meaning and individualism in each interview, enabling the researcher to keep each participant’s voice and body language in mind while reviewing the transcripts. Notes were made about each interview, both during the meeting with the interviewee and afterwards, when reading the transcripts. When each transcription was complete, a final check was made; at this stage, the researcher listened again to the voice recording and reviewed the transcript to ensure that any nuances were reflected appropriately in the text.

After each transcript review, the researcher annotated the text files with brief comments about key themes related to views on technology, oncology EPR systems, and the participants’ experiences. As the review of the transcripts progressed, it began to generate an initial picture of commonalities and variations in the oncologists’ perspectives. As the researcher became more familiar with the different participants and their responses to the interview questions, their variation in thinking about EPR systems started to emerge further, in relation to *what* they were experiencing. The overall attitude of each oncologist towards the use of technology and EPR systems constituted the structural aspect of their conceptions: *how* they experienced the systems in their clinical work. The annotations recorded on each transcript were then compared to begin establishing potential variations in clinicians’ thoughts about, and experiences of, EPR

systems in oncology. It should be noted that although the familiarisation stage is typically the first in the phenomenographical method, the data collection and transcription in this study took place over several months; consequently, familiarisation and analysis were conducted as parallel and iterative processes in stages. However, comprehensive analyses following the subsequent stages of the phenomenographical method could not be completed until all of the full transcripts had been annotated and the researcher had familiarised himself with them.

2. *Compilation*

Once the initial familiarisation stage was complete, the transcripts were loaded into the NVivo software application for the next stages of analysis. Passages from the interview transcripts that included noteworthy information were first highlighted on a paper format printout of each transcript before being highlighted on the electronic version in NVivo to create and assign nodes. In contrast with other techniques for qualitative interview data analyses, the phenomenographical approach does not require all remarks in a transcript to be coded (Yates et al., 2012); however, the investigator should be careful not to include phrases or passages of text impulsively, without considering their broader relevance to the topic in question. Thus, the transcripts were initially reviewed in a holistic manner, with significant excerpts highlighted and viewed alongside other comparable text.

Prior to creating nodes for the excerpts, a node was created for each interview transcript. This allowed passages about similar issues to be grouped together (i.e. compiled) against appropriately named nodes, but also for selected phrases from the same interviewee to be viewed together. To illustrate this grouping process, a screen shot is provided as Appendix G, showing a series of nodes in NVivo that were created for the first category of description. In this example, the main display panel on the bottom right of the screen shows several quotations from a single respondent, which were all coded to the same node related to using workarounds. The ability to code the text in this way meant that excerpts could be viewed both within the context of comments made by other oncologists about the same issue, and also within the context of the individual participant's opinions on other topics.

3. *Condensation*

Initially, the passages of text selected for coding were highlighted in full and, in many cases, quite lengthy excerpts were used in order to ensure that the particular issue being discussed was thoroughly explained during analyses. Condensation of these passages was achieved by focusing on the central point that the interviewee was articulating. The condensed passages of text were noted separately from the main pool of meaning (node) and retained as verbatim quotations, but shortened where possible, without changing the keywords and main point and

context of the statements.

4. Grouping

Through the use of NVivo, the coded excerpts of text that were deemed most pertinent to the oncologists' views and experiences of using EPR systems were pooled into groups of similar topics or sub-topics by coding them against an appropriately named node. As an example, several of the oncologists mentioned "workarounds" in their interviews. Initially, there were different statements made by the participants about how they would perform certain tasks if the EPR system was not available, or if they felt they had an easier or more efficient way of completing them without using the system. During the familiarisation and condensation stages, it became apparent that this was a recurring theme among several of the oncologists. Therefore, in the grouping stage of the process, it was appropriate to cluster these statements into a common "pool of meaning."

It should be clarified that individual oncologists could have multiple conceptions, and not all conceptions were centrally linked to an individual, as phrases could be selected from the transcripts and grouped according to their focus and connotation, rather than the particular oncologist from whom they originated. Furthermore, this meant that oncologists were not limited to being linked to only one category, but could indicate multiple conceptions, especially as they were asked to reflect on their experiences outside of the workplace, in their medical training, and working at other hospitals. Because of this, it was important not to focus solely on each transcript as an independent silo of data, as several of the participants were found to experience conceptions that differed in their central focus and therefore fell into more than one of the identified categories. This complication is important to explain, as without recognition of an overlap in the categories, the analyses would have been oversimplified. Notwithstanding the fact that some oncologists voiced conceptions that could be categorised into more than one pool of meaning, the final step in this stage of the analyses was to cluster the excerpts provisionally into categories of description.

At this stage, it was apparent that some of the pools of meaning could be grouped together under a broader categorisation. As an example, one of the referential aspects of some oncologists' thinking included the use of various workarounds to avoid performing certain tasks using the EPR systems. While participants with a different primary conception about EPR systems might also use workarounds under certain circumstances, those oncologists who tended to avoid the use of EPR systems were also more likely to experience the EPR system as a basic information-recording device, rather than a sophisticated clinical support tool. This contrast meant that, conceptually, the use of workarounds to avoid using the systems and the perspective on the value and primary purpose of the EPR system could be linked conceptually

and grouped together logically as referential features of a common over-arching category of description.

5. Comparison

Following the grouping of the various pools of meaning into initial over-arching categories of description, each of the pools (and the various phrases contained within them) were compared to distinguish whether analogous or contrasting ways of experiencing the use of EPR systems were found in other areas of the data, to establish any variation in the perspectives of and attitude toward them. The creation of pools of meaning is essentially a tentative, precursor stage to the formation of the categories of description, whereby similar phrases or passages about a particular theme are grouped together for further analysis. Constant comparison is a procedure that originally formed part of the Grounded Theory research method but, as acknowledged by Boeije (2002), it is also used in other approaches to qualitative data analyses. The main aim of the constant comparison method (CCM) is the systemisation of the analyses. Boeije (2002) further explained that in qualitative data analyses, the primary intellectual device is comparison. The technique of comparing and contrasting is utilised in virtually all intellectual work during analyses: developing categories, setting their boundaries, allocating the segments to categories, evaluating the content of each category, identifying negative features, etc. The aim is to distinguish conceptual likenesses, to enhance the discriminative dominance of categories, and to uncover patterns (Tesch, 1990, p. 96).

Using the CCM technique, during this stage of analysis, the original pools of meaning and their groupings were revised as the commonalities and critical variation in the core content of the excerpts became clearer. As part of an iterative process that involved re-visiting the transcripts and the groupings of text, the excerpts were occasionally moved from one pool of meaning to another, an existing node was re-named to reflect adjustment in focus, or a new node was created. The main aim of this process of comparison was to gain a clear understanding of the core meaning of the issues being articulated by the oncologists and to also describe their experiences from a second-order perspective. Akerlind (2012) explained that Marton believed that traditional research applied an external viewpoint which she termed “first-order” and that, in phenomenography, a “from-the-inside” or “second-order” perspective was required to describe the worldview of the research participants.

6. Naming

The sixth stage of analysis involved labelling the overarching categories of description, using terms that would appropriately convey their core meaning. As with the previous stages, this step was an iterative process, and the original titles given to each category were adjusted following

more detailed consideration of the content and groupings of excerpts. The choice of an appropriate name for each category was influenced by various guidance on this stage of the process in the literature, which suggests that categories of description are usually stated in the form “phenomenon (x) is viewed as something (y)” (Fetterman, 1988).

Initially, pools of meaning were labelled with short descriptions in this format: for example, “EPRs are seen as patient safety systems” and “EPRs are seen as clinical decision support tools.” However, during the iterative updates to the pools of meaning and overarching categories of description, more descriptive titles were developed and then subsequently shortened to focus on the most pertinent conceptions they described.

7. *Contrastive comparison*

In the final stage of phenomenographical analyses, more detailed descriptions were developed for each of the categories, emphasizing their unique features and also their similarities. This step involved articulating the referential aspects of each conception within the category of description, using quotations from the transcripts to demonstrate the key characteristics of each category. Each category of description comprised multiple quotations from the transcripts and, as mentioned previously, each interviewee could hold more than one conception; therefore, each conception was based upon the experiences of more than one oncologist. As per the methodological guidance in the literature, the categories of description were considered in relation to the original source data to ensure that they incorporated all of the significant variations in experience (Marton, 1986).

It should also be noted that some aspects of variation might exist in all of the categories of description. As an example, the referential aspect relating to “workarounds” featured in all categories of description, but with a different emphasis on the underlying reason. The critical variation was related to the different reasons why the oncologists used workarounds in different scenarios. The key distinction in this particular example was the desire to use workarounds as the preferred, or default, approach to undertaking clinical tasks (avoiding the use of EPR systems) versus the unavoidable use of workarounds due to system unavailability or inadequate functionality.

Once a comprehensive description of each conception had been developed, the researcher considered interrelations across categories. In the final stage of the analysis, the outcome space was produced to show the logical, hierarchical relationship between the categories. This was first produced as a tabular summary description and then visually represented in a diagram. The outcome space diagram (Figure 5.4.2) incorporates axes designed to provide further context by showing the positioning of each category in relation to relative levels of systems thinking and technology acceptance. Although this feature is not based on statistical or scientific data, it is intended to illustrate the conceptual positioning of the categories of description in relation to the

overarching socio-technical systems theoretical frameworks used in this research, further emphasising their hierarchical nature.

It should be acknowledged that while the process of phenomenographical analyses broadly follows a sequential series of stages, in practice, a linear process of analysis was not followed rigidly; the actual process was more iterative in nature. As the analysis progressed, it was apparent that earlier stages needed to be revisited for further analysis, evaluation, and critical reflection due to the identification of additional themes that emerged in the later stages. This iterative process was conducted over a period of time, during which the stages were followed in sequence and reviewed multiple times, following a logical structure that led to the creation of a clear outcome space.

As noted in the literature, phenomenography can be a time-consuming approach to data analysis, but eventually a stage is reached where the excerpts have been classified, grouped, and organised so that a stable system of meaning is reached. The final output from the process in this research is depicted in the diagram below (Figure 5.3.1), which shows the pools of meaning grouped into three categories of description. As previously explained, the raw data were processed through seven stages in accordance with the phenomenographical approach to analyses. The flow chart on the right-hand side of the diagram depicts activities that took place at each of these stages with regard to selecting interesting and relevant excerpts, processing them into pools of meaning, and undergoing an iterative process of conceptually linking and grouping until the distinct categories of description emerged.

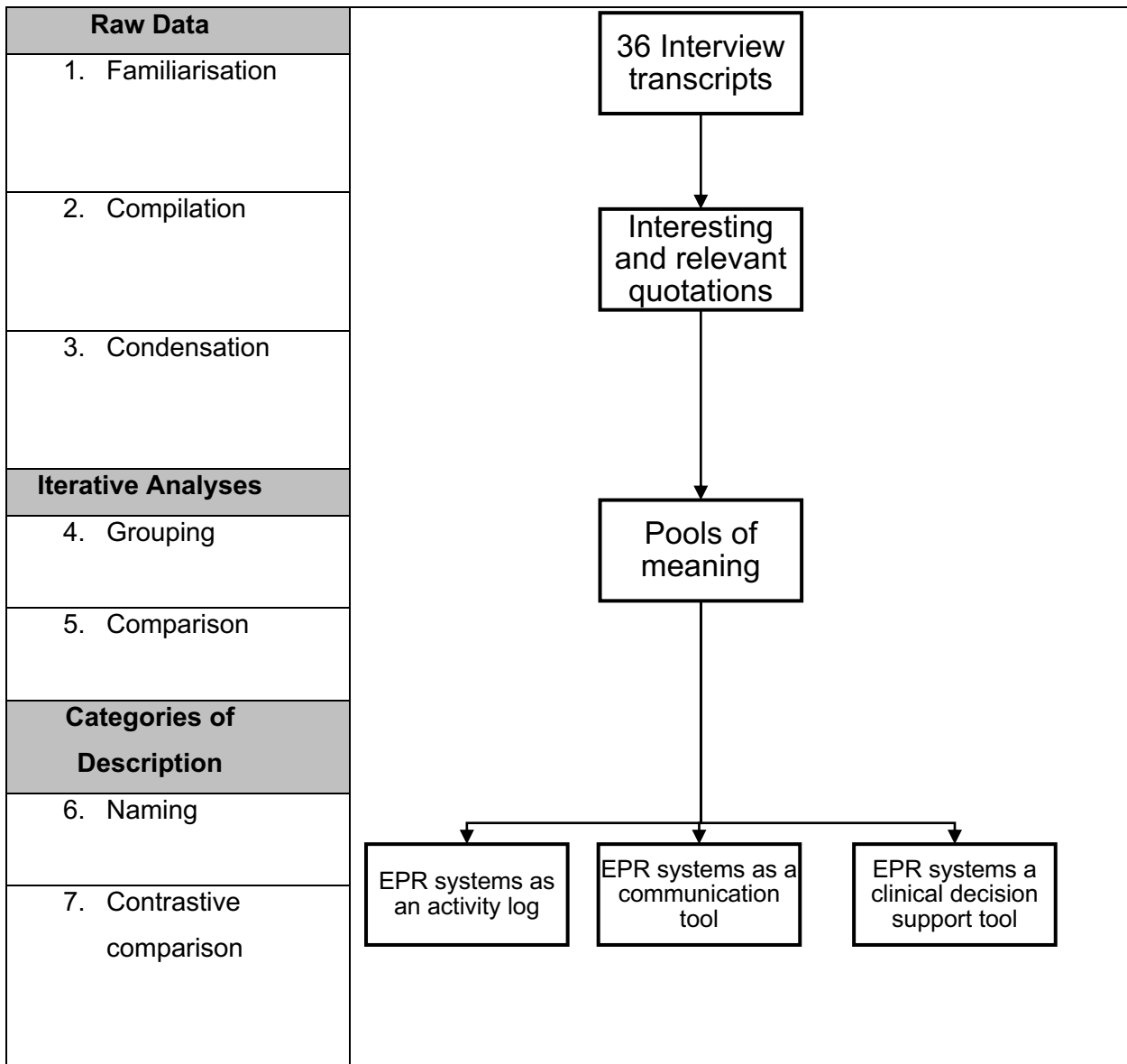


Figure 5.3.1 Process of phenomenographical analyses

5.3.9 Reliability and validity

As stated in Chapter Three, the measures used for evaluating the reliability and validity of qualitative research are different from those used in quantitative research. In this main phase of the research (the qualitative study), the themes identified, the rationale for the pools of meaning, and the subsequent emergence of the categories of description were informally reviewed by fellow PhD researchers to confirm that logical interpretation and categorisation had been followed. Additionally, the integrity of the results was validated via member checking, whereby a summary of the findings and an evaluation form (Appendix F) were issued to the interviewees to obtain feedback and verify that the key results of the study were endorsed from their perspectives. Four replies were received from the 36 oncologists. Although this was a low response rate, the four participants who did respond signified that the findings offered in the

summary results paper were a reliable and truthful depiction of the conversations that they had participated in during the interviews, and that they gave fair coverage of the range of different topics discussed and the responses given.

In this research, it is acknowledged that the data generated and analysed is limited to one particular case study site and organisational context that is not necessarily representative of the whole population of oncologists and their views on EPR systems; the study aimed for transferability rather than generalizability. Given that the maturity and adoption levels of EPR systems are currently at similar levels across NHS cancer centres, the primary aim of this study was to obtain rich data that represents the experiences of numerous oncologists (many of whom had worked in other treatment centres during their careers) and thereby generate potentially transferrable outcomes.

The dependability of the study was ensured via comprehensive record-keeping, in which detailed notes were produced at each stage of the process. This record comprised the participant information sheet and interview guide (Appendix E), consent document, audio files, transcripts, the researcher's notes about the interviews, and NVivo coding logs. This combined documentation provides a complete view of the study, outlining processes and procedures that could be repeated by other researchers conducting similar or follow-up research.

The trustworthiness of the study findings mainly depends upon ensuring that any potential bias on the part of the researcher is identified and controlled during the interviews and subsequent analyses. This was particularly important in this study due to the researcher's role within the organisation and the fact that some of the interviewees were colleagues known to the researcher. To avoid any bias due to these established professional relationships, the researcher emphasised that the interviews were being conducted in his role as a PhD student, not as a senior manager at the study site, and that the interviews were strictly confidential; therefore, the intention was that interviewees should be relaxed and honest in giving their views and opinions about the interview topics. The researcher was also mindful not to introduce any bias in the analysis stage due to his existing knowledge of some of the information systems in use at the study site (although this prior knowledge did prove useful in contextualising some of the insights provided by the participants). Furthermore, the interview guide and strategies for avoiding bias were discussed with the research supervisor, ensuring, for example, that no leading questions were present in the guide or used as follow-up questions. These limitations will be discussed further in Section 5.7.

5.4 Summary of Results

This section of the chapter explains the sample characteristics and the results of the main phase of research.

5.4.1 Sample characteristics

A total of 36 oncologists were interviewed during the main phase of data collection, with the duration of the interviews ranging from 25 to 70 minutes (mean = 42 minutes). At the time of data collection, a total of 75 oncologists were employed at the case study site, including consultants, specialist registrars, and speciality doctors. Due to very low numbers, palliative and psychological medicine consultants ($n = 2$) were not included; radiologists ($n = 7$), who may not work exclusively or full-time in oncology, were also excluded. As these consultants worked on rotation covering a range of other clinical specialities and did not interact directly with the core oncology EPR system, it was deemed appropriate to exclude them from the study to avoid any anomalies in the results.

Foundation doctors (formerly referred to as senior house officers within the NHS) on placement at the case study site as part of their medical training were also excluded from the study, and three potential participants were on maternity leave at the time of the invitation to participate, reducing the total number of eligible participants to 72. The overall response rate from the group of eligible participants in the qualitative study was therefore 50%.

To ensure confidentiality and protect the identity of participants, gender has not been included in the summary table of sample characteristics shown in Table 5.4-1 below, but of those who participated, 64% were male ($n = 23$) and 36% were female ($n = 13$) with ages ranging from 28 to 64 years old. Since one of the participants did not enter their age on the basic information sheet, this individual was not included in the calculation of mean age, which was 44 years old. In Table 5.4-1, age groups have been used to further protect the identity of individual research participants. The participants were asked how long they had worked at the study site, and the responses ranged from one year to 20 years ($\bar{x} = 7.6$ years), with the time in their current job role also ranging from one to 20 years ($\bar{x} = 5.6$ years).

Several types of oncologist were interviewed, with the most significant two categories being medical oncologists, who specialise in the treatment of cancer with systemic anti-cancer treatment (SACT) (44%, $n = 16$), and clinical oncologists, who are also trained to treat cancer diseases with radiotherapy (56%, $n = 20$). Within the participant group, five of the oncologists had academic roles in addition to their clinical roles and, for the purposes of data analysis, they have been categorised according to their clinical role, i.e., as either medical oncologists or

clinical oncologists, as appropriate. One participant was a speciality doctor, a position that can also be categorised according to the post-holder's clinical role, and the same applied to the medical director. One participant was a consultant pulmonologist (a doctor who was trained in diseases and conditions of the chest but was also licensed to prescribe chemotherapy), and it was agreed with the participant that for the purposes of this study, their role could be appropriately categorised as a medical oncologist, meaning that all participants could be appropriately classed as either a clinical oncologist or a medical oncologist.

The oncologists were also categorised into two other main groups, "consultant" and "registrar," with the professor roles being classed as consultants and the clinical research fellow and speciality doctor role being classed as registrars for the purposes of data analysis. Although the speciality grade doctors are qualified and experienced doctors, within the oncology clinical speciality, these two groups can be thought of as "senior oncologists" (consultants: 78%, $n = 28$) and "junior oncologists" (registrars: 22%, $n = 8$).

To enable appropriate presentation of the results of the data analyses whilst ensuring the confidentiality and anonymity of the participants, the IDs in Table 5.1 below were converted into the two main participant types and randomly re-numbered within each type, i.e. Consultant Medical Oncologist (MO) 1 to 15; Consultant Clinical Oncologist (CO) 1 to 20. In the Results section, the participant type and updated number are cited with each quotation.

New ID	Participant ID	Job title	Age group	Time working at case study site (years)	Duration of interview (minutes)
CO1	Pilot 1	Clinical Oncology Specialist Registrar	36–45	5	43
CO2	Pilot 2	Clinical Oncology Specialist Registrar	26–35	5	35
MO1	Pilot 3	Consultant Medical Oncologist (and Professor of Translational Medicine)	Not given	3	26
CO3	Pilot 4	Consultant Clinical Oncologist (and Professor of Radiation Oncology)	>55	1	44
MO2	Pilot 5	Consultant Medical Oncologist	36–45	8	29
MO3	Pilot 6	Consultant Medical Oncologist	36–45	1	40
CO4	Pilot 7	Consultant Clinical Oncologist	36–45	6	35
MO4	Main 1	Consultant Medical Oncologist	36–45	6	30
MO5	Main 2	Consultant Medical Oncologist	36–45	8	50
CO5	Main 3	Consultant Clinical Oncologist	36–45	8	26
CO6	Main 4	Consultant Clinical Oncologist	26–35	7	33
CO7	Main 5	Consultant Clinical Oncologist	46–55	15	54
CO8	Main 6	Consultant Clinical Oncologist	46–55	19	46
MO6	Main 7	Consultant Medical Oncologist	36–45	5	51
CO9	Main 8	Consultant Clinical Oncologist	36–45	8	40
CO10	Main 9	Consultant Clinical Oncologist	36–45	5	35
CO11	Main 10	Clinical Oncology Specialist Registrar	26–35	1	34
CO12	Main 11	Consultant Clinical Oncologist	46–55	20	61
MO7	Main 12	Consultant Medical Oncologist	46–55	4	66
MO8	Main 13	Consultant Medical Oncologist (and Professor of Medical Oncology)	36–45	4	40
CO13	Main 14	Consultant Clinical Oncologist	46–55	12	58
CO14	Main 15	Clinical Oncology Specialist Registrar	26–35	5	32
MO9	Main 16	Consultant Medical Oncologist	36–45	3	44
CO15	Main 17	Consultant Clinical Oncologist	46–55	20	38
CO16	Main 18	Clinical Oncology Specialist Registrar	26–35	2	53
MO10	Main 19	Consultant Medical Oncologist	46–55	5	46
CO17	Main 20	Speciality Doctor Clinical Oncology	36–45	5	54
CO18	Main 21	Consultant Clinical Oncologist	>55	15	34
MO11	Main 22	Medical Oncologist Specialist Registrar (and Clinical Research Fellow)	26–35	2	25
CO19	Main 23	Consultant Clinical Oncologist (and Medical Director)	>55	3	51
CO20	Main 24	Consultant Clinical Oncologist	36–45	14	42
MO12	Main 25	Consultant Medical Oncologist (and Chief Clinical Information Officer)	36–45	5	44
MO13	Main 26	Consultant Medical Oncologist (and Clinical Director)	46–55	17	30
MO14	Main 27	Medical Oncologist Specialist Registrar	36–45	4	70
MO15	Main 28	Consultant Medical Oncologist	>55	20	39
MO16	Main 29	Consultant Pulmonologist (Medical Oncologist)	>55	1	35

Table 5.4-1 Sample characteristics

5.4.2 Overview of the results of phenomenographical analyses

This section presents the findings of the phenomenographical analyses in the following ways. Firstly, the top issues in the technology dimension of FITT (Ammenwerth et al., 2006) are presented, followed by findings from the task dimensions, including which clinical tasks were well supported by the EPR systems and which weren't. Next, the alignment between the FITT model dimensions is discussed. Following this, in sub-Section 5.4.3, a more in-depth analysis of the three main categories of discussion is explained, before the details of the conceptions that make up each of the categories are provided in Section 5.5.

As explained in Chapter Three (Section 3.8.2), the qualitative interviews were broadly structured with reference to the FITT model (Ammenwerth et al., 2006), with questions being grouped into sections that related to each of the three dimensions: individual, technology, and tasks. Figure 5.4.1 below presents the high-level question areas in a diagrammatic format. Although the individual dimension provides interesting contextual information, the main aim of this dimension was to establish a trusting rapport with each interviewee, so that they felt comfortable talking openly about their views and experiences. High-level analyses of the question responses in this category found little variation that would indicate any notable differences in conceptions about general background, roles, responsibilities etc. The main sub-topics within this dimension that led to further phenomenographical analyses were related to general views about information technology and IT literacy.

The other two FITT dimensions, related to technology and tasks, were the main focus of the phenomenographical analyses. As previously mentioned, Figure 5.4.1 shows the different sequential stages of the process of analysing the interview transcripts, which led to the identification and naming of the outcome spaces.

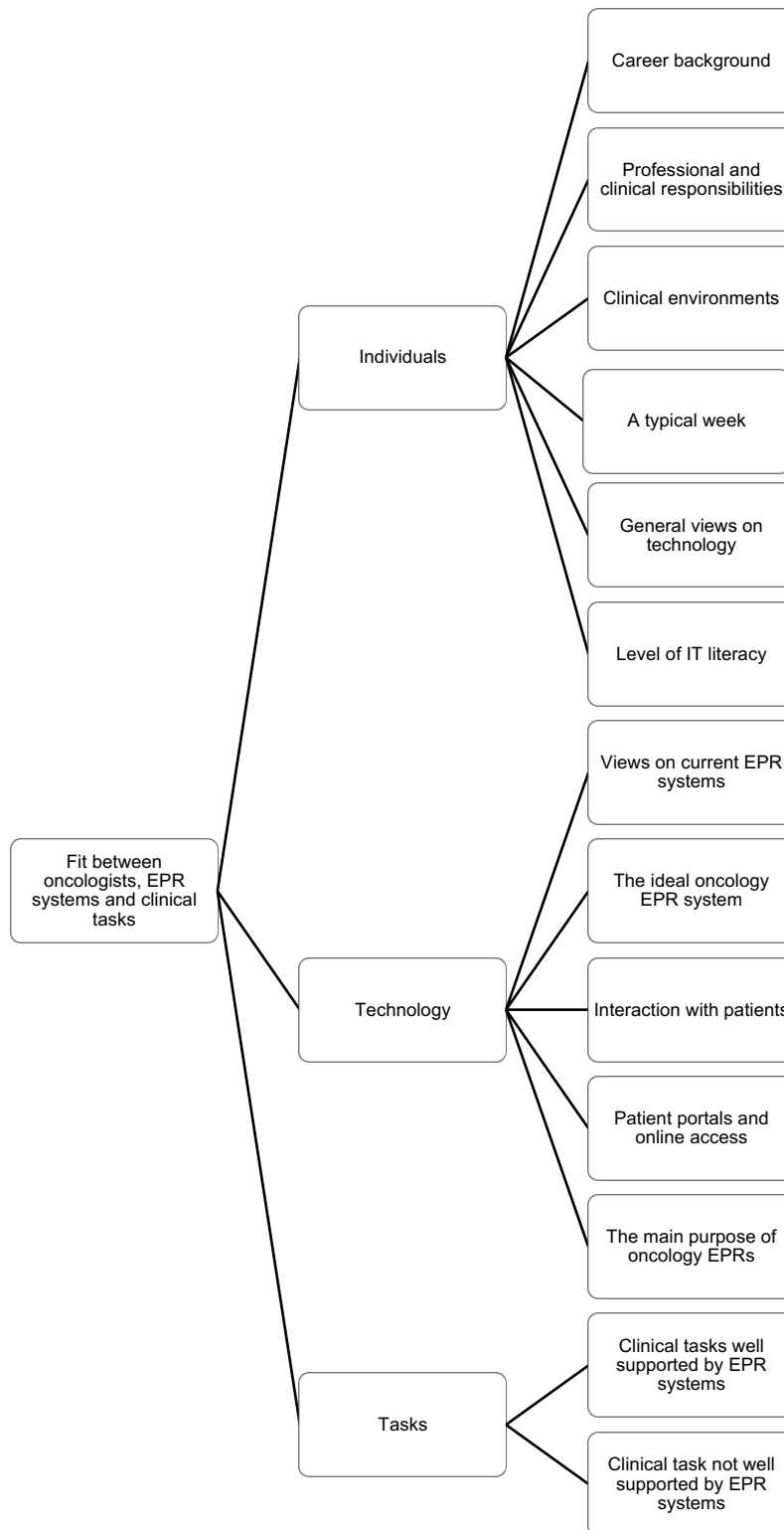


Figure 5.4.1 FITT dimensions and interview themes

Analyses of the individual dimension of FITT (which are explained in more detail in Chapter Six, Discussion) identified several themes that affect the adoption and use of EPRs at the case study site. These include the demographic profiles within the sample characteristics summarised in Table 5.4-1, the experience of using IT systems, self-reported levels of IT literacy, and users' attitudes towards technology in general.

Within the technology dimension, participants were asked about their experiences and views of using EPR systems in oncology and to describe how their ideal system would work. The most important issues that emerged in this area were:

- the requirements for improved integration with other hospital EPR systems – for example, easier access to ordering and viewing diagnostic test results within the oncology record
- improved accessibility – fewer passwords to remember and fewer steps to login to disparate systems
- multi-cycle prescribing of SACT – improved automated workflow processes
- real-time clinical noting – to avoid delays and improve currency of records
- clinical decision support – for example, automatic chemotherapy adjustment based on laboratory test results and changes in patients' height and weight
- clinical messaging within the system – to improve secure communication among clinical teams.

In the third dimension, which was concerned with clinical tasks, the participants reported a number of tasks that were well-supported by clinical IT systems, including radiotherapy planning, PACS image sharing, and digital dictation. Tasks that were not well-supported included: electronic prescribing of chemotherapy; pathology laboratory test orders and results acknowledgement; and access to integrated, complete, and contemporary information for MDTs and outpatient consultations.

With regards to analysing the fit between the three dimensions in the FITT model, in summary, the results suggested that the fit between the oncologists and the EPR systems was reasonably well-aligned: most participants felt that the requirements and expectations of the technology had been clearly explained, and they identified a common set of problem areas where the technology needed to be improved (which in turn would contribute to improved alignment). One key problem area was that individual consultant workloads had not been adjusted to reflect changes in clinical workflows and the duration of certain tasks (e.g. prescribing chemotherapy). This indicated that the fit between technology and tasks, and between individuals and tasks, was more problematic and less well-aligned than the fit between individuals and technology. Chapter Six of the thesis provides further analyses and discussion relating to the FITT model and its application to the triangulated results of the study.

The following section presents the outcome space constituted by the three categories of description identified from the phenomenographical analyses.

5.4.3 Overview of oncology EPR categories of description and outcome space

After phenomenographical analyses of the data were completed, the “outcome space” produced by the study included three main categories of description:

- C1: EPR systems were seen as a simple activity legal record of a patient’s care and treatment;
- C2: EPR systems were seen as a means of providing information to aid memory and facilitate communication;
- C3: EPR systems were seen as advanced tools for clinical workflow, decision support, and interoperability.

These categories of description are explained in summary in Table 5.4-2 and in more detail later in the next section of this chapter, Section 5.5.

Category no.	Category of description	Explanation
C1. EPR = activity log	EPR systems were seen as a simple legal record of a patient’s care and treatment	Oncologists in this category thought about EPR systems as a simple collection of records that are primarily required for logging information for legal/record-keeping purposes. They did not see their experience of using the EPR systems as central to their role as clinicians; rather, they viewed maintaining patient records as an incidental task, with limited benefit or added value. These participants would often apply workarounds to avoid the use of the EPR systems, and/or would rely on others to mediate the input and retrieval of information.
C2. EPR = communication tool	EPR systems were seen as sources of information to aid memory and facilitate communication	In this category, oncologists also thought of the EPR systems and patient records as primarily a log of what has happened to the patient, including their diagnosis, treatment and clinical indications. Unlike oncologists in the first category, they thought that this record-keeping was not only important for legal purposes. These clinicians regarded EPR systems as beneficial to patient care, since these systems assist clinical staff with information and facilitate communication.
C3. EPR = decision support tool	EPR systems were seen as advanced tools for clinical workflow, decision support, and interoperability	Oncologists who thought about EPR systems in this category saw the systems as being an integral part of their clinical work, an essential tool to support their communication, decision-making, and clinical workflows.

Table 5.4.2 Summary of oncology EPR outcome space

These categories of description and the outcome space illustrated that oncologists

experience their work with EPR systems in several ways. While there is not always a clear one-to-one relationship between participants and categories of description, and participants may think of EPR systems differently in different circumstances, analyses of the results indicated that each participant in the study had a dominant, or primary, category of description (and some also had a secondary conception). This reflects that, although the categories of description have features that make them distinct, they are hierarchical and may have some common features or content, which means they can overlap at their boundaries. These relationships between categories are depicted in Figure 5.4.2 below, which provides a visual representation of the oncology EPR outcome space, reflecting the oncologists' conceptions on a spectrum of "records thinking" versus "systems thinking."

From a technology acceptance perspective, this figure illustrates how the different categories of description relate to the perceived usefulness of the systems. The inclusion of the axis labelled as "systems thinking and perceived usefulness of EPR systems" is intended to help illustrate the hierarchical nature of the categories of description with reference to these concepts that are relevant to the categories of description and the progression in thinking about systems thinking and technology acceptance. It should be noted that this diagram is presented for explanatory purposes only, and further evidence would be required to assert any statistically relevant correlation between these concepts. For example, an individual clinician might recognise that EPRs are meant to support multiple different functions beyond record-keeping but still not find EPRs very useful in their own experience. Conversely, a clinician might find EPRs highly useful, but only for a limited set of activities, such as basic record-keeping. Acknowledging these limitations, it was still deemed appropriate to provide the illustration on the basis of a general point that oncologists in the third category indicated a stronger level of technology acceptance and awareness of systems thinking than those in the first and second categories.

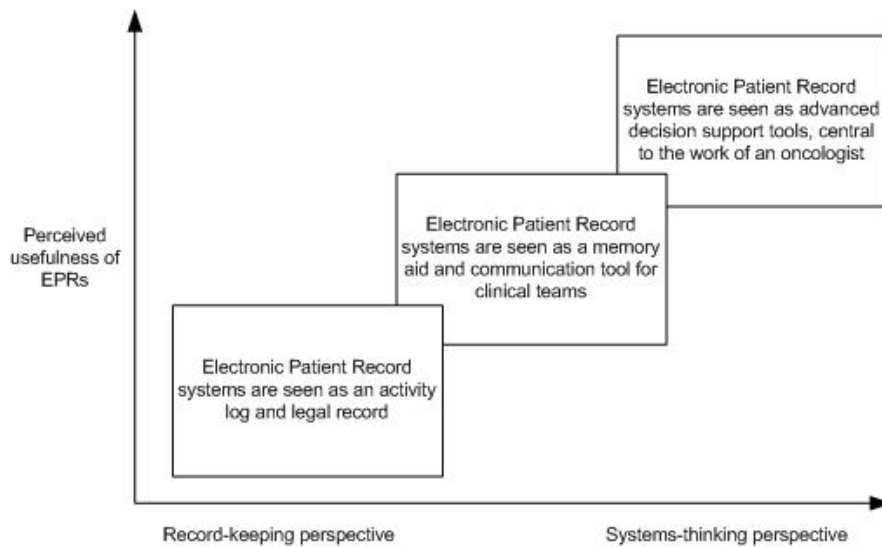


Figure 5.4.2 Oncology EPR outcome space

Among the research participants in this study, the majority of oncologists thought about EPR systems in the second category of description, with slightly fewer in the first category and only a small number in the third category.

The first two categories are different from the third because, in categories one and two, the oncologists thought of EPR systems as a collection of “records,” whereas oncologists in category three thought about EPRs as more holistic information systems that include “tools” which support them in their clinical work. This distinction is one of the key variations in oncologists’ thinking about EPRs. The word “record” has different meanings. The Oxford Dictionary defines the noun “record” in this context as “a thing constituting a piece of evidence about the past, especially an account kept in writing or some other permanent form” (Oxford Dictionary, 2015); in contrast, a “system” is defined as “a set of things working together as parts of a mechanism or an interconnecting network; a complex whole” (Oxford Dictionary, 2015).

In the first category of description, i.e., viewing EPR systems as a simple activity log, oncologists perceived a medical record as a factual account of events. Berg (1996) explained it as “what has taken place,” containing details of the patient’s current condition, their clinical history, and diagnostic and therapeutic processes completed. In this category, the record is also thought of as a storage facility, i.e., a data repository (Dick & Steen, 1991).

In the first category of description, oncologists perceived a medical record as a factual account of events. Berg (1996) explained it as “what has taken place,” containing details of the patient’s current condition, their clinical history, and diagnostic and therapeutic processes completed.

In this category, the record is also thought of as a storage facility, i.e., a data repository (Dick & Steen, 1991).

In common with the outcome spaces produced by other phenomenographical studies (e.g. Edwards, 2006), these results indicated that the categories of description exist in a hierarchy, whereby some oncologists thought about EPR software applications as being merely a set of records, while others thought about them as being more than records, including tools and functionality to support work processes that go beyond accessing and using information (such as making clinical decisions).

All three categories are related to different meanings that are linked to the clinicians' experiences of using EPR systems. Moreover, they are related to different awareness structures, different approaches to accessing and recording clinical information, and different ways of using the systems to support clinical work. The implications of the outcome space and its relationship to the FITT framework are discussed in the next chapter (Chapter Six).

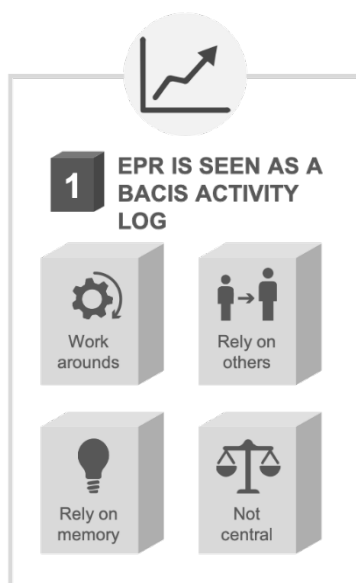
5.5 Detailed analyses and results

This section provides more detailed information about each of the three categories of description that were outlined in the preceding section, along with an explanation of the referential and structural aspects of each category. A sub-section is used for each category of description, with sub-headings for each of the referential aspects, followed by the structural aspects. For each category, several referential aspects explain the key features of "what" the oncologists were experiencing, whereas the final sub-heading in each sub-section (structural aspects) describes "how" they experienced the EPR systems in their clinical work. To provide a clear structure for the following sections, the three categories are referred to as C1, C2, and C3 with each of the referential aspects using an "Rn" suffix within each category, labelled as C1R1, C1R2, C1R3, C2R1, etc. A label is not used for the structural aspects, as these are summarized under a single sub-heading in each category.

As explained in Chapter Three, in phenomenography, the referential feature is concerned with "what is focused on" (Prosser & Millar, 1989, p. 517). Harris (2011) reported a comprehensive analysis of the referential and structural aspects of conceptions originally described by Marton, explaining that in more recent phenomenographical studies, the terms were often replaced by "what" and "how" respectively. In this study, the referential aspects therefore refer to the various issues that oncologists have in the forefront of their minds when experiencing the use of EPR systems in their clinical work.

5.5.1 C1: EPR as a simple activity log / legal record

The referential features of this category of description will be explained, with quotes selected from the interview transcripts to exemplify how the analysis developed from statements made by the oncologists. The focus in this conception was on the use of paper-based medical records, memory, and workarounds to maintain traditional working practices. Accordingly, EPR systems were perceived as a barrier to efficient and effective clinical work. The referential properties of this category of description are:



- workarounds to avoid use of EPR systems (C1R1);
- innate reliance on other professionals for information when needed (C1R2);
- reliance on prompts and own memory to record and store information about patients (C1R3);
- the EPR system is not central to clinical work processes (C1R4)

Figure 5.5.1 Conceptions within Category of Description C1

C1R1: Workarounds to avoid use of EPR systems

A workaround is defined as “a method for overcoming a problem or limitation in a program or system” (Oxford Dictionary, 2018). Several oncologists described various workarounds that they employed in order to avoid either retrieving or entering information into the electronic patient record systems. They saw these workarounds as being necessary due to poor functionality, system configuration, or accessibility problems; in addition, some oncologists perceived these workarounds as a necessary feature of a disjointed and inefficient overall socio-technical information system within the hospitals. For example, several participants described the workflow processes related to ordering blood tests and receiving the results as particularly inefficient:

“The steps are dependent on at least two, if not three humans feeding back and this is where I think the software and IT should be helping us rather than us humans pandering to the deficiencies of the system.” (MO6)

Highlighting the desire to find more efficient workarounds to avoid using the EPR systems where possible, one of the doctors stated:

“Actually, most likely when I think about EPRs, I think oh my God, not another thing I have to do all day.” (MO5)

This proclivity towards workarounds has been reported in other healthcare research studies, not only related to the use of information technology systems but also routine practical tasks undertaken in a clinical environment. Acknowledging that healthcare staff implement workarounds due to the complexity of clinical care processes, Debono et al. (2013, p. 2) referred to behaviours related to the definition of workarounds, including “violations, deviations, problem solving, improvisations, procedural failures and shortcuts.” While oncologists thinking about the EPR systems in other categories of description may also have occasion to use a workaround if necessary, the oncologists in the first category of description appeared to have an overall preference to use established workarounds, as opposed to either accepting the deficiency of an EPR-based task or process or actively working to improve it.

C1R2: Innate reliance on other professionals for information when needed

Some participants indicated that they did not see information gathering or data entry as being part of their responsibilities as a doctor. These participants believed that other healthcare workers should complete these activities in preparation for their consultations with patients:

“I’m not highly computer literate. I ask other people to do things.” (MO4)

One of the medical oncologists articulated how the overall information system might be improved with a two-stage process involving various information-gathering activities prior to clinics, but, when probed for further clarification, this participant clarified that this information-gathering would not be the responsibility of medical staff:

“What you’d want in there would be all the patient demographics, all the stuff that we dictate which would be their diagnosis but also the pathway leading to that diagnosis. So that would be all the data for scans... that could all be put in by somebody else based on their investigations because if the medics had to do it, it would be a nightmare.” (MO6)

Several of the oncologists referred to the inefficiency of recording and information access, which appeared to be linked to their thinking that others should assume responsibility for many computer-based tasks. For example, with regards to chemotherapy scheduling, one of the

oncologists felt that the EPR system should be improved, but still thought that Scheduling Clerks would be necessary to assist with certain tasks:

“We shouldn’t have to have the middle-men schedulers for that job, although I think they should still be there to oversee, sometimes overbook if necessary, change—you know, remove patients who aren’t going to turn up.” (MO5)

These responses indicated that poor design, usability, and efficiency could be factors that affect the adoption and use of the EPR systems, but it should be acknowledged that there could also be additional factors, such as perceptions relating to qualifications, training, experience, role, and status. A small number of oncologists stated that other, more junior medical staff should undertake EPR-based tasks on their behalf. For the oncologists who think in this way, this conception within the first category of description would not necessarily change even if the shortcomings of the EPR systems were fully resolved.

C1R3: Reliance on prompts and own memory to record and store information about patients

Due to frustrations related to accessibility, efficiency, usability, and workflow functionality, which were themes that emerged in the exploratory study (Chapter Four, Section 4.4), several doctors referred to reliance on their own memory to retrieve clinical information about a particular patient, in some cases on the basis that it was faster and more reliable. Some participants explained as follows:

“[the EPR system] has its drawbacks and its strengths and so I’m just fiddling around with it and trying to - it’s generally quite slow so I mostly work with my memory rather than this EPR.” (CO8)

“I would remember everything that I needed to know for the consultation whilst I’m having the consultation.” (CO17)

“It’ll be from memory but the same day because I’ll have been thinking about it. So, I do like that but also if I have dictated something and it’s—you know, there’s obviously—it’s just not acceptable, I can change it there and then and the secretary can update it and get it sent off without wasting paper.” (MO6)

Other statements in this category made by oncologists indicated a preference for relying on their own memory, compared to the perceived inconvenience of logging into the EPR systems, only to find that the information was time-consuming to locate and may be incomplete.

However, whilst a small number of oncologists mentioned their reliance on memory, one interviewee highlighted concerns about relying on memory if there are no traditional paper-based medical notes available as a backup for the EPR system:

“If you haven’t got that then, you’re essentially going in with nothing, so that involved you sitting in a different room assimilating all that information to memory, pretty much, and then going in and then, without a doubt, a patient will catch you out, saying well, what about that scan and you think well, I forgot you’d even had that scan.” (CO10)

With reference to completing certain tasks during clinic consultations and others at the end of the day, one of the consultants referred to writing clinic letters, stating *“it’ll be from memory but the same day because I’ll have been thinking about it”* (MO6). It was unclear why this doctor chose to work in this way when the majority of others tended to use digital dictation to record notes for clinical letters at the end of each individual patient consultation.

To summarise, this referential aspect related to memory, it was apparent that some oncologists preferred to rely on their own memory rather than use the EPR systems, even though they had at least a subconscious awareness that their memory might not be fully reliable.

C1R4: The EPR system is not central to clinical work processes

Due to the range of different clinical information systems in use both at the primary study site and at other peripheral hospitals where outreach clinics are provided, some of the oncologists seemed unclear about what the “core” or main EPR systems were. When asked about the systems they used, they first thought of the IT hardware that was available to them for general communication purposes, e.g., Blackberry devices for mobile access to emails. Several of the oncologists needed prompting and some further clarification of what the EPR systems actually were, indicating that they did not hold a focused view as to exactly which systems constituted the EPR. For example, when asked about his use of the core EPR systems, one of the medical oncologists did not appear to consider the primary oncology EPR or prescribing systems, but immediately referred to the local hospital’s diagnostic systems for viewing laboratory and radiology test results:

“We use ICE for getting patient results, fairly user-friendly. You can get duplication of patient results. You can only look at one screen at a time; you can’t open one screen, open another one, so it can be limiting, but you can tag the lab results. What else do we use? X-ray system, for looking at x-rays and reports.” (MO1)

Other oncologists also thought first of issues relating to accessibility and equipment before they considered the information and functionality aspects of the EPR systems. For example, one oncologist explained:

“So, the main thing I probably use is the iPad which obviously has access work-wise to my emails. I say, most of my work is probably off-site so I use the iPad.” (MO4)

Another oncologist actually used the phrase that the systems were “out of sight and out of mind” when referring to their use of the EPR systems:

“There hasn’t really been any sort of imperative to need and to use that so it’s fallen out of sight and out of mind at the moment. Again, that’s going to change of course when we don’t have paper notes any more, but I’ll need re-inducting and re-training in terms of—and resetting of passwords to be able to do that.” (MO8)

Other oncologists referred to the use of the systems as a “side-line”:

“This is something I do as a bit of a side-line. It’s not my main job. If you sit me in front of a computer to do radiotherapy outlining, I’m in my comfort zone. So, it’s not about computers, it’s about familiarity and repetition.” (CO7)

In summarising this conception, it was apparent that some oncologists did not have the core EPR system in the forefront of their minds, even when prompted to think about the various information technology solutions that they use in their clinical work. This tendency to think first about end user hardware devices indicated that the EPR systems were not a prominent feature in the referential conceptions of the oncologists in this category of description.

Structural aspect

As explained previously, the structural aspects of the conception are about “how” the oncologists experienced the various referential aspects (i.e. “what” they experienced). At the core of this conception was the relationship between the oncologist and traditional sources of information, which include paper-format medical records, information accessed via a co-worker, or memorized information, sometimes prompted by the most recent clinical letter. The focus was on requiring, obtaining, and using patient information to maintain existing working practices and processes, in order to counteract the problems associated with EPR systems.

One of the most important aspects of this category of description is the way that oncologists in this group thought about the primary purpose of EPR systems. A relatively small number of the oncologists fell into this category, but those who did were notably distinct from other groups

in thinking that the main purpose of EPR systems was to store information and record a basic activity log of a patient’s diagnosis and treatment, primarily for legal reasons. One oncologist referred to facilitating patient management as the primary purpose of EPR systems, but also said, “clearly there’s a second purpose which is as a legal document that annotates what you’ve done and why you did it for legal reasons” (CO13).

Due to problems associated with accessibility and usability, EPR systems in this conception were perceived as an inconvenience. Within this backdrop, oncologists were aware that the EPR system was available and that it may contain potentially useful and relevant clinical information but, on balance, they preferred to continue using paper systems, co-workers as information mediators, and their own memories in order to maintain the perceived efficiency of current working practices. Some of the oncologists indicated awareness that they were expected to use the EPR systems; however, they still chose not to do so because they perceived established workaround solutions as more efficient (C1R1).

5.5.2 C2: EPR as a tool for workflow support and communication

The critical variation that separates this conception from the “maintaining existing practices” conception were discrepancies in the perceived value of information recorded in EPR systems and their functionality to support and improve working practices. Oncologists who held to this conception focussed on embracing EPR systems as a central part of working as an oncologist and recognizing the potential for improved workflows, efficiency, and patient experience. However, in many cases, participants embraced these systems with some ambivalence because they felt frustrated about poor design, usability, accessibility, and efficiency. This category of description comprised the following referential aspects:


 <p>2 EPR IS SEEN AS A COMMUNICATION AIDE</p> <ul style="list-style-type: none"> Workflow support System Design Not just a record Paper Structure 	<ul style="list-style-type: none"> • latent need for workflow support and medical information (C2R1); • frustration related to poor system design and usability (C2R2); • recognition that the EPR is more than a record (C2R3); • assumption that good EPR design is based upon electronic replication of paper medical records (e.g. charts, chemotherapy prescriptions) (C2R4)
---	---

Figure 5.5.2 Conceptions within Category of Description C2

C2R1: Latent need for workflow support and medical information

Many of the oncologists interviewed appeared to recognise that the complexity and volume of their work required support in the form of EPR system workflow processes and rapid access to medical records, although only a small number specifically used the phrase “workflow” when describing the complex sequences and variations in clinical tasks to be undertaken in the service. This underlying need was apparent when oncologists in this category described their ideal EPR system, referring, for example, to the need for a personalised homepage with task lists:

“The other thing really I would perhaps like, I think that was mentioned in some talks I remember - about logging in and then the computer or the system would recognise who you are and then it will tell you for example on that day what you’re expected to do, you know, what clinic you’re doing.” (MO7)

“What I’ve liked ... I suppose I could say is that it all linked in one, it’s not—you don’t have to come out to go to PACS. You don’t have to come out to go to e-prescribing and you don’t have to come out to look on Evolve. It’s all just one big kind of system...” (CO14)

“It contains a lot of background information that you need, which I find useful.” (CO11)

The requirement for rapid access to information being driven by automated workflow appeared to be a common theme; several oncologists alluded to the current EPR systems as passive, noting that these systems require the user to initiate tasks from prompts outside of the system and to then to browse through records looking for particular information.

C2R2: Frustration related to poor system design and usability

Although the majority of oncologists seemed to accept the need for computerized systems, many of them felt frustrated about their overall experience of using EPRs. Frustration was an important issue in this category of description, as numerous doctors expressed dissatisfaction with the current systems. Several of the oncologists drew comparisons with technology they used at home and questioned why clinical information systems at the hospital were not as intuitive or easy to use. These comments indicated that to some degree, these oncologists accepted that the EPR systems were a necessary part of their overall work system.

“e-prescribing, I think—if you’re not organised, it can be a nightmare. I think having taken over from somebody else, it was very difficult to start with and I’m only now just getting used to it...” (CO2)

Additionally, other oncologists described challenges related to passwords, lack of training, the poor usability, and the number of different systems that are used. For example:

“Well, because we move round six months at a time, it’s very difficult to get a password and get trained in each centre that we go to.” (CO14)

“I think if I want some information, one) it should be easier to access, so that means you don’t involve multiple clicks where you go from one screen to another.” (MO10)

“...the systems that we use, they’re not as intuitive and they’re not as quick so it’s that—e-prescribing, if you could just point at what you wanted and if it was intuitive.” (CO12)

“I can’t see the notes that the dieticians and the nurses put on Maxims, so I’m reading it as part of my portal, which seems a bit odd from a clinical point of view.” (CO16)

Another consultant explained some of the difficulties relating to e-Prescribing as follows:

“the ordering of the system is counter-intuitive. The ordering of the menu, when you open up the breast menu, is not in the right order. It’s in a mixed-bag order, not in an order you would think about, firstly.” (MO1)

Several oncologists used the word “clunky” when describing usability problems related to the EPR systems:

“The main one we use clearly is [name of information system] which is awful, clunky, old-fashioned, difficult, not terribly obvious; seems to have lots of things that it can do but you never seem to be able to do them. So, I find it challenging to use effectively.” (CO13)

These comments illustrate the extent to which poor usability was a problem for oncologists, providing further evidence of the themes that emerged in the exploratory study. The extent of usability issues was evident due to the range of different examples given covering functionality in more than one area of the EPR sub-systems e.g. the core EPR, the ePrescribing system and the electronic document management system (EDMS) were all cited as sources of frustration by more than one oncologist in this category.

C2R3: Recognition that the EPR system is more than just a record

The oncologists' frustration in using the EPR systems indicated their expectation that the systems should provide more than just a record of activity; they felt that the systems should also provide functionality and workflow support to assist them in undertaking their clinical work. This conception is distinct from the way that oncologists thought about the system in the first category. Several oncologists cited examples to indicate their expectation of workflow support with reference to the functionality required to provide effective functionality for prescribing chemotherapy, ordering diagnostic tests, etc.:

"We want it to do so much more than notes, right. So, underneath that then, there's the ability for an EPR to link all sorts of things together and pull things—so what the notes can't do and what the EPR can do is pull together different strands into one place; different results and different locations, x-rays here, and actually also it calculates things so you've got a height and weight over here, you've got a creatinine⁴ over there." (CO19)

In a different way, another oncologist articulated this conception in relation to the record not just being a passive artefact:

"It's important not just to record the information but for us to know that we know it, that we've seen it, that we've thought about it and that we are adding that information to whatever the plan is that we've got for the patient." (CO17)

In summary, oncologists' thoughts in this category of description indicated a clear recognition that an EPR system should provide a mechanism for sharing information and aiding collaborative clinical work, beyond the limitations of basic activity log.

C2R4: Assumption that effective EPR design is based upon electronic replication of paper medical records (e.g. chart, medical records folder, chemotherapy prescription, etc.)

Several oncologists suggested that electronic patient record systems should be designed to replicate the format of paper-based recording and filing systems. This perspective may result from their familiarity with a particular method of recording and storing information that has become efficient and habitual for them over time; therefore, they saw any significant change that requires learning new processes as slowing down their work. Two main examples were cited by different clinicians: the medical records file and the chemotherapy prescription form.

⁴ Creatinine is a waste product from the normal breakdown of muscle tissue.

“With notes it’s generally easier because you can just see it and I think it’s partly because of what we’re used to – the way we’re used to processing information. It’s easy to just see on a page or if you just flick over the page.” (CO17)

“I guess the slight frustration to me with e-prescribing is that perhaps the same interface could be adopted. Why not just make the bit that the doctor looks at look the same as the paper?” (MO8)

“It would seem to me that a computer screen could very easily re-duplicate what that page looks like and all the oncologist has to do is fill in those gaps.” (MO8)

“Paper notes that we’re kind of used to flicking through and I’m sure there are clever things that can be done but the main thing is making it easy for us to transition from that being able to flick through, stop at a page and open sort of thing.” (MO5)

These views on how EPR systems should be structured emerged as a relevant referential characteristic in this category of description because the oncologists thought of an EPR system as being more than a basic record and felt frustrated about the poor design and usability issues, some of them appeared to think that good design of the electronic system was predicated on replicating paper-based structures and processes.

Structural Aspects

This category of description (C2) was focused on an acceptance of, and willingness to use, the EPR systems, combined with a sense of frustration that problems related to accessibility, usability, and integration were often a hindrance to efficient workflow processes. The oncologists recognized that EPR systems were a necessary evolution in the progression of information systems for modern working practices, but they noted the systems’ apparent shortcomings and limitations compared to their experiences of using computer systems outside of the workplace. A central feature of this conception was awareness that the EPR system facilitated communication and information sharing among clinicians. In the backdrop to this category of description, oncologists were also aware of the potential for EPR systems to provide improved user experience and efficiency; however, this awareness did not feature as prominently in comparison with the third category. This limited focus on the potential benefits of EPRs was primarily because oncologists perceived the systems as being poorly designed and offering limited functionality; in addition, they tended to think that good design was predicated on re-creating paper-based recording forms and information storage structures.

5.5.3 C3: EPR as an integral part of the clinical work of oncologists

In line with the hierarchical nature of the categories of description, this conception overlaps with the second category described in the previous sub-section. In this category, there is an incremental change in the conceptions about the EPR systems that was evident in the interviews with oncologists, in the following referential aspects:



- EPRs are an essential tool for supporting the work of an oncologist with advanced clinical decision support (CDS) (C3R1);
- recognition that the ongoing development and improvement of EPR systems requires clinical engagement and input from oncologists (C3R2);
- a view that paper-based systems are dated, inefficient and inherently risky (C3R3);
- patients should have direct access to their EPR (C3R4)

Figure 5.5.3 Conceptions within Category of Description C3

C3R1: EPRs are an essential tool for supporting oncologists with advanced CDS

Some oncologists indicated that one of the important purposes of the EPR system is to improve their ability to care for patients. This entails using the complete and accurate records that provide information to make immediate and long-term decisions. These oncologists recognized that EPR systems are more than a basic activity record and communication tool; they are an essential information source and also potentially a sophisticated tool for advanced clinical decision support:

“I would say that the IT’s absolutely mandatory and it can only improve really your ability to care for the patient by giving you the most full information about what’s going on at that exact moment in time.” (CO16)

“You want the patient’s outcome to be better and you want the IT system to help with that.” (MO7)

“I have an interest in using technology for patient care and I’m actually involved in developing a telemedicine programme.” (CO3)

The tone of these quotes is notably different from those used to illustrate the conceptions held by oncologists in previous two categories of description (C1 and C2). The conception held in this referential aspect of the third category of description is that the EPR system is not just a log, record, or communication tool, but a system that should provide prognostic tools, access to treatment protocols and advanced clinical decision support functionality. Some of the oncologists alluded to this in their explanations of how the EPR system should be central to supporting their clinical work. For example, a small number of the oncologists mentioned the requirement for automated alerts:

“The other thing that the system doesn’t have is alerts. So, for example, if they’re on, say, a medication which is contra-indicated⁵ when you’re having radiotherapy, flagging that up when you put the details into the system would be something useful to have.”
(CO9)

Although the term “clinical decision support” was not used by many of the interviewees, the examples given of where the EPR systems could assist clinical end users in a more sophisticated manner illustrated the thoughts that a minority of oncologists appeared to have about this topic.

C3R2: The ongoing development and improvement of EPR systems requires clinical engagement and input from oncologists

One of the main referential features of this category of description was the conception that oncologists should take ownership of, and be instrumental in, the design, development, and the ongoing improvement of the EPR systems.

In the previous two categories, none of the oncologists indicated that they themselves were responsible for the quality, efficiency, usability and usefulness of the EPR system they used in their daily work as clinicians. The conception held in this category therefore indicated recognition by a small minority of oncologists that participative design is crucial for designing systems and configuring workflow processes that are tailored to meet their specific requirements.

“... whoever develops the system, they must look at [understand that] the guys who are going to be using [the systems] are not IT experts.” (CO15)

⁵ A contraindication is where a specific treatment should be withheld due to the identification of a particular condition that could cause harm to the patient.

When discussing the ideal oncology EPR system, none of the oncologists specifically mentioned the approach to designing and developing the solution; however, a small number of them did state that systems would be best designed with input from end users. One of the oncologists in this category said, “I’m going to go at it from a very user-orientated perspective” (MO12), showing clear awareness of terminology and a concept related to system design.

C3R3: Paper-based systems are dated, inefficient, and inherently risky

In clear contrast to the perspectives in the first and second categories of description, a small number of the doctors referred to problems with paper-based medical records, arguing the case strongly for EPR systems to be implemented fully. As the following oncologists explained:

“It frustrates me to the nth degree that handwriting is still a big role and a big factor, that sheets of paper are falling out of people’s notes. It just feels to me that we’re at 2015 and some notes are like a medical-legal nightmare waiting to happen.” (CO16)

“I prefer it to writing on a piece of paper though because the old paper prescriptions we had got very messy and confusing scribbles and signs everywhere and you couldn’t really see who had signed for what.” (CO14)

“One of the big irritations for me is that we’ve still got paper trails and people faxing clinic lists to prescribe the next chemo.” (CO10)

With reference to the clinical trials treatment protocols not having been computerized for ePrescribing, one medical oncologist stated a dissatisfaction with still having to use paper-based processes:

“A lot of my patients in clinical trials and you do get paper and you realise this is the old system that I used to do, and I don’t like it.” (CO20)

Although only a limited number of oncologists held this conception, based on the interviews, it was apparent that this recognition was not only a clear departure from the preferences for maintaining existing systems and workarounds. It was also an implicit acknowledgement that modern, intuitive computer applications should not necessarily be designed to replicate paper-based form and folder storage structures, as some oncologists believed in the previous category of description.

C3R4: Patients should have direct access to their EPR

In this category of description, the oncologists tended to be less cautious about the idea of making EPRs directly accessible to patients. Some oncologists evidently favoured patient access. For example:

“Yeah, I mean overall I think I’m in favour of that; giving patient access to—I think it helps a lot of things in terms of say for example, they know when their appointment is.”
(MO10)

“I think, on the whole, it would be probably more fruitful for the long term if patients are allowed routine access to their records.” (CO16)

“...you’ve got all this data you can store and you can share and you can use and patients are able to access their records...” (CO12)

This conception was clearly in contrast with those of other oncologists, who had reservations about patients having access to the medical information held in their oncology records. This view may not always be associated with the other conceptions held in the first category of description. However, analyses of the interview discussions suggested that oncologists who held other referential conceptions in this third category were more likely to hold the opinion that patients should be provided with appropriate facilities and processes to directly access the data in their EPR.

Structural Aspects

At the core of this category of description, oncologists viewed EPR systems as an essential tool, without which they would be unable to undertake their clinical work effectively. This perspective is based on an inherent acceptance that computerized patient records are a necessary and important part of the overall socio-technical information system needed to provide cancer treatment services for patients. In the background, these oncologists are aware of the systems’ limitations, and they share the frustrations of oncologists in the second category of description; however, they place more emphasis on the importance of achieving system improvements.

Table 5.5-1 provides a summary of the referential and structural aspects of each of the categories of description and the core conceptions within them. The final column explains the critical aspects of variation, highlighting the key differences in each category.

Category	Referential aspect (what)	Structural aspect (how)	Critical aspects of variation
C1: EPR systems as a basic activity log	<ul style="list-style-type: none"> • Workarounds to avoid use of EPR systems (C1R1) • Innate reliance on other professionals for information when needed (C1R2) • Reliance on prompts and own memory to record and store information about patients (C1R3) • Maintaining a basic legal record or activity log (C1R4) 	<ul style="list-style-type: none"> • Relationship between the oncologist and traditional sources of information, which was either a paper-format medical record, information accessed via a co-worker, or memorized information • Focus on requiring, obtaining and using patient information to maintain existing working practices and processes, to counteract problems associated with EPR systems • Due to problems with accessibility and usability, EPR systems in this conception were perceived as an inconvenience 	<ul style="list-style-type: none"> • EPR systems seen as an inconvenience • Main purpose of EPR systems is for information storage • Reliance on others for mediated access to information
C2: EPR systems as a communication tool	<ul style="list-style-type: none"> • Latent need for workflow support and medical information (C2R1) • Frustration related to poor system design and usability (C2R2) • Recognition that the EPR is more than a record (C2R3) • Assumption that good EPR design is based upon electronic replication of paper medical records (e.g. chart, chemotherapy prescription) (C2R4) 	<ul style="list-style-type: none"> • Acceptance of and willingness to use the EPR systems, coalesced with a sense of frustration that problems related to accessibility, usability and integration; often a hindrance to efficient workflow processes • Recognition that EPR systems were a necessary evolution in the progression of information systems for modern working practices, but aware of difficulties compared to their experiences of using systems outside of the workplace • Awareness that the EPR system facilitated communication and information-sharing among clinicians • Awareness of the potential for the EPR systems to provide improved user experience and efficiency 	<ul style="list-style-type: none"> • A discrepancy in the perceived value of information recorded in EPR systems and their functionality to support and improve working practices • Embracing EPR systems as a central part of working as an oncologist and recognising the potential for improved workflows, efficiency and patient experience, but in many cases with ambivalence due to frustrations about poor design, usability, accessibility and efficiency
C3: EPR systems as an advanced workflow support tool	<ul style="list-style-type: none"> • EPRs are an essential tool for supporting the work of an oncologist with advanced CDS (C3R1) • Recognition that the ongoing development and improvement of EPR systems requires clinical engagement and input from oncologists (C3R2) • A view that paper-based systems are dated, inefficient and inherently risky (C3R3) • EPRs belong to the patient; it is their data (C3R4) 	<ul style="list-style-type: none"> • Views the EPR systems as being an essential tool, without which they would be unable to undertake their clinical work effectively • Inherent acceptance that computerised patient records are a necessary and important part of the overall socio-technical information system 	<ul style="list-style-type: none"> • Clear recognition that EPR systems are integral to the clinical work of an oncologist • Understanding of the requirement for expert oncologist involvement in the ongoing design, development and improvement of EPR systems • EPR system has the potential to provide advanced workflow and clinical decision support

Table 5.5-1 Summary of conceptions of EPR systems

5.6 Patterns of conceptions

The analysis revealed three different categories of description related to how the oncologists thought about and experienced EPR systems. As previously explained, the study participants and the various conceptions they were found to hold were neither unilateral nor mutually exclusive. That is to say some oncologists hold multiple conceptions that might be in more than one category of description. Table 5.6-1 summarises the patterns of conception by showing the categories of description within which each oncologist held an identified conception related to EPR systems.

Table 5.6-1 shows that five of the oncologists thought about EPR systems only as defined in the first category of description, nine held conceptions in both the first and second category, 14 oncologists held conceptions only in the second category of description, six held conceptions in the second and third categories of description, and only two participants held conceptions in the third category only.

To explain the logic for this categorisation, the categories of description should be thought of as a continuum, starting with the most basic group of conceptions and then progressing with increasing sophistication and complexity toward the third category of description. Conceptually, the different themes identified were grouped together in accordance with the logical groupings and hierarchical relationships specified in the approach to phenomenographical analyses. However, due to the complex nature of human perception and thought processes, it was apparent that many of the oncologists held conceptions in more than one category. Due to the hierarchical nature of the categories of description, however, none of the participants held conceptions in all three categories or in only categories one and category three.

Figure 5.6.1 below illustrates this point by showing one of the participants (MO2) who held conceptions in categories of description one (C1) and two (C2).

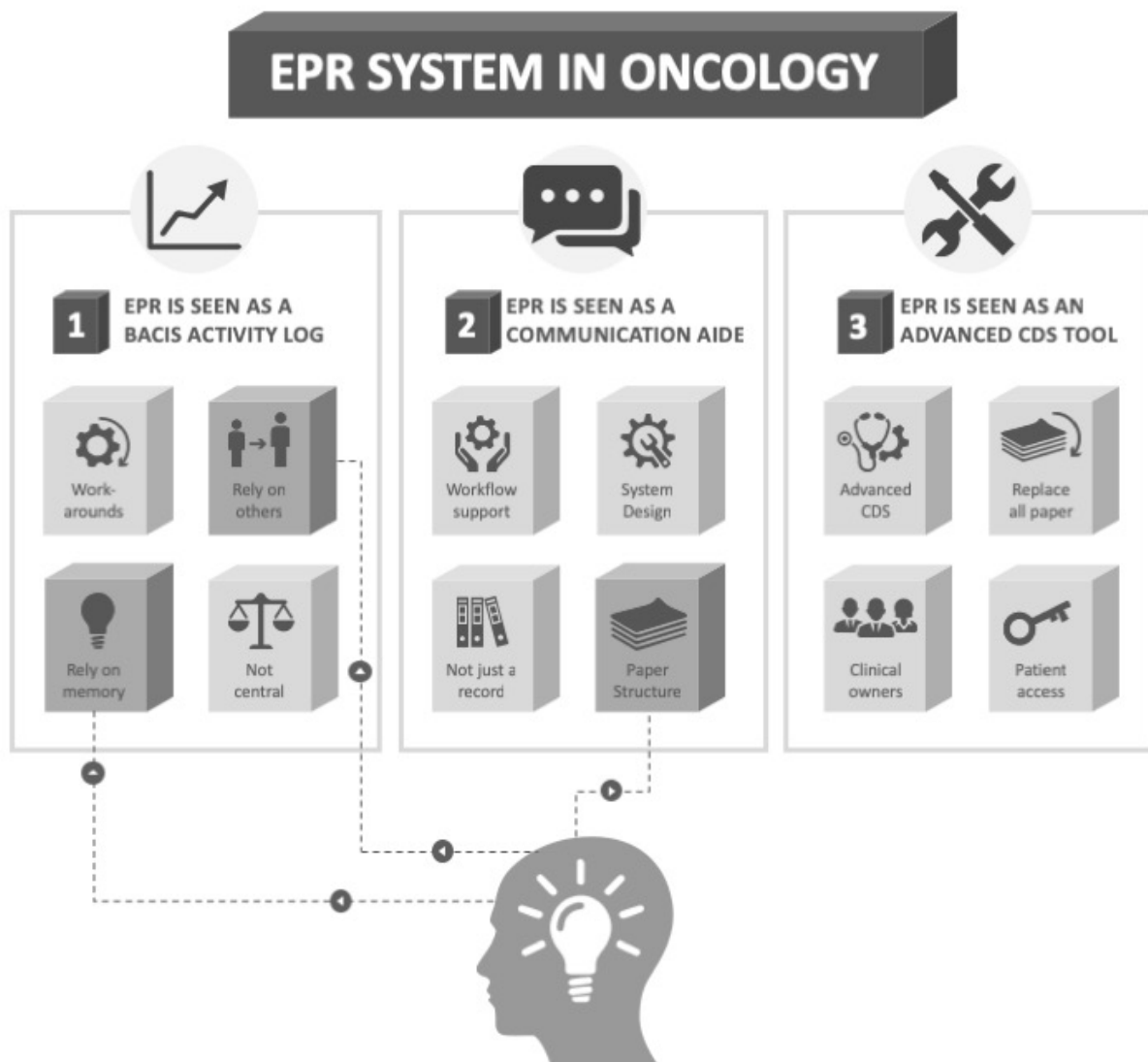


Figure 5.6.1 Example of participant (MO2) with conceptions in multiple categories of description (i.e., C1R2, C1R3, C2R4)

Participant	Job Role	Categories of Description		
		1	2	3
MO3	Consultant Medical Oncologist	✓	X	X
MO8	Consultant Medical Oncologist	✓	X	X
MO9	Consultant Medical Oncologist	✓	X	X
CO17	Specialty Doctor Clinical Oncology	✓	X	X
MO16	Consultant Medical Oncologist	✓	X	X
MO1	Consultant Medical Oncologist	✓	✓	X
MO2	Consultant Medical Oncologist	✓	✓	X
CO4	Consultant Clinical Oncologist	✓	✓	X
MO4	Consultant Medical Oncologist	✓	✓	X
CO5	Consultant Clinical Oncologist	✓	✓	X
CO8	Consultant Clinical Oncologist	✓	✓	X
MO6	Consultant Medical Oncologist	✓	✓	X
CO11	Clinical Oncology Specialist Registrar	✓	✓	X
CO14	Clinical Oncology Specialist Registrar	✓	✓	X
CO1	Clinical Oncology Specialist Registrar	X	✓	X
CO2	Clinical Oncology Specialist Registrar	X	✓	X
MO5	Consultant Medical Oncologist	X	✓	X
CO6	Consultant Clinical Oncologist	X	✓	X
CO7	Consultant Clinical Oncologist	X	✓	X
MO7	Consultant Medical Oncologist	X	✓	X
CO13	Consultant Clinical Oncologist	X	✓	X
CO15	Consultant Clinical Oncologist	X	✓	X
CO18	Consultant Clinical Oncologist	X	✓	X
MO11	Medical Oncologist Specialist Registrar	X	✓	X
CO19	Consultant Clinical Oncologist	X	✓	X
MO13	Consultant Medical Oncologist	X	✓	X
MO14	Medical Oncologist Specialist Registrar	X	✓	X
MO15	Consultant Medical Oncologist	X	✓	X
CO3	Consultant Clinical Oncologist	X	✓	✓
CO9	Consultant Clinical Oncologist	X	✓	✓
CO10	Consultant Clinical Oncologist	X	✓	✓
CO12	Consultant Clinical Oncologist	X	✓	✓
MO10	Consultant Medical Oncologist	X	✓	✓
CO20	Consultant Clinical Oncologist	X	✓	✓
MO12	Consultant Medical Oncologist	X	X	✓
CO16	Clinical Oncology Specialist Registrar	X	X	✓

Table 5.6-1 Patterns of conception for individual oncologists

5.7 Strengths and limitations of the interview study

Having presented the results of the main qualitative study in the previous sections, this section now summarises the main strengths of this phase of the research before reflecting on this phase's limitations, elaborating on the comments made at the end of Section 5.3.

The use of phenomenography as method to support the epistemological approach in this research was found to be a strength in that it allowed the researcher to think about EPR systems through the lens of the oncologists' own experiences, thereby providing an in-depth qualitative perspective. The key research question concerning the factors that affect the adoption and use of the EPR systems is answered from a qualitative perspective that illustrates the range of different views, experiences, and conceptions held by oncologists. All of these should be considered important factors in conjunction with those identified in the exploratory study. These factors are explored further in Chapter Six, Discussion.

With regards to limitations, in this study a strategic decision was made to use purposive sampling to develop a very closely-defined sample of research participants, i.e., oncologists who use EPR systems. While this enabled a very detailed and in-depth understanding of their perspectives, it means that the study findings relate specifically to this sub-set of EPR users and do not provide a holistic understanding of user views and experiences across the full range of healthcare professionals who interact with EPRs. Further research should similarly explore the views of other groups of healthcare professionals.

In addition to this, it should be acknowledged that the qualitative study was conducted in a single specific cancer treatment centre where specific EPR systems were used. It is quite possible that oncologists' perspectives will vary at different cancer centres where different information systems, operating models, and organisational structures exist. Whilst qualitative studies do not intend to be representative, the setting of the study was in a typical NHS cancer centre with some common information systems and many other organisational features that are common to other centres in the United Kingdom. Ergo, the findings should, to some extent at least, be relevant and transferable to other NHS cancer centres with similar types of EPR systems in use.

With reference to the qualitative analysis, it is also acknowledged that researchers might produce numerous different interpretations of the same transcripts depending on their own interests, perceptions, and preconceptions. Although it is quite rigorous as a methodology for data analysis, phenomenography seems likely to introduce the possibility for bias on the researcher's part. This is an important issue with regards to distinguishing contextualizing insights from a kind of interpretation that might distort the data or compromise its validity. The

main precautions against this possibility were to sense-check the perceived logical grouping of pools of meaning with other researchers external to the study site and the research phenomenon and to sense-check conceptual thinking with the research supervisor.

It should also be acknowledged that as the researcher worked full-time as the Head of the Information Management and Technology department at the study site, it was, to some extent unavoidable that there might be an inherent bias toward EPR systems and a personal stake in demonstrating that they are beneficial. Whilst this potential for bias is to some degree inevitable, careful measures were taken to mitigate this and to prevent it from influencing first the views of the participants and the data collection, and subsequently the coding and analysis, as far as possible. However, the researcher being employed at the site helped to facilitate the research, and the study may not have been possible, or at least as comprehensive, had this not been the case.

Recognising that resources are variable for PhD students, in this study a sole researcher undertook the processes of data collection and analyses. In addition to this, the researcher worked full-time at the study site; therefore, the risk of bias and the impact of the researcher's own professional knowledge and experience and personal relationships had to be carefully considered throughout the design, implementation and reporting of the study. To reduce the risk of bias and any impact on the results of the study, this issue was clearly acknowledged and discussed with an experienced research supervisor. The credibility of the results was also validated by member checking where a summary of findings was sent to the participants for review and feedback, as explained earlier in Section 5.3.9.

5.8 Further research required

To establish the extent of generalisability of the findings to the wider population of oncologists at the study site, and also to those working at other cancer centres and in different healthcare systems, a larger-scale study using representative sampling would be required. The application of quantitative research methods, as an extension to the exploratory study presented in Chapter Four, would potentially help validate the findings from this part of the study. Whilst the qualitative study demonstrated that a number of factors may influence the adoption and use of EPR systems in oncology, further research could be undertaken to verify the wider generalisability of the findings, the application of the FITT model, and other elements of the CICERO model (discussed further in Chapter Six). This would help to establish a more robust and comprehensive understanding of the various components of onco-EPR in a socio-technical systems context. Furthermore, repeating the qualitative study within other cancer treatment centres could identify other issues and themes that did not emerge during the case study site in this research.

Plans to introduce new EPR systems at Clatterbridge Cancer Centre, and discussions with the oncologists about this, suggested that results could change if a longitudinal study were conducted in the future. At the time of the study, the digitisation of patient records was approximately halfway complete, and the new hospital-wide EPR system was scheduled for implementation to replace four separate EPR applications currently in use. In the future, further research will therefore be needed to see whether these changes have an association with or impact on the factors that currently affect adoption and use of the systems. It should be clarified here that further empirical research is required, not just the evaluation of specific EPR systems being implemented in practice.

5.9 Conclusion

In this chapter, the details of the main phase of the research were explained and discussed in detail. Semi-structured interviews were used to obtain rich, in-depth data about oncologists' views and experiences of working with EPRs and clinical information systems. A phenomenographical approach to data analyses was then applied to obtain an improved understanding of oncologists' perspectives about the EPR systems.

From the data analyses, three categories of description emerged. In the first category, oncologists thought about the EPR systems as a basic record of clinical activity with little recognition of the potential for the system to aid communication and work tasks; this category was given the shorthand label "EPR as an activity log." Oncologists in the second category, "EPR as a communication tool," believed that EPR systems facilitate collaborative working and communication among clinical teams. In the third category, "EPR for advanced clinical decision support," oncologists regarded EPRs as an integral part of their overall socio-technical system for providing cancer care.

In addition to the main categories of description that emerged from data analyses, the key findings included several themes and constructs that will be discussed further in Chapter Six in relation to FITT and other TAMs and the findings of the exploratory research that were presented in Chapter Four. This further analysis and discussion will then be used to inform the final version of the CICERO model, also presented in the following chapter (Chapter Six).

Chapter Six: Discussion

6.1 Introduction

As stated in Section 1.7, the main aim of the research described in this thesis was to investigate the factors that can influence oncologists' adoption and use of Electronic Patient Record (EPR) systems in cancer services. To respond to the overarching research aim, an exploratory quantitative study was conducted (described in Chapter Four), followed by a more in-depth qualitative study (described in Chapter Five).

The previous two chapters reported the results of the study, highlighting that accessibility, usability, and interoperability were very important factors affecting the adoption and use of EPRs and that oncologists fall into three distinct categories in the way that they think about and experience using clinical information systems.

Based on the prior literature, the importance of accessibility and usability were not unexpected findings, but the study presented in this thesis found interoperability to be a much more prominent feature than in similar previous investigations (Galligioni et al., 2009; Sicotte et al., 2016).

This chapter compares and combines the findings of the two phases of this study, using triangulation techniques to consider the compatibility of the methodologies used. It also undertakes further analysis of the collated results of the two studies and the application of the FITT theoretical framework. Following the introduction in this section, the results of the quantitative and qualitative studies are discussed in Section 6.2, elaborating on the results previously presented in Chapters Four and Five, with discussion related to the FITT theoretical framework, which was confirmed as a suitable model for investigating EPR adoption and use. Sections 6.3 and 6.4 are dedicated to data triangulation and theoretical triangulation respectively, with the aim of explaining the extent to which the patient records survey results were confirmed by the in-depth qualitative study. The methodological triangulation is explained in Section 6.5, followed by the details of the final version of the CICERO conceptual model in Section 6.6. The limitations of the overall mixed methods study are discussed in Section 6.7, and the conclusions of this chapter are presented in Section 6.8.

6.2 Triangulation

As explained in Chapter Three, triangulation is an important aspect of any mixed methods research study. Where different methods have been used to investigate the same phenomena, this may lead to variation in the study findings. Through comparison and contrast, results can then be confirmed, reinforced, or questioned further, depending on the extent of reconciliation. The purpose of this section is therefore twofold: firstly, to explain the importance of triangulation in this study; secondly, to present the confirmed results and to discuss them with reference to FITT, the theoretical framework selected for the study, and also with reference to the literature about previous relevant studies in the field of socio-technical systems in healthcare.

The reasons for adopting a mixed methods approach to the study were explained in Chapter Three (Section 3.6.4). As noted by Wu (2012), a mixed methods study of technology acceptance expands the limited focus of the traditionally quantitative-based concepts of “usefulness” and “ease of use,” allowing for a more comprehensive socio-technical perspective on the particular phenomena and context under investigation. As mentioned in Chapter Three, triangulation is used at one level to examine whether the results are aligned and consistent when multiple or mixed methods are used in a study, and additionally for completeness and confirmation. The basic point of triangulation is that a researcher can have increased confidence in the results of a study if the application of different methods leads to similar results. Mertens and Hesse-Biber (2012) explained that while the term “triangulate” originally referred to a technique used by surveyors (determining the location of an unknown object in a physical space by specifying two known points in the same area), social scientists later adapted and applied this term to the process of evaluation and validation of research findings. Triangulation enables validation of data via cross verification from multiple sources. More specifically, it is concerned with the application and amalgamation of multiple research methodologies in the study of the same phenomena—in the case of the research described in this thesis, EPR systems in cancer services. Triangulation was particularly useful in the present study as it allowed some limitations in the exploratory phase to be mitigated, thereby strengthening the confidence in the overall research findings. The patient records survey data included responses from a wide range of EPR end users, whereas the interviews were conducted with medical staff only. Triangulation was therefore important in comparing a sub-set of the quantitative results with the more focussed interview data in the second phase.

Several authors have proposed definitions of triangulation. For example, Adami and Kiger (2005, p. 19) explained that “triangulation in research refers to the use of multiple techniques for gathering and/or handling data within a single study.” They stated that the initial purpose of triangulation was to obtain confirmation of ostensible findings. Since the 1990s support has developed for an additional, second purpose: completeness (Adami & Kiger, 2005). Fielding and

Schreier (2001) identified three models of triangulation. Firstly, the validity model considers triangulation to be the validation of results from using different methods. Secondly, the complementarity model uses the word “triangulation” to refer to a way of obtaining a wider, more comprehensive view of a research context. Thirdly, the trigonometrical approach involves a combination of methods that symbolise the research phenomenon being discovered using alternative measures.

This research predominantly used the validity model in order to provide mutual validation of the patient records survey findings and the qualitative interviews with oncologists. However, due to the two phases of the study being conducted sequentially, the triangulation of results was primarily providing validation of the initial findings from the exploratory study. That is to say that the interviews helped to validate the results of the patient records survey questionnaire. The output of the triangulation exercise also enabled the validation, further development, and completeness of the CICERO model, confirming additional themes for inclusion in the final version. The triangulated and additional findings are presented in Section 6.6 of this chapter, which describes the final version of CICERO.

6.2.1 Confirmation of results

Before more in-depth phenomenographical analyses of the interview transcripts were conducted, the basic thematic results of the main qualitative study were summarised as part of the member checking procedure. These results are discussed below, with reference to the three FITT framework dimensions: individual, technology and tasks (Ammenwerth et al., 2006).

Individual Dimension

The main reasons why doctors chose to specialise in oncology were the research-focused nature of clinical work in this field, the continuity of care and ongoing relationship with patients, and being part of a multi-disciplinary team (MDT). Participants described a range of professional and clinical responsibilities, including: delivering chemotherapy treatment, conducting clinical trials, seeing new patients, radiotherapy planning, participating in MDT meetings, providing acute oncology services, providing clinical education for junior doctors, and completing management tasks. Within the CCC site, participants mentioned several clinical environments: the outpatient department, the chemotherapy day case unit, inpatient wards, and radiotherapy treatment sets. Clinical environments at other hospital sites included outpatient departments, inpatient wards, and chemotherapy clinics.

Several respondents specifically mentioned iPhones and iPads as the main type of technology that they use outside of the workplace, and many stated that information technology (IT) was “vital,” “critical,” “essential,” or “impossible to live without.” Most participants indicated that IT

was an essential part of their lives, and many of them also accepted that technology will be used increasingly in the workplace and in their job roles as oncologists.

Commenting on their own level of IT literacy, the majority of doctors said they felt they were competent in using computers, with a third describing their technological proficiency as “average,” “intermediate,” or “adequate.” Only one participant reported a low level of IT literacy. One point these findings highlight is that users’ frustrations cannot be attributed to lack of proficiency in computer use, as several oncologists alluded to the technical nature of their medical work and in some cases, extensive use of computer systems in clinical research conducted as part of their training. With reference to the FITT model, it follows that the difficulties reported in this study were more related to the lack of alignment between technology and tasks than they were to individuals and technology per se.

Technology Dimension

Several different systems in use at CCC were discussed, including the Maxims “core” EPR, Ascribe ePrescribing, Evolve EDRMS, and Carestream PACS. A few oncologists were satisfied with the current EPR systems used at the Trust and felt that they were fit for the purpose, but the majority felt that various problems and concerns prevented the systems from fully supporting their clinical work activities. Key concerns that emerged from the analyses were: accessibility and remote access; software functionality; interoperability and integration with other hospital systems; usability; and availability and completeness of clinical information in EPRs. These key concerns reinforced those reported by Galligioni et al. (2009) with regard to the importance of software functionality being based on user requirements and having good usability. These findings were also consistent with the results from Sicotte et al. (2016), who also identified interoperability and integration with other hospital systems as key factors affecting clinicians’ technology acceptance and use; in addition, these findings confirmed recommendations made by Yu (2011). These aspects are discussed in further detail below.

Participants described the ideal oncology solution as a highly intuitive application, similar to how apps work on an iPad, with good usability and workflow support. Access would be quick and easy, without compromising security, and the system would recognize the user logging in and instantly provide information about clinics and patients due to be seen. Several oncologists described various task (“to do”) lists, indicating a requirement for the system to provide prescriptive workflow support. When using the EPR system in the patient context, the patient’s record should be presented in a “flow sheet” format with all relevant clinical information displayed in one place. The ideal system would automatically collate relevant clinical history and allow patient records to be flagged for discussion at multi-disciplinary team (MDT) meetings. Systemic Anti-Cancer treatment (SACT) prescribing functionality would include intuitive multi-cycle capability, allowing a full course of treatment to be prescribed and easily amended if required. The system would also include a messaging function so that messages about individual patients could be exchanged between clinicians and added directly into the patient’s record. Another feature that would be included in the ideal oncology EPR system is alerts. For example, if a

patient were on medication that was contra-indicated when radiotherapy was being given, the system would automatically flag this up to the clinician when they entered the patient's details into the system. Many of the oncologists used the phrase "one system" and emphasised the need for improved system integration. In addition to improved interoperability and information sharing with EPR systems used at other hospitals, one doctor explained that an ideal system would also be seamlessly integrated so that users would not have to come out of the core EPR system to gain access to PACS, e-prescribing, or EDMS. Another oncologist specified that it should take no longer than 15 seconds to locate and view any clinical information about the patient. Several interviewees suggested that a regional laboratory ordering and results system would be highly beneficial for oncology services.

Due to the nature of medical oncology work in cancer services, many participants raised concerns about electronic prescribing through EPR systems. Participants described functional requirements including multi-cycle prescribing; integration with appointment scheduling; dose-banding; integration with laboratory systems; and advanced clinical decision support. Interviewees gave mixed responses when asked whether they thought electronic prescribing was safer than paper-based systems. Whilst many oncologists recognised the potential safety improvements offered by electronic systems, several pointed out that there is still potential for human error; they noted that a mistake made in an electronic prescribing system could potentially have an adverse impact on many patients, whereas an error in a paper-based system would usually only affect one individual patient. Overall, there seemed to be a consensus that electronic prescribing should be safer, but that currently available software applications are not as advanced as they could be in terms of usability, functionality, and clinical decision support.

When asked about their views on providing patients with access to their own medical records, most of the oncologists interviewed were of the opinion that the patient's record belongs to the patient and that they would be happy for them to have direct access to it. This opinion appeared to be based on moral principles regarding data ownership; however, some oncologists raised concerns about the potential for misinterpretation of information that could cause distress to patients and their families, and they suggested that access to medical records might be need to be mediated, with clinicians screening information prior to approving it for inclusion in the patient-facing version of the medical record. This was a particularly interesting aspect of the research findings, highlighting a tension between the desire to provide open, self-empowered care for patients but indicating a paternalistic tendency where the individuals' medical records are concerned. Some oncologists were also concerned that if the information made directly available to patients was not controlled, it could generate a high number of queries that would create an additional workload for clinical teams. Again, this alluded to a paradox concerning the balance of care for an individual patient versus the wider caseload of an oncologist, where capacity was clearly a concern. Although it was not explicitly stated by oncologists commenting on this issue,

it appeared that any expansion of oncologist capacity or potential use of other healthcare professionals to provide some form of mediation service was not a consideration that came to mind.

Tasks Dimension

Participants reported a number of tasks that are well-supported by clinical IT systems that are not part of the core EPR, including radiotherapy planning, PACS image sharing, and digital dictation. When asked which clinical tasks were most problematic, the interviewees referred to ordering laboratory tests as a difficult issue, as the existing EPR functionality was inefficient to use, requiring too many clicks. Laboratory tests ordered at peripheral clinics were also problematic due to delays in getting paper-based results sent out and scanned into the oncology EPR system. Some oncologists described the process of scanning other paper-based information into the Evolve system as a particular problem due to the time delay. Other task-related concerns were electronic prescribing (because the process takes longer than paper-based prescribing), the lack of multi-cycle functionality and integration with appointment scheduling (as discussed in the technology dimension), and clinical noting (for which the current systems do not provide adequate, easy-to-use features).

When asked what they regarded as the main purpose of EPR systems in oncology, many interviewees referred to “safety,” with statements such as “EPR is a clinical record that allows for safe and effective clinical practice” (CO4). Some thought that the main purpose was to prevent the loss of medical records, and others referred to information security, efficiency, and information sharing. Many of the results and themes that emerged from the quantitative study were validated by the qualitative study, which is discussed below in relation to user and task characteristics.

User characteristics

The outcomes of the qualitative study indicated that various factors, such as the oncologists’ age, experience with technology outside of the workplace, IT literacy, and attitude towards computerised information systems, could influence their use of EPR systems in clinical environments. Within these factors, user attitude is a key aspect of a person’s judgements, assessment, and behaviours (Kim, 2009). The findings of this study supported Kim’s definition, whereby the phenomenographical analyses found three categories of description related to how EPR systems were viewed and experienced, influenced by the oncologists’ attitudes towards the EPR systems. As mentioned in the literature review (Chapter Two), attitude regarding behaviour is a clear predictor of behaviour, and beliefs are precursory to attitudes about behaviour (Ajzen, 1991). Davis et al. (1989) proposed that variables such as system features, user traits, task features, politics, and organisational environment can affect user attitudes; this, in turn, can affect the use of computerised systems. In the quantitative study (Chapter Four),

therefore, the correlation between user characteristics (e.g. role, age group, work experience, IT literacy) and user attitudes were investigated. The results of the exploratory study did not find any significant association between roles, age groups, or other sample characteristics.

In the qualitative investigation, however, several oncologists indicated that age was a factor that influences their attitudes towards using information technology generally, including the use of EPR systems. While other technology acceptance studies have found evidence of age being linked to attitude (e.g. Classen et al., 2013; Shahrokni, Pinheiro, & Pournaki, 2015), analyses of the quantitative data obtained via the patient records survey in this research found that there was not a statistically significant correlation between age groups and user satisfaction levels. The unclear association between age, attitude, and satisfaction with the EPR systems in this study indicated that other factors might influence user attitudes toward EPR systems more than age does. Although the quantitative study yielded little statistical evidence of age as an influential factor, analyses of interview transcripts from the qualitative study indicated that the younger oncologists in the sample were more likely to have grown up using technology in their daily lives and to have used more computerised information systems during their medical training; because they had more experience using information technology, it is reasonable to conclude that they had a more positive attitude towards using EPR systems in the workplace.

Comparable findings have been reported in other studies. Whilst other studies might have indicated that age would be an important factor in attitudes towards technology, with older users holding more negative attitudes, several studies included in Ward's comprehensive review of technology acceptance studies in healthcare found that, broadly speaking, this was not the case (Ward et al., 2008). For example, Lai, Leung, Wong, and Johnston (2004) were not able to establish any effect of age on the transition from intention to actual use of an EPR system. Loomis, Ries, Saywell, and Thakker (2002) also reported that there were no statistically significant differences between age groups of EPR system users and non-users. This lack of age-related impact might be because the extent of computer usage by oncologists, whereby they have used computer systems routinely in their clinical work for several years (e.g. clinical oncologists using computer planning system for radiotherapy). In addition to this, there were examples of oncologists in the study in more than one age band, who referred to the need for computer literacy in order to undertake clinical research effectively.

Araujo, Paiva, Jesuino, and Magalhaes (2000) discovered that computer use and age group did not have a significant impact on participants' attitudes towards using an IT system. These researchers did, however, see indications among the participants of a clear intention towards utilisation and that this was associated with attitude. Related to this aspect of the individual dimension, Hong, Chan, Thong, Chasalow, and Dhillon (2013) reported that, where age is considered as a concept in information systems research, it is usually concerned with

chronological age, whereas perceived age (i.e., how old individuals perceive themselves to be, rather than their chronological age) can potentially influence attitudes towards technology. The study found that among older participants who thought of themselves as “young at heart” (i.e., their actual age was greater than how old they actually felt), perceived usefulness and perceived ease of use had a notable influence on their level of technology adoption; among participants whose perceived age was more closely aligned with their chronological age, perceived ease of use and subjective norms were most influential (Hong et al., 2013). Whilst this differentiation was not specifically explored in the current study at Clatterbridge Cancer Centre, several of the participants did allude to age differences when discussing their children’s use of technology at home and their own use of technology at work: “I can adapt but I’m not the kind of guy who would Google everything. You know, if there’s information, let’s Google it and check it, as these young people do nowadays” (CO15). This sense of generational differences might, perhaps, help to explain why age was not statistically associated with intention in the quantitative study, but appeared to be important in the qualitative study.

Task Characteristics

One of the primary objectives of implementing EPR systems in healthcare is to improve patient safety and efficiency with more accessible patient records. As illustrated by the literature review in Chapter Two, in order to achieve these benefits, users have to accept, adopt, and use IT solutions (Davis, 1993; Menachemi & Collum, 2011). The nature and complexity of clinical work in oncology makes it particularly challenging to achieve user acceptance; oncologists have to work in multiple clinical environments, often using multiple, disjointed clinical information systems for different tasks. Several of the oncologists who participated in the qualitative study recognised the complexity of their clinical work as well as the difficulties faced by IT departments in the NHS, which are tasked with improving interoperability and user experience while maintaining robust information security across organisational boundaries. These findings were consistent with those reported in Shulman et al. (2008), who highlighted the complexity of oncology treatment pathways, and Snyder et al. (2011), who also referred to the level of complexity in oncology EPR systems, particularly in relation to ePrescribing for SACT.

The quantitative study obtained a range of information about the use of EPR systems to support both clinical and administrative tasks and established that, for medical staff, the most helpful workflow support was for viewing PACS images, dictating clinical letters, and viewing medical history remotely from numerous hospital sites. The more problematic issues for clinical tasks related to ordering diagnostic tests and chemotherapy treatment. These are high-volume routine tasks in oncology for which the EPR systems provided limited support, as the design and performance of the software provided poor usability and efficiency of use. With regard to the task dimension, the qualitative study corroborated the findings of the survey questionnaire to a

large extent; several oncologists, including those who had not participated in the earlier survey questionnaire, reported problems with EPR support for tasks related to ordering and reviewing tests and prescribing chemotherapy.

In the quantitative study, some of the task-related problems with EPR systems also emerged from the free-text question that asked respondents to state the three most positive and the three most negative aspects of the patient record systems. To summarise, both the quantitative and the qualitative studies highlighted problems with the EPR systems supporting the following tasks: acknowledging and signing off laboratory test results; searching for clinical documents in the electronic document management system; prescribing a full course of chemotherapy treatment; and accessing clinical history information. These findings were also comparable to those in previous studies; Sicotte et al. (2016) highlighted problems specifically with incomplete and lost orders. As noted previously, a range of challenges were also reported about electronic prescribing; this result aligns with studies by Hede et al. (2009), Small et al. (2008) and DesRoches et al. (2010), all of which called for improved integration with core EPR functionality to improve ePMA functionality and workflow in cancer services.

6.2.2 Completeness of results

A further use of triangulation is to achieve an improved understanding of information when one component of the overall investigation displays results that have not been seen in other components. These new data improve the completeness of results, in that they provide additional insights beyond what was obtained in the separate studies. In this research, both the quantitative and the qualitative studies demonstrated complementary findings in some areas, but triangulation was still deemed necessary to validate others. For example, in the quantitative study, it was not obvious which themes that emerged were the most important from a clinician's point of view. Nonetheless, the qualitative interviews investigated the exploratory results in detail and found that accessibility, usability, and integration of the EPR systems were the most influential factors from the oncologists' perspectives. These key factors are discussed further below.

Accessibility

Accessibility was one of the most important factors affecting the oncologists' attitudes toward EPR systems. Several of the oncologists were notably frustrated when talking about accessibility problems. In particular, some of the registrars, who worked at numerous external hospital sites on rotation as part of their training, were visibly annoyed when talking about the difficulties of obtaining user logins and passwords in order to access EPR systems at peripheral clinic location

(n.b. whilst the following quote may not fully illustrate the extent of frustration, the audio recording reflected this in the participant's tone and the researcher's notes taken at the time reinforced this observation) :

“Part of the problem is some places actually don't have very good coverage, either Internet or—either Wi-Fi or 3G coverage—so some hospital sites don't have very good access. So, we're reliant more on the desktops which often are a little bit old and slow and—but we usually manage.” (Dr.1)

In contrast, other oncologists commented that keeping patient records in electronic format made these records more accessible. The improved accessibility appeared to be an important aspect of moving to fully electronic patient records. On the one hand, digitising patient records meant that they could be available remotely to multiple users, thus significantly improving access to clinical information. On the other hand, the range of different systems in use and difficulties associated with passwords meant that, in some cases, the oncologists found it more difficult to access information than they did when the systems were entirely paper-based. This accessibility paradox was important in illustrating oncologists' different conceptions about this particular aspect of working with EPR systems; some participants were very frustrated, and others were ambivalent about the improved or reduced accessibility of patient records. Both Sicotte et al. (2016) and Galligioni et al. (2009) found that many clinicians struggled with similar accessibility issues, and the study confirmed this to also be the case in a UK-based centre.

Usability

As reported in Chapters Two and Five, usability was found to be a key issue for the EPR users at the case study site. It emerged as a potential issue from the results of the IBM CUSQ incorporated into the patient records survey, and also as a theme from the free-text responses related to the most positive and negative aspects of the EPR systems. The qualitative study explored this theme in more depth and confirmed that usability was a key factor impacting on the adoption and acceptance of the systems. The triangulation of the results is explored further below, following a brief reminder of the definition of usability, for context.

According to Shackel and Richardson (1991), the concept of usability was originally debated and proposed by Shackel (1981) and subsequently adapted and refined by Bennett (1984). The formal definition suggested for usability of an electronic information system is “the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios” (Shackel & Richardson, 1991, p. 24). Another, more concise definition is provided by the international standard, ISO 9241-11, which describes usability as “the extent to which a product can be used by specified users to achieve specified goals with

effectiveness, efficiency and satisfaction in a specified context of use.” In the context of this study, EPR usability can be thought of as the capability of oncologists to fulfil a range of clinical, oncology-related tasks easily and effectively using the EPR systems, given appropriate training and support.

As noted previously, in the exploratory study described in Chapter Four, the patient records survey questionnaire included a section of questions related to EPR usability satisfaction (CUSQ). As previously noted, this section of the survey was grouped into three different sub-scales related to system usefulness (SYSUSE), information quality (INFQUAL), and interface quality (INTERQUAL). The results indicated that, whilst the EPR user groups were neither strongly satisfied nor dissatisfied in any of the categories, the aspect of usability satisfaction that participants felt most negatively about was interface quality. Following on from the survey questionnaire and the usability theme that emerged from the negative free text comments, in the interviews, many of the oncologists also described the EPR systems as inefficient and difficult to use. A noticeable number of participants used the word “clunky” (defined as “solid, heavy, and old-fashioned”) when describing their experiences using the systems. It should be emphasised again here that the study was concerned with researching users’ experiences of the range of systems in use at multiple hospital sites, not just evaluating specific systems in use at CCC, the main study site. However, the results of the SYSUSE sub-scale were noticeably consistent with those reported by Sicotte et al. (2016), where oncology clinicians using a legacy EPR system (i.e., a system that was planned to be replaced by a new, more modern and integrated EPR software application) at a Canadian cancer centre reported that they were also neither strongly satisfied nor dissatisfied in scores from a range of questions related to perceived system usefulness. In Sicotte et al.’s study (2016), the perceived system usefulness questions were split into two main categories: firstly, those that related to benefits for individual clinical work and secondly, those related to benefits for collective clinical work. The mean scores for the latter category were slightly lower than the score for the individual work benefits, but with an expectation from users that a new system would provide a higher increase in benefits for collective work than for individual clinicians. This indicated an expectation that future EPR developments would provide improved functionality for information sharing and team working.

In the study presented in this thesis, a majority of participants shared negative views of EPR usability, with the exception of two oncologists who felt that the systems were very good, at least compared to paper-based medical records. One participant suggested that oncologists should be more accepting of the systems and not complain so much: “So it’s down to you to adapt to the system rather than the system adapt to you, because the system can’t adapt to all the various consultants or various doctors and individuals and the way they work” (CO20). This is not only a pragmatic and logical way of thinking about EPR systems; importantly, it is also a qualitatively

different way of thinking compared to that of other oncologists, who felt that the EPR systems should adapt to them as users.

Integration and interoperability

The lack of seamless integration and interoperability of the EPR systems was another common theme highlighted by many of the oncologists in the interviews. They gave several examples of how the systems were disjointed and lacking in synchronisation and interoperability, such as the disparate systems for chemotherapy prescribing and appointment scheduling.

One of the issues highlighted by several oncologists was that the electronic prescribing system was a separate application from the main EPR system. Although integration had been achieved at the user interface level, giving users the ability to launch the electronic prescribing system without having to enter login credentials again, there were still problems related to data transfer between the two systems. As one oncologist suggested, this separate prescribing system felt like a “cumbersome add-on” (Dr.1). For example, appointments for chemotherapy treatment were made in a scheduling system separate from the prescribing system, so that if an appointment was changed or cancelled, the system would not automatically change or cancel the associated prescription. This separation led to an inefficient workflow process that required significant human intervention; administrative support staff had to continually check across the two systems for discrepancies and chase consultants for late or emergency prescriptions to be entered into the system.

This particular theme related to integration and interoperability seemed to elucidate more similarities than differences among the oncologists. There are two main approaches to EPR systems. In the “best of breed” approach, several distinct systems are combined to provide the most advanced and rich functionality for each specific clinical task. In contrast, in the fully integrated approach, a single EPR system provides the full range of required functionality but does not necessarily provide the most advanced support for each specialized task. Based on the oncologists’ responses, they appeared overwhelmingly in favour of a single integrated system, rather than a “best of breed” system.

The only notable exception to this general support for integrated systems was that many participants regarded radiotherapy planning as a discrete and separate application that did not need to be fully integrated with other systems. These planning systems can be differentiated from other components of an overall Onco-EPR solution, as they were only being used by the clinical oncologists (just over half of all participants) for planning radiotherapy treatment. The clinical oncologists who commented on radiotherapy planning systems explained that due to the specialized nature of the software, it was only used on dedicated computer workstations based

in the hospital's computer planning department, where specially trained therapy radiographers were available to work with oncologists as a team in a quiet, non-clinical area, using the software to outline the patient's tumour with contours and dosing information. This software does require integration of the radiotherapy record and the verification system that is used to control the linear accelerators, but due to its highly technical nature, it is usually considered to be part of a medical device and a separate system from the EPR. As this issue will be common to all oncology treatment centres, it poses a particular research challenge in relation to investigating the comprehensive socio-technical information systems in cancer services. This explanation, given by some of the clinical oncologists, was in line with the findings of the literature review (Section 2.13), which highlighted that while many studies have been conducted about the development, implementation, and use of radiotherapy information systems, very few have been conducted in the context of holistic cancer-centre-wide chemo-radiation workflows, where patients may have a treatment plan involving multiple treatment modalities. This study therefore provides new insights in the context of oncologists using a comprehensive suite of oncology EPR systems across the full range of cancer therapies.

This example may indicate a difference in thinking between clinical oncologists (who primarily use radiotherapy treatment) and medical oncologists (who primarily use chemotherapy treatment). However, this difference was not necessarily notable from a phenomenographic perspective, as it could simply be attributable to the fact that medical oncologists do not use this particular subset of Onco-EPR functionality (i.e. the difference in clinical and medical oncologists' experiences in this case may be due to them using different EPR sub-systems, rather than holding different conceptions about the use of the systems that they each use).

Another concern about integration and interoperability that several oncologists mentioned was the need for a more integrated solution for ordering pathology laboratory tests and obtaining the results of these tests. At the time of the study, whilst blood test orders for patients being treated at the main CCC hospital site could be submitted electronically on the EPR system, tests at other peripheral clinic locations were ordered using either paper request cards or the host hospital's diagnostic system, which was not linked to the cancer centre's EPR system and used a paper-based process to send test results back to the ordering clinician. In contrast, equivalent IT solutions for diagnostic imaging in the form of picture archiving and communication systems (PACS) were much more advanced, with a regional consortium of NHS hospitals all using the same commercial product and an integration solution called the "global worklist" that provides a master patient index of approximately two million residents in the Cheshire and Merseyside area of Northwest England. The global worklist provided functionality for imaging studies (e.g. CT, MRI and PET-CT scans), held in different hospital systems in the consortium, to be viewed by, and transferred to, other hospital systems when required. Many of the oncologists interviewed cited this as one of the best IT solutions supporting their clinical work. This research did not

evaluate this system itself but suggests that the concept is applicable to other regional cancer centres, both in the UK and internationally, due to these centres' significant dependency on imaging data flows. Based on the views of several oncologists, having an equivalent integrated regional system for laboratory test results would make an important positive difference to user experience and the efficiency of clinical workflows in oncology services.

The problems related to integration and interoperability found in the results of the present study provide strong support for Bjørnstad and Ellingsen's (2019) claim that the work required to achieve effective integration of systems is often neglected. Bjørnstad and Ellingsen (2019) highlighted the importance of integration and interoperability in their paper titled "Data work: A condition for integrations in health care." Based on an evaluation of large-scale EPR system used for medication management in a Norwegian Health Authority, the paper discusses a sociotechnical perspective based on the notion that "data work" is embedded within the integration of EPR systems. Importantly, Bjørnstad and Ellingsen (2019) also note that, conventionally, the focus of integrating clinical systems has been on establishing certain data elements that need to be shared between systems, whereas this approach is too basic and suggests that integration is purely a technical task. In concluding, the authors explain that the overall integration is a socio-technical engagement and that it requires effort on the part of end users, sometimes requiring more time than previous workarounds.

With regards to the complexity of integration and interoperability issues, Winthereick and Vikkelso (2005) also highlighted dilemmas related to inter-organisational communication, explaining that "healthcare is practised within a widely distributed organisational network" (p. 43). Reflecting that healthcare is too fragmented and that patient journeys transcend multiple organisations, the authors note that ICT solutions can be used to transfer data and coordinate care, but that standardisation of procedures and effective communication are also vitally important.

6.3 Data triangulation

As discussed in Chapter Three (Section 3.11), data triangulation is concerned with the use of multiple data sources to establish different perspectives about a common phenomenon in order to validate the research results. According to Carter, Bryant-Lukosius, DiCenso, Blythe, and Neville (2014), data source triangulation concerns the gathering of data from various categories of people, involving individuals, groups, families, and societies, to obtain numerous perspectives and corroboration of data. In this study, several sources of data were explored, including the

literature related to previous studies, the patient records survey results, and the in-depth qualitative data gathered during the interviews with oncologists.

In order to triangulate the survey results with the interview transcripts, the themes that emerged from the free text responses to the questionnaire were compared against the themes that initially emerged from analyses of the audio recordings and transcriptions. This exercise was based on coding activities prior to completing the more advanced phenomenographical analyses, and it led to the identification of important key words and associated words that related to obvious themes emerging from the discussions with oncologists. In essence, this led to the confirmation of accessibility, integration and interoperability, and usability as the most important themes, as they elicited such a noticeable number of comments and suggestions from the participants.

In the qualitative study, different sub-categories of oncologist were interviewed as specific sub-groups of the respondents to the exploratory survey questionnaire. Similarities in oncologists' views, as reported in the survey results (Chapter Four), assisted with developing the interview guide to focus on the most important issues regarding the use of EPR systems in a cancer centre. The variation in oncologists' experiences and perspectives also helped to develop an improved understanding of their collective and individual perceptions of computerised information systems in a cancer centre. Due to its focus on the variation in the way people think about and experience phenomena, phenomenography proved to be particularly effective in highlighting the differences in conceptions about oncology EPR systems. Likewise, in the patient records survey, a wide range of different staff groups were invited to participate. This broad participation assisted with gaining a more comprehensive view of users' perspectives about the factors influencing the use of EPR systems.

6.4 Theoretical triangulation

Theoretical triangulation in qualitative research usually entails viewing the data through different theoretical perspectives to analyse and interpret data and produce findings. It includes the selection of theories that have demonstrated that the underlying assumptions will emerge from varying types of understanding that are embedded in the data (Ma & Norwich, 2007). As explained in the Methodology chapter, this study adopted an overall approach in the field of socio-technical systems thinking. It used a combination of theories related to Computer Supportive Cooperative Work (CSCW), conceptual system modelling, and technology acceptance. As reported by Fitzpatrick and Ellingsen (2013), CSCW has a relatively long history of providing insights into healthcare workflow and task management, covering both paper-based and computerised systems. As noted in Chapter Two, a central premise of CSCW is that a socio-technical systems perspective is necessary when designing and developing software solutions for collaborative work, sometimes referred to as "groupware."

To further explain the field of groupware or CSCW in relation to this study, it is appropriate to briefly summarise a comprehensive literature review covering a 23-year period prior to this research study (1998 to 2011) and published after this research had commenced (Fitzpatrick & Ellingsen, 2013). In this review, 128 CSCW-related papers were analysed, profiled, and reported, with four main themes identified. The first theme was “artefact and technology-mediated healthcare work,” the second theme was “locating healthcare work in space and time,” the third was “expanding contexts of healthcare work,” and the fourth was “designing systems to support healthcare work” (Fitzpatrick & Ellingsen, 2013).

This review is relevant to the present study because, in essence, the FITT theory, described in Chapter Three, can be thought of as a type of CSCW acceptance model, the application of which produced themes similar to those identified in the previous literature. This study found concordance with the key themes identified in the CSCW review, as the combination of FITT and the phenomenographical approach to the main study allowed the EPR systems to be viewed “through CSCW lenses”; that is to say, this study developed a holistic socio-technical systems perspective through the eyes of oncologists. The study focused primarily on the first CSCW theme, i.e., artefact- and technology-mediated healthcare work, as the EPR systems in the cancer centre were the artefacts facilitating clinical work in radiotherapy and chemotherapy services. In keeping with many other CSCW studies (as reported by Fitzpatrick & Ellingsen, 2013), the exploratory research also investigated the use of paper records, recognising that, at the time of the study, some oncology medical records were stored and maintained in hybrid format. With reference to the second CSCW theme, the study also considered issues pertaining to locating healthcare work in space and time, as the nature of oncology work involves significant “spatial specialisation” with regards to diagnostic services such as radiology, laboratory, and cytotoxic pharmacy. Furthermore, the mobility of work in regional cancer treatment services was a related theme that emerged from the study; many participants described their desire for clinical information systems to be made more accessible, particularly from remote locations. The expanding contexts of healthcare work also constitute a particularly relevant theme as the work of a regional oncology service traverses organisational boundaries, presenting challenges for remote access as well as the integration of patient records. As noted previously in Chapter Five, accessibility and integration were two areas of significant focus and discussion in the interviews with oncologists. Finally, with reference to the fourth CSCW theme, the design of systems to support the clinical work of oncologist was a key feature of the study, whereby the oncologists were asked to describe their ideal EPR system, as well as discussing the problems and limitations of current systems. In summary, whilst similar themes were identified in the current study, the use of FITT and phenomenography adds to the existing body of CSCW healthcare research by providing insights from the perspectives of clinicians.

Fitzpatrick and Ellingsen (2013) also reported that many CSCW studies use their findings to suggest system design guidelines. The present study has followed this trend and added to the range of guidelines available with regards to the presentation of findings in the CICERO framework. It is also relevant to note here the alignment with CSCW themes generally, as the second category of description (C2) was how the largest group of oncologists thought about and experienced EPR systems, with a clear emphasis on collaborative work, information sharing, and team-based workflow functionality.

In consolidating the oncologists' views of what an ideal oncology EPR system design would be, there seemed to be a shared view that the ideal system would be fully integrated and provide quick and easy access. The system should be intuitive and seamlessly connected to the EPR systems used at other referring hospitals, providing access to all information on the patient's medical history.

"Well I think an ideal system would be to integrate—obviously we're seeing peripheral patients—to integrate their peripheral information with ours, to be able to have access to that at any point, and their blood tests and things, but I think that would be such a broad—you know, it's such a huge volume of information, I don't know how that would be possible." (CO11)

Many oncologists also stated that their ideal system would include a messaging function, so that clinicians could exchange messages about individual patients and record these exchanges directly into the patient's record, avoiding the need for patient-related e-mails outside of the EPR system. This is consistent with functional requirements described in other EPR studies in oncology, although in some cases the replacement of traditional email communication with inbuilt EPR system messaging has led to adverse incidents such as important clinical messages being overlooked (Gross et al., 2016). In terms of core functionality, for oncologists this includes multi-cycle treatment scheduling and SACT prescribing, with pathology test result data used to inform dose reduction. A flow sheet view of the patient's record should provide a view of chemotherapy administration at a glance, providing clinical decision support by enabling oncologists to observe trends and patterns.

Another issue about which oncologists held differing opinions was the extent to which EPRs should be designed with a structure similar to that of paper-based medical records. Some of the oncologists stated a preference for the electronic systems to mirror the structure of paper-based medical notes as closely as possible, whereas others felt that traditional paper-based methods were not necessarily the most intuitive way to store the information needed for different clinical tasks. The oncologists with this perspective seemed to recognize that different tasks have different workflows and sequences of locating and recording information.

The oncologists' views on the ideal EPR system were useful in informing the development of the CICERO model explained in further detail later in this chapter. The current study found strong alignment with the CSCW themes identified in the review by Fitzpatrick and Ellingsen (2013), particularly with respect to the design of systems to support clinical work. In summary, clinicians' challenges with EPRs and their visions for improved EPR systems appear to have remained largely consistent over the past 25-30 years.

As explained in Chapter Three (Section 3.9), within the specific context of socio-technical systems thinking, the Fit between Individuals, Technology, and Tasks (FITT) model (Ammenwerth et al., 2006) was applied as the primary theoretical model in this study. Ammenwerth et al. (2006) were the first leading proponents of FITT, which has subsequently been utilised and refined by several other researchers in various clinical settings. The following section explain the application of FITT to the results of the quantitative and qualitative parts of the study in this thesis.

Fit between Individuals, Technology, and Tasks (FITT)

The FITT model (Ammenwerth et al. , 2006) proposes that in order to maximize the adoption of information technology, three dimensions (individuals, technology, and tasks) must be aligned within a socio-technical system. An implicit premise of this model is that "the whole is greater than the sum of the parts," in the sense that this overall alignment should achieve a level of adoption that is greater than the level that would be achieved by the alignment of any two of the three dimensions.

With reference to the outcome space derived from the phenomenographical analyses in this study, it is argued that the categories of description corroborate the FITT model. Oncologists in the first category may be prone to thinking about EPR systems as basic records of clinical activity, as there is no alignment of technology, individuals, and tasks, or limited alignment of just two of the three dimensions. The second category of description, in which the majority of oncologists' conceptions about EPRs resided, is characteristic of a socio-technical system where only two of the three dimensions are properly aligned. This apparent lack of complete cohesion among the dimensions is a logical conclusion from the point of view that better alignment should lead to increased adoption of EPRs; as a consequence, oncologists in this category of description might be more likely to regard EPRs as an integral part of their overall role and clinical work system.

The FITT model ("**F**it between **I**ndividuals, **T**ask and **T**echnology") is founded on the notion that IT adoption in a healthcare context is contingent upon the alignment or "fit" among the

characteristics of the people (e.g. computer literacy, enthusiasm), the features of the computerised systems (e.g. usability, functionality, performance), and the attributes of the clinical practice and workflows (e.g. structure and intricacies of clinical practice).

Ammenwerth et al. (2006) explained that, in the FITT model, an "individual" can signify an individual person or a particular group of people who use technology. "Technology" refers to the combination of information systems and their components required to conduct particular work activities. However, the technology dimension is not limited to computerized systems but also includes other tools that individuals utilize to accomplish their tasks; consequently, in the context of patient records, "technology" includes paper-based record-keeping methods. The "task" dimension refers to the entire range of work activities and processes to be completed by the clinician (e.g., ordering diagnostic tests and prescribing treatment), which are facilitated by the technology.

Previous socio-technical research studies (e.g. Sheikh et al., 2011) have tended to focus on EPR system developments and implementations from an organisational perspective. The present study counters this tendency by focusing more on individual user experiences; in the FITT model (Ammenwerth et al., 2006), organisational features and characteristics can be found within either the individual dimension or the task dimension (i.e. the organisation of work activities).

With this focus on user perceptions and experiences in mind, the aim of an EPR implementation programme is to achieve an optimal balance and alignment of the task, technology, and individual dimensions. As explained by Ammenwerth et al. (2006), essentially what this means is that individual end user involvement in the specification, procurement, design, and implementation of an EPR system can enhance the alignment between the three dimensions. Importantly, individuals must also possess sufficient knowledge, skills and enthusiasm to complete particular tasks using the EPR system and in turn, the system must provide sufficient functionality and usability to facilitate completion of tasks. Finally, the individual must be appropriately trained and sufficiently IT literate to use the technology; a misalignment or insufficient fit will likely lead to difficulties during the deployment of new EPR systems (Ammenwerth et al., 2006).

According to Ammenwerth et al. (2006), the quality of fit is contingent upon the characteristics of the three domains: individual; technology; and tasks. The authors explained a number of examples that are adapted here to illustrate how the characteristics influence the impact of the different fit dimensions:

- Characteristics of the individual domain: IT awareness, inspiration and attention to the task to be undertaken, receptiveness to alternative working practices, team ethos, organisational context, collaboration, and political issues.
- Characteristics of the task domain: planning and preparation of the tasks to be completed, activities and their interdependencies, and intricacy of role responsibilities.
- Characteristics of the technology dimension: functionality, performance and usability of software and hardware tools; technical infrastructure and integration; and interoperability with other clinical systems.

To affect and increase the level of alignment of the three areas, the lead managers, health informaticians, and clinicians involved in implementing clinical IT systems can directly influence the various characteristics of the dimensions. Ammenwerth et al. (2006) illustrated the ability to influence the factors with reference to document-based processes in which a restructuring of the workflow may increase the alignment of task and technology dimensions; associated training provision for clinicians may improve the alignment of individuals and technology; and a technical system upgrade may provide functional enhancements that affect both individual-technology and task-technology alignment. Several examples from the interviews with oncologists appeared to support this view; for example, the requirement for a functional enhancement to ePrescribing for SACT was mentioned by several participants, who indicated that multi-cycle prescribing functionality would increase both individual-technology and task-technology alignment.

Purposeful interventions can affect the extent of alignment among the three dimensions. For example, in the individual dimension, clinical stakeholders can be involved in the specification and procurement of an EPR system, the design of training courses, support arrangements, and other management decisions. In the task dimension, workflow processes can be restructured and optimised with clearly defined user roles and responsibilities. In the technology dimension, interventions can include the optimisation of EPR hardware and software through upgrades and functional enhancements. It should be noted, however, that a majority of clinical stakeholders might not necessarily *want* to be involved in these processes, based on the findings of this study. Given their focus on clinical work and their limited capacity for work beyond this, medical management personnel and oncologists themselves may find it challenging to take time for getting involved in EPR system procurement, design, and/or training.

In addition to the interventions that can be made in the three dimensions, there are also external influences that can affect the level of alignment; these cannot be fully controlled by senior management or EPR project managers in the hospital. Ammenwerth et al. (2006) offered examples such as staffing changes, human resource capacity, and hospital strategy alterations

(individual dimension); increased complexity, patient demographics, and organisational changes (task dimension); and new NHS information standards notices (ISNs) and technology developments (technology dimension). Some of these influences were acknowledged during the interviews with oncologists, most notably resource capacity and references to the hospital's operating model and plans for a new hospital to be built in Liverpool.

Importantly, because of these external influences, Ammenwerth et al. (2006) stated that it is impossible to maintain a static position across all three dimensions; consequently, it is not possible to achieve a fixed position with regard to EPR system adoption. They also explained that external influences can enhance or reduce the level of fit between the dimensions, whereas the interventions of hospital senior managers and members of the EPR project team will be intended to improve alignment. There might only be a partially static scenario when positive and negative variations in one or more dimensions are temporarily balanced. The authors referred to these dynamics and the ongoing process of managing them as a "loop-back system" (Ammenwerth et al., 2006, p. 5).

However, whilst clinical involvement at the case study site was known to have featured prominently in the approach to EPR system developments, very few of the oncologists interviewed mentioned being personally involved in the design, development, or implementation of the systems. This pattern among the oncologists' responses gave the impression that clinicians did not see the interventions described by Ammenwerth et al. (2006) as their own direct responsibility, but rather saw these interventions as a more general NHS "management" issue across the various hospital settings.

In a similar study, in which Lesselroth, Yang, McConnachie, Brenk, and Winterbottom (2011) applied the FITT model, participant interviews revealed a number of critical technical and social barriers to acceptance of a clinical decision support system. The investigators categorised the results in accordance with the dimensions of the FITT framework (e.g. individual, technology, tasks) and the relationships between them. The most important problems that were established were the use of a variety of work-around processes, deficiencies in usability when ordering tests and treatments, and inaccurate clinical decision support (CDS) guidance. Moreover, the workflow configuration for medical staff was inconsistent and did not align properly with clinical processes, leading users to bypass the system-recommended pathways.

As explained in Chapter Five, workarounds were a prominent feature in the results of the qualitative study. According to Yang, Ng, Kankanhalli, and Luen Yip (2012), workarounds are necessary due to a misfit between EPR systems and work processes. With regards to the FITT model, Yang et al. (2012) essentially argued that the misalignment in healthcare information

systems is primarily related to the technology and tasks interrelationship. The findings of the present study indicate strong support for the key points made by Yang et al. (2012), who suggest that EPR system users may react to problems with the system (e.g. related to accessibility, integration or usability) by “augmenting, fitting, or working around” (p. 43).

Using a similar approach to Lesselroth et al. (2011), and to assist with triangulation, the key findings from the interviews with oncologists were also analysed and grouped as issues and barriers identified in each of the three dimensions of the FITT model. Table 6.4-1 below sets out the main issues and barriers that were reported in both the quantitative and qualitative study and are therefore considered to be results arising from the triangulation of the studies.

		Issues or barriers to oncology EPR success	Recommended interventions to improve performance
Actors in system	Task	<ul style="list-style-type: none"> • Time pressures due to clinical workload (no transition time allowance to gain familiarity with new systems and processes) • Poor design and inefficiency of software functionality • Inefficient workflow for proactive management of clinical tasks 	<ul style="list-style-type: none"> • Clinic template to be temporarily adjusted for initial phase of new system implementation • Participative design approach using real patient use cases to refine and improve workflow • Extensive usability testing should be undertaken using practising oncologists
	User	<ul style="list-style-type: none"> • IT literacy / user competency is a relatively minor concern • Evidence-based clinical benefits of IS technology in oncology is very limited 	<ul style="list-style-type: none"> • Online self-help hints and tips and in context access to clinical protocols and guidelines • Baseline process efficiency of high-volume transactions (e.g. prescribing) before implementing changes
	Technology	<ul style="list-style-type: none"> • Poor design of user interface • Poor access and availability • Limited integration and interoperability with other systems 	<ul style="list-style-type: none"> • Technology solutions (i.e., EPR) should be designed for easy access (e.g. single sign-on) and high availability • An integration engine should be procured as a central component of overall system architecture
Interfaces	Task Technology	<ul style="list-style-type: none"> • Oncologists found user interface and functionality of the technology to be poorly designed, adversely impacting on the efficiency of tasks 	<ul style="list-style-type: none"> • System functional requirements specifications should be developed using participative design and signed off by clinical stakeholders
	User Technology	<ul style="list-style-type: none"> • Decision support functionality not fully developed or reliable 	<ul style="list-style-type: none"> • EPR systems should proactively generate oncologist workflow tasks • Laboratory results should automatically trigger treatment plan review
	User Task	<ul style="list-style-type: none"> • Multi-cycling SACT prescribing unavailable • No built-in protocols or guidelines for easy reference 	<ul style="list-style-type: none"> • Software functionality based on detailed process maps • Online treatment guidelines in context of EPR order sets

Table 6.4-1 Socio-technical issues identified during oncology EPR implementation.
Findings are categorised using the FITT framework (adapted from Ammenwerth et al., 2006)

Fit between individuals and task

Individuals and tasks were not well-aligned in relation to some of the clinical tasks undertaken using the EPR systems. One task that participants frequently described as problematic was

electronic prescribing of chemotherapy. Several oncologists described this task as inefficient. Some attributed this inefficiency to the EPR systems' lack of multi-cycle scheduling functionality, which required clinicians to complete the same task of prescribing for every cycle, rather than prescribing the full course and then cancelling or amending future cycles as needed. Whilst this is an issue related to the system functionality, which can be considered part of the technology dimension of FITT, it is actually the task of prescribing itself that is poorly aligned with the oncologists' need for a smooth workflow process.

Another task that participants described as problematic was ordering pathology laboratory tests. Unlike chemotherapy prescribing, for which one EPR system was being used for all patients and treatments (except clinical trials), the task of ordering blood tests was complicated by the fact that multiple EPR systems and paper request cards were used in different clinical settings. An oncologist could use the main EPR system for ordering a blood test when based at one of the main cancer centre locations, but when working at an outreach clinic, this oncologist might have had to use a different system or a paper request card.

Fit between individuals and technology

This fit was reasonably well-aligned in the sense that most oncologists felt comfortable using technology, both in clinical environments and in their lives outside of the workplace. Where misalignment was indicated, it was usually related to problems with access and the requirement to use multiple systems. The majority of oncologists felt that they were IT literate enough to use the EPR solutions. Generally, participants accepted computerised information systems as a necessary part of providing clinical services; however, some oncologists expressed frustration with the limited accessibility, usability, interoperability, or integration of these systems.

Fit between task and technology

This fit was found to be somewhat problematic in several areas. The patient records survey (Chapter Four) revealed a wide range of problems relating to the EPR system functionality, efficiency of workflows, and the accessibility and availability of systems, particularly in remote clinic locations. The interviews with oncologists (Chapter Five) supported the comments made in the patient records survey with many of the participants giving examples of the difficulties, expanding on the relatively brief textual responses to the questionnaire. During the interview discussions, it was apparent that many oncologists regarded poor software design as a key factor; several noted that the EPR system technology was not optimally configured to support clinical tasks. Ordering blood tests and signing off the results and prescribing SACT were two frequently cited examples of this problem.

In summarising the triangulation of FITT according to the selected socio-technical systems framework and the theoretical aspects of the phenomenographic analyses of the data, the study found the two perspectives (i.e. phenomenography and social-technical systems) to be complementary. Whilst it is recognised that phenomenography is a methodology, rather than just a perspective, the methodology itself is founded on the premise that the researcher deliberately assumes a second-order perspective and views the phenomena being investigated through the eyes of the participants. The FITT alignment between the three dimensions was therefore also viewed from the oncologists' own perspective; this approach strengthened the interpretation of results from the quantitative study. As the researcher's role as Head of Information Management and Technology at the case study site involved listening to the views and observing the experiences of the oncologists using the EPR systems over several years, this also allowed, to some extent at least, an end user's perspective to be adopted more easily when conducting this research.

6.5 Methodological triangulation

As outlined in Chapter Three, there are two main types of methods triangulation, namely, within-methods triangulation and between-methods triangulation. Rees and Bath (2001) explained that between-methods triangulation is concerned with the combination of research strategies using different methods. The authors described a case study relating to cancer nursing and argued that the use of both qualitative and quantitative approaches established good convergent validity for the study. Additionally, they argued that between-methods triangulation enabled a more comprehensive view of the phenomenon under investigation than what would have been possible using only either method singularly. In summary, Rees and Bath (2001) found between-methods triangulation helpful for identifying the information sources for partners of women with breast cancer, and they recommended this approach for use in other information-focused research projects in cancer services.

In this study, data were also gathered using quantitative and qualitative methods. Whilst the application of two methods usually requires more time than using a single method (O'Byrne, 2007), this cost of time is justified in that the mixed methods approach provided additional insights into the factors that could affect users' attitudes towards using EPR systems in cancer services and their related IT usage. In this research, the phenomenographical approach to the qualitative study allowed an in-depth study of oncologists' views and experiences, to explore and enhance the findings of the survey questionnaire, and it provided richer and more detailed insights about EPR adoption and use in cancer services. This resulted in key findings presented as the outcome space that included the three different categories of description of how oncologists think about EPR systems and the application of mixed methods also established the

most significant themes that emerged from the survey: system usability; integration/interoperability; and accessibility/availability.

The use of a mixed methods approach specifically within the field of technology acceptance was advocated by Wu (2012), who argued that there is a requirement to progress technology acceptance research by shifting away from the traditional dominance of the quantitative questionnaire study. Wu (2012) emphasised the importance of a mixed methods approach and the necessity for evaluation of TAM concepts in interpretive, as well as positivist, theories, highlighting the importance of methodological triangulation. With reference to Creswell (2003), the sequential explanatory design (illustrated in Figure 6.4.1 below) is where investigators initially collect and analyse quantitative data before using qualitative methods to probe, explicate, or triangulate the quantitative findings (Wu, 2012). As detailed in Chapter Three, the same approach was employed in this research, as illustrated in Figure 6.1 below.

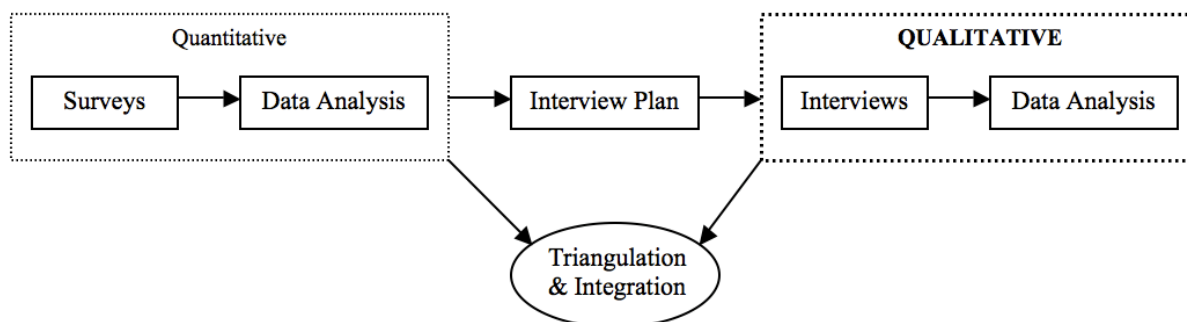


Figure 6.4.1 Sequential Mixed Methods Design with Emphasis on the Qualitative Phase

(reprinted pending permission from Wu, 2012)

As explained in Chapter Three, having opted to apply a mixed methods approach to the study, the researcher's intention was to then design a novel framework or model for presentation of the findings, updated through several iterations as the results emerged and were triangulated. The idea for the model, named CICERO, was initially explained in Chapter Two (Section 2.13). The second and third, final version, developed following the empirical stages of the research, are described in further detail in the following section.

6.6 CICERO conceptual model

In response to the main research aim, this mixed methods study found the most important factors affecting the adoption and use of EPRs to be the integration, accessibility/availability, and usability of the systems (Chapter 6, Section 6.2.1). The design of a conceptual model that incorporates specific guidance and recommendations about these factors, in combination with a range of other important areas for consideration, was therefore adopted as a novel way to

present the research findings. In practice, it is anticipated that users may select single or multiple components of the model, depending on the context and project requirements, then use the summary guidance as a checklist highlighting key issues for consideration and pointers to other relevant research findings.

As discussed in Chapter Two, the model is called CICERO, an acronym for “**C**omprehensive, **I**ntegrated, **C**ustomisable, **E**lectronic **R**ecords for **O**ncology.” CICERO does not describe a vendor or technology-specific toolset or system solution; rather, it is a conceptual model designed to support further research about EPR systems in oncology, from which practical guidelines for practitioners and commercial technology providers will potentially emerge, to inform more efficient and effective EPR design, development and implementation projects. The author’s intention is that the final published version of CICERO will be recognised by researchers, oncology informaticians, clinicians, and managers as a definitive reference model that encapsulates the existing body of research on the subject of oncology EPRs, and incorporates relevant research findings in a clear format, including the findings from this PhD study. As noted in Chapter Two, previous research has investigated the possibility of creating a definitive reference source of clinical documentation for oncology, some of which could potentially be viewed as elements of clinical content for use in conjunction with CICERO. For example, Wagner et al. (2015) conducted a study to establish whether a single source of clinical documentation could be constructed for all oncology entities via application of a single class without branching entities into groups. They concluded that this standardised approach would not be viable, but that a comprehensive document workflow could be created using a tiered approach contingent on the disease type. Within a single tier, branching routes for variations of EPR system recording screens and workflows can then be selected and adapted from use with various entities and stages of disease and associated clinical pathway (Wagner et al., 2015). This reflects the level of complexity in the layers of detail that sit behind the CICERO framework, where EPR system workflow configuration requirements should be standardised where possible but vary between disease groups. Whilst the scope of CICERO does not include detailed functional specifications, it is important to acknowledge the requirement for and importance of them. The study by Wagner et al. (2015) is relevant here as experience in the configuration of complex oncology order sets at the study site found similar constraints in the level of standardisation that could be achieved across disease groups. Munkvold et al. (2007) investigated a particular area of EPR system content, nursing plans – commonly referred to as care plans in the UK, and concluded that plans should be thought of as more of a network (distributed, heterogeneous, and negotiated) rather than a singular artefact within the care record. This illustrates the complex multi-dimensional nature of the components included in the CICERO model and the importance of interoperability.

Whilst comprehensive in its coverage of the scope of oncology information systems used in a large treatment centre, the CICERO model does not prescribe detailed specifications for clinical configuration of EPR systems. Rather, it offers a framework reference model and points to guidelines that are grounded in empirical research findings. In this regard, CICERO can be thought of as an overall architectural framework for existing and new research findings related to clinical content, guidelines, checklists, and recommendations. During the course of this research, the model was first updated to Version Two following the exploratory research study. After the results of the main qualitative study were determined, the model was further updated to Versions Two (UML2 version) and Three, as explained in this section.

In considering the methods that could be adopted for creating CICERO, several established system-modelling techniques were identified and evaluated for suitability. One of the most well-known approaches in the wider subject area of socio-technical systems is soft systems methodology (SSM) (Checkland, 2000). SSM has previously been used to model the cancer care domain in South Wales, UK (Allam et al., 2004). The researchers working on this project developed a root definition for the wider cancer care system (i.e. not just the EPR system, but the holistic system of patient identification, referral and treatment). Using the SSM root definition, the researchers first applied the "CATWOE" approach to defining the customer, actor, transformation process, Weltanschauung (worldview), owner, and environmental constraints relating to the problem domain. They produced a conceptual model, shown in Figure 6.6.1 below, as an example of an SSM "rich picture" diagram. A rich picture diagram is a type of diagram used in SSM that is essentially a visual representation of a complex system of interconnected objects, features or activities, referred to as "rich" due to its ability to convey a complex system on a single page. Its purpose is to provide a graphical illustration that would otherwise require potentially thousands of words of narrative to explain in textual format.

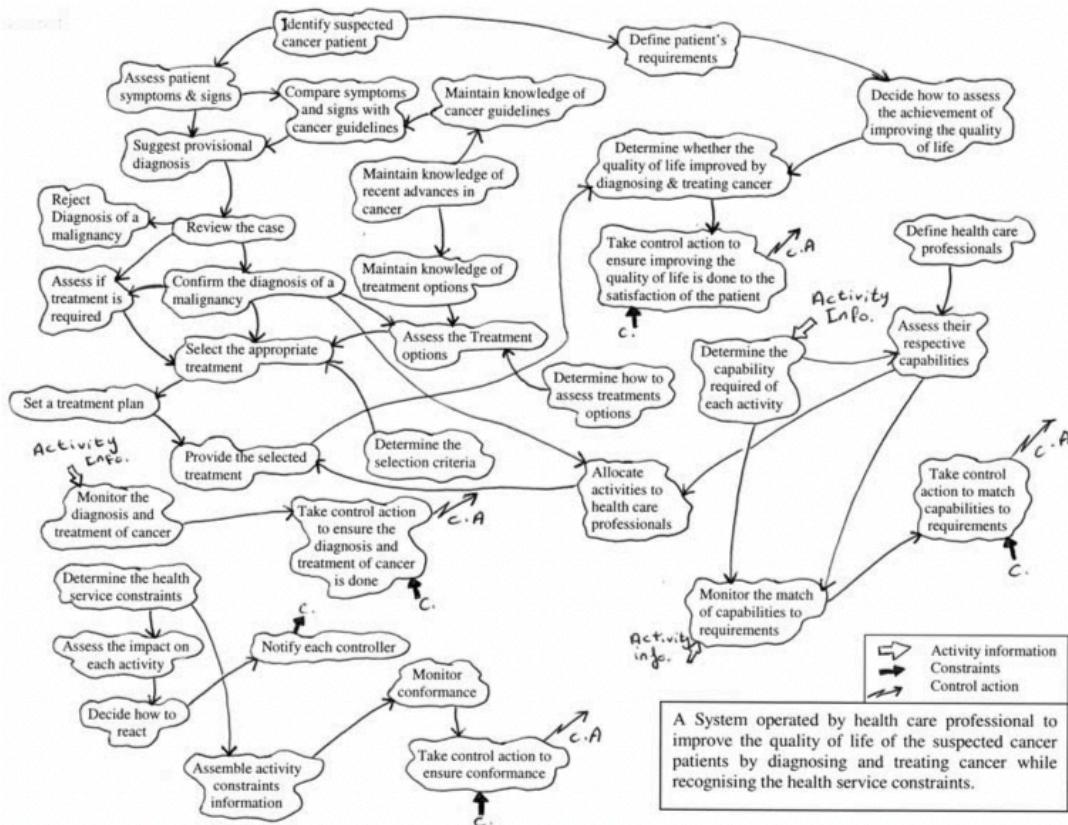


Figure 6.6.1 SSM Rich Picture Diagram of a Cancer Care System

(Reprinted with permission from Allam, Gray, McIntosh, & Morrey, 2004, p. 211)

Whist soft systems methodology has been used to illustrate an application of systems thinking methodology, this is a method that is used for a wide range of different purposes. In many respects it is a diagnostic problem-solving tool and a phrase sometimes affiliated with the concept of a rich picture diagram is “a picture is worth a thousand words”, meaning that diagrams are a helpful way to illustrate complex information. It was not the intention in this study to use SSM as a methodology for investigating and analysing technology acceptance in cancer services, but it was helpful to use some of the core concepts of the SSM for the purposes of developing the CICERO model as an overarching diagrammatic format of presenting complex phenomena.

During the early stages of this current research, SSM was initially used to map out the oncology information systems used at the case study site. The various components of the overall system were then identified and presented in the original version of CICERO in Chapter Two, then used to produce a type of SSM rich picture diagram in a basic two-dimensional block format. In order to develop the model into a format that could be recognized as an information systems architecture conforming to an established modelling language, UML2 was then used to provide a more detailed technical view of the overall oncology information system. Having been previously trained in UML2 diagramming techniques, the researcher converted the basic block diagram into UML2 format by identifying specific components, using the component diagram

shapes to denote them, and then, where applicable, grouping them together as components of a larger sub-system.

In accordance with information systems modelling techniques, the first stage of decomposition of the high-level design in CICERO v1 was to separate the presentation, application, and data layers into three major subsystems. This standard approach to modelling information systems is based on the principle that the presentation layer is responsible for all aspects of the user interface, the application layer handles business logic (e.g. system functionality and workflow processes), and the data layer is where data are stored, ensuring that the systems objects persist. As a concept, CICERO aims to integrate the presentation layer, ideally to a single user interface with one requirement for authentication and login (as per the ideal system described by many of the oncologists). However, due to the specialised nature of some of the sub-systems, it is unlikely that all functionality required by oncologists would be available in a single integrated system. Therefore, the CICERO model recommends to solution designers that a single sign-on agent and other user interface (UI)-level integration methods are used, allowing the clinical end users to move seamlessly between sub-systems. Whilst the subsystems are typically organised into the three main areas described above, UML2 also allows subsystems to be illustrated where a group of components have specific dependencies and interfaces for a particular area of functionality. For example, the Radiology Information System (RIS), the Picture Archiving and Communication System (PACS), and Vendor Neutral Archive (VNA) are all replaceable components within a sub-system called Radiology (which could also be named Diagnostic Imaging). To illustrate the subsystems of CICERO as a complex multi-layer system architecture, CICERO v2 is first displayed in Figure 6.6.2 below in the three-tier model, including presentation, application, and data layers.

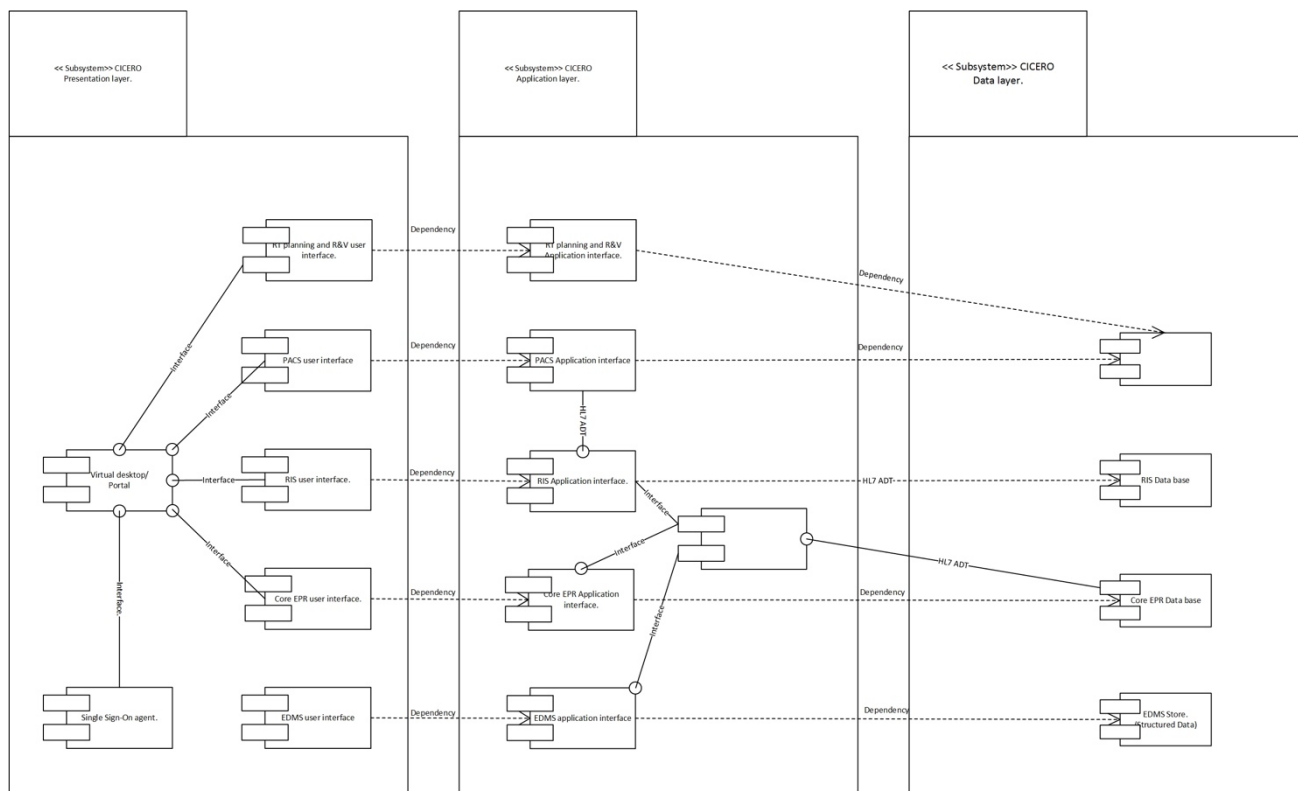


Figure 6.6.2 CICERO UML2 Component Diagram

In the presentation layer, the primary user interface is consolidated into a virtual desktop or portal with a single sign-on agent, meaning the user interface for specific applications can be accessed from a single location (sometimes referred to as a “landing page”) without the oncologist having to remember and enter multiple passwords. In the application layer, the business logic for each application is included as a specific component, as the programming, calculation, and workflow processes are unique to each module and are replaceable. It is important to note that the integration engine component is a key feature of the overall system architecture, as it allows data messages to be transferred between components. Typically, these messages will conform to globally recognised interoperability standards for healthcare systems, such as HL7 (as explained in Chapter 2). In the NHS, the current interoperability standard to which hospitals are expected to adhere is HL7 FIHR (Fast Interoperability Healthcare Resources; FIHR release 3 April 2017). This standard is important because it allows the components to exchange data with other components in a format that facilitates interoperability; use of this standard also means that components of the overall system architecture can be replaced more easily when required.

In the data layer of CICERO v2, there are three main data storage platforms. Firstly, the core EPR system database contains the master patient index (MPI) and all structured data relating to individual patients’ medical records. This master system uses a HL7 ADT message (admissions, discharges and transfers) to update all downstream systems with new patient registration and demographic updates. In the NHS, it is preferable for the core EPR database to

be connected to the patient demographics service (PDS, one of the national “spine” systems) in order to validate each patient’s NHS number and ensure the most up-to-date GP practice registration.

To produce the UML2 diagram, several modelling tools were evaluated using free trial versions. An application called Edraw Max (licensed by Edraw Soft Ltd.) was selected as the preferred tool due to its menu of UML2-specific shapes and its intuitive user interface. In a UML2 component diagram, the relationship between system components is defined using lines with different symbols to indicate whether there is a dependency or an interface. In UML2, interfaces are either already in place or “required” with different symbols to distinguish them. Because CICERO is a model of a comprehensive integrated system, rather than a model of the systems in use at the case study site, the UML2 diagram simplified the approach to producing the model by assuming that, in the ideal oncology information system (as described by the research participants), all necessary interfaces for efficient information flows and usability will be in place.

The second version of CICERO (v2) applied an established method of information systems modelling by using one of the UML2 structure diagrams, called a component diagram (Figure 6.6.2). The primary purpose of a component diagram is to illustrate the structural relationships among the replaceable units (components) of a system. It illustrates the structure of an overall system as “black boxes” with their interfaces available for replacement or re-use. Whilst UML2 includes a range of diagram types for modelling different aspects of a system’s structure and behaviour, the rationale for using a component diagram as part of CICERO development is that this diagram enables researchers to focus on the high-level discreet modules or components of an oncology information system (Bell, 2004).

A component diagram is appropriate for use in creating an architecture-level artefact, as opposed to other UML diagram types that are used for illustrating the design of physical system components such as hardware and IT networks. Because CICERO is a conceptual model designed to provide a framework of functional areas and socio-technical considerations (as opposed to a comprehensive software or technical solution design), it is not intended to produce a wide range of UML2 diagrams for modelling system behaviour and structure. Rather, CICERO is intended to demonstrate that a conceptual model can be translated into a format that can be understood by technical architects, system designers, and developers. Having demonstrated how a UML2 component diagram can be developed from the original version of CICERO, in the future, technical architects in oncology could further develop a range of other UML2 diagrams to assist with technical solution design and interoperability.

This translation could be achieved, for example, by EPR design and implementation teams selecting appropriate sub-systems or components of the full CICERO architecture and

developing additional UML2 structural diagrams to model the static state of the sub-system or component in greater detail (e.g. interfaces, nodes, classes and objects), using Class, Object and Deployment diagrams, with an emphasis on defining required interfaces with other sub-systems and components within the CICERO model. The aim here is to ensure that sub-systems or components (which may be combination of commercial vendor products and in-house developed software) would be replaceable within the CICERO framework concept, while ensuring that seamless integration and interoperability is achieved and maintained where possible. In a similar manner, various UML2 behavioural models may also be used by the EPR design team to complete the system model with the dynamic aspects. This could include, for example, a series of use case diagrams for specific clinical pathways, e.g., SACT lung cancer protocols and various other UML2 behavioural diagrams, such as Statechart and Activity diagrams. A range of other reference material may be used to inform the design process, including the HL7 specifications and other research literature referred to in Chapter Two.

Having demonstrated compatibility of the model with a recognised system modelling language, further development of CICERO into the third version reverted back to a rich picture diagram format, this time using a three-dimensional “infographic” format as an enhancement to the original two-dimensional block diagram, CICERO v1. This shift to a three-dimensional format alludes to the complex multi-dimensional nature of the model’s content. Infographics have been defined as a “graphic visual representation of information, data or knowledge” (Newsom & Haynes, 2004, p. 236) designed to enhance perception by using graphics to augment the human visual process of identifying patterns and trends. In effect, CICERO v3 uses a combination of SSM’s rich picture diagram approach and a UML2 structure diagram, and it also incorporates the recommended visual presentation of the phenomenographical outcome space and an adapted version of the diagram used in Ammenwerth et al.’s FITT methodology (2006). The aim of bringing these three aspects together is to offer a comprehensive overview of the complex scope of the overarching socio-technical information systems in oncology. Therefore, this section presents the updated, final version of CICERO that incorporates the outcomes of the phenomenographical analyses. In this version, the socio-technical considerations have been updated to reflect the key themes that emerged from analyses of the interview transcripts. Following triangulation of the results, the key factors have been highlighted in the CICERO diagram to indicate their increased importance in comparison with the other themes identified. Analyses using the FITT model also allowed this model to be adapted and presented as part of CICERO, using the connection symbol to illustrate the extent of alignment between the dimensions, in accordance with the visual representation used in the original FITT paper (Ammenwerth, 2006). The FITT diagram uses a lightning bolt-style arrow symbol to indicate where there was a problem with fit or alignment and a sun symbol to indicate good alignment. In CICERO v3, the sun symbol is therefore placed between technology and users and users and tasks, but the lightning bolt arrow is placed between technology and tasks, highlighting the

problems with alignment that were found in this research study. An additional unit has also been added to the rich picture diagram to reflect the emphasis on interoperability with third-party clinical systems. In summary, the infographic style v3 of CICERO incorporates the results of the phenomenographical analyses and the application of FITT.

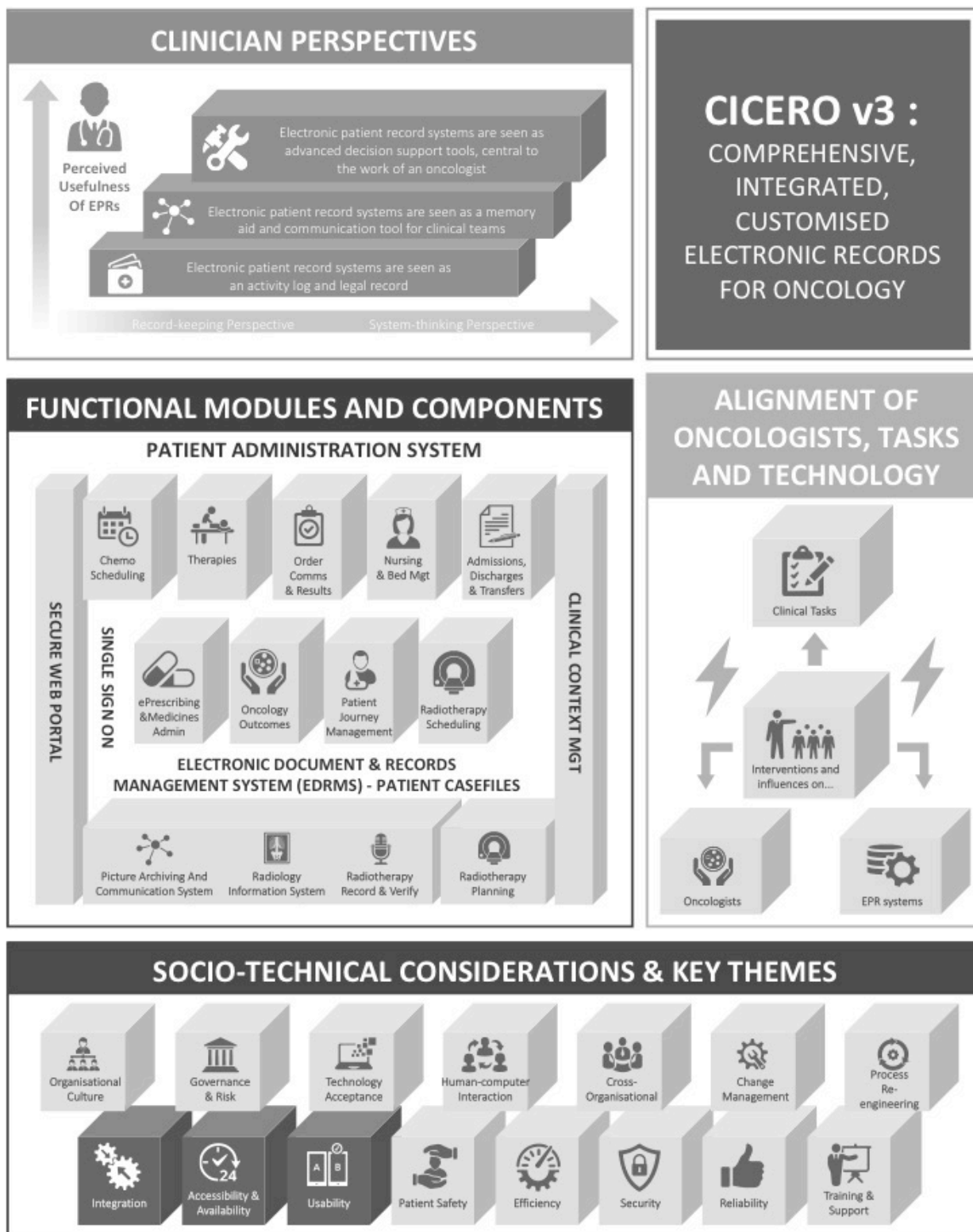


Figure 6.6.3 CICERO v3 Conceptual Model

The following sections describe each component of the final version of the model in more detail and discuss practical recommendations for health informatics practitioners and hospital

management personnel who are responsible for the specification, procurement, configuration, and implementation of EPR systems.

Functional modules / components – description and recommendations

With reference to the range of functionality covered by CICERO, Figure 6.6.4 below highlights the relevant section of the full diagram, followed by a description of each of the modules.

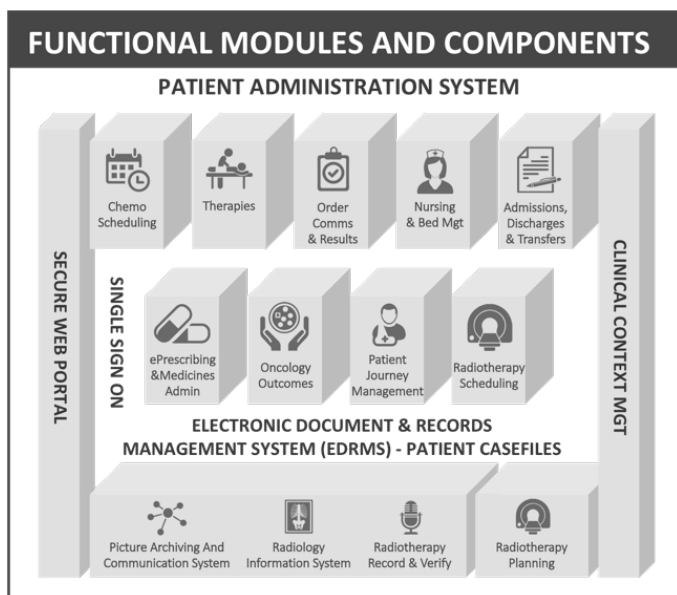


Figure 6.6.4 CICERO functional modules and components

Electronic Document and Records Management System (EDRMS)

EDRMS is a transitional technology that allows organisations to digitise (scan) paper format records into digital images. Several oncologists commented on the difficulties associated with searching for information within an EDRMS (both at CCC and at other host hospitals where EDRMS has been implemented). A common view was that the electronic casefile should be designed to replicate the structure of a traditional paper-based medical record. However, other participants voiced a contrasting view that optimal design would be determined through participative design and comprehensive usability testing. In any case, the EDRMS component is proposed as an essential sub-system to facilitate the transition from hybrid patient records (where the paper record is viewed as the primary record) to a fully electronic system. In time, once the organisation has ceased originating paper documents and can automatically convert paper being received from external sources into electronic format, the overall volume of documents may be reduced, such that the EDRMS component becomes an archive and new active documents can be loaded directly into the core EPR system.

Order Communications and Results Reporting

Order communications and results reporting provide functionality for clinicians to order diagnostic tests (e.g., radiology and pathology) and view the results. In some cases, this functionality is provided as an integrated module of the core EPR system, but in other cases, a third-party application (in this study, one such application was the Sunquest ICE system) is used in conjunction with the core EPR. For regional oncology services, it is preferable to reduce the number of source systems processing orders and providing test results in order to consolidate laboratory services. Some oncologists reported an improved user experience with a separate, dedicated order communications system, which offers the advantage of being able to see diagnostic results from tests ordered by other hospital departments. However, the disadvantage to this approach is that the results data were not stored into the core EPR system and therefore would not be available for use in clinical decision support processes. For example, if a patient's creatinine clearance level (the kidney's ability to handle creatinine, a waste product from the normal breakdown of muscle tissue) was outside of the normal range when a laboratory result was sent to the EPR system, the system could be configured with an alert and workflow process to automatically stop future chemotherapy appointments and prescriptions until an oncologist had reviewed the patient's case.

Radiology Information System (RIS)

Similar to laboratory tests, diagnostic imaging is a core activity within oncology services. Many oncologists discussed the need for an integrated and efficient workflow process to ensure that radiology examinations can be ordered efficiently and that radiologists' reports of the results can be stored as part of the patient's overall record. An industry trend in this area (identified through the researcher's industry knowledge and professional network, rather than through this research) is that PACS functionality is developing to include reporting facilities (Digital Health Media, 2017). This development means that a radiologist can record the details of their report (i.e., assessment of the imaging study) directly into the system, with no need for a separate RIS. This component of CICERO may therefore become redundant within the next few years.

Picture Archive and Communication System (PACS)

PACS is an essential component of the oncology information system and is widely described as one of the most successful examples of computerised information systems in oncology. Many EPR systems offer the functionality to store PACS images within the core EPR system, but for oncology, this may not be the most appropriate method of storage. An EPR design team should consider whether a PACS viewer could be incorporated within the core EPR system, allowing access in both user and patient context to imaging studies (and associated radiology reports).

The GWL was reported to be particularly helpful to the work of oncologists, allowing access to imaging studies that were conducted at other hospital sites.

Chemotherapy scheduling

Efficient scheduling of chemotherapy treatments requires software functionality that facilitates booking multiple appointments, which may be subject to change depending on the patient's clinical condition and availability. Several oncologists discussed the difficulty and inefficiency associated with treatment scheduling being disconnected from prescribing; this disconnect led to the need for significant manual intervention to try to synchronise these processes that should be linked seamlessly. With reference to the FITT model, this is an example of a misalignment between technology and tasks that is not unique to the case study site, but is an internationally recognised issue in oncology (Galligioni et al., 2009; Sicotte et al., 2016), as reported in the literature review in Chapter Two (Section 2.8).

Electronic prescribing and medicines administration (ePMA)

ePMA is a critical component within an oncology EPR system, as it is used to prescribe cancer treatments. Several oncologists cited full course or multi-cycle prescribing as the main area of system functionality that is not currently available in the ePrescribing system at the study site. As one interviewee reported, it is "being able to prescribe a course of treatment and then, if you have to alter a date, it will alter the subsequent dates automatically" (M28). When an oncologist prescribes a course of SACT, it is usually a protocol requiring several cycles of chemotherapy over a defined time period with set intervals between treatment appointments. Multi-cycle prescribing is where the entire course of treatment, including all subsequent cycles, is prescribed at the same time as the first cycle. For oncologists, this makes the management of the patient pathway more efficient, but the system needs to be able to deal with potentially complex changes to the series of appointments (for example, if the patient is acutely unwell and has to defer a scheduled appointment).

Nursing and Bed Management

Whilst bed management was not a topic discussed in detail with the oncologists in this study, it is an important aspect of oncology care, requiring sophisticated software for the management of patient flow (admissions, discharges, and transfers). Furthermore, a range of oncology-specific nursing assessment and care planning tools are required for safe and effective patient care. During the course of this research, a new regional Acute Oncology service was established with the aim of reducing admissions to inpatient beds and length of stay. This development had

specific informatics requirements as part of the cross-organisational care pathways, as reported by the author of this thesis in a journal paper (Neville-Webb et al., 2013).

With regard to nursing assessments and care plans, there is a range of oncology-specific information requirements that the EPR system must take into account. For patients undergoing SACT, the management of side effects can include: neutropenic sepsis⁶; chemotherapy-induced nausea and vomiting; chemotherapy-induced diarrhoea; alopecia (hair loss); stomatitis (inflammation of the mouth and lips); fatigue; hypersensitivity; peripheral neuropathy⁷; and extravasation⁸ (Roe & Lennan, 2014).

Patient Journey Management System

The Patient Journey Management System is used to track the status of each patient in relation to various targets that are used in oncology, with a view to ensuring the best possible clinical outcomes by reducing waiting time for treatment as far as possible. In the UK NHS, in addition to the standard 18-week referral-to-treatment (RTT) target for all GP referrals to acute hospitals, there is a range of target cancer waiting times (CWT), within which patients are expected to be seen/treated. The key targets that NHS cancer treatment services are currently required to track and report are: the two-week wait (with a target for 93% of patients to be seen by a specialist within 14 days of an urgent GP referral for suspected cancer); the 31-day wait (with a target for 96% target of patients to receive their first definitive treatment within 31 days of a cancer diagnosis); and the 62-day wait (with a target for 85% of patients to commence their initial treatment for cancer within 62 days following an urgent GP referral for suspected cancer).

The idea of a Patient Journey Management System (PJMS) is to provide an easy-access visual representation of an individual patient's pathway, showing time scales and key events and highlighting where a waiting time target is likely to be breached. This allows corrective action to be taken to minimise the likelihood that a patient will not be treated within the target timescale. Whilst it may not be called PJMS, CICERO recommends that an oncology EPR system include a graphical representation with predictive algorithms to automatically flag patients at risk of breaching the waiting time target. This feature should be prominent in a timeline view of the patient's record. With reference to this area of functionality it is important to acknowledge that the cancer waiting targets are policy-driven and specific to the UK, even though the policy is informed by evidence-based timelines for optimal treatment.

Socio-technical and human factors

⁶ A life-threatening complication of SACT, neutropenic sepsis is a major inflammatory reaction to a suspected bacterial infection (NICE, 2012)

⁷ Nerve damage to peripheral digits, i.e. toes and fingers.

⁸ The accidental leakage of IV administered drugs into the body from a drip in the vein (Goutos, Cogswell & Giele, 2014).

Based on the triangulated findings of the study, the bottom left section of the CICERO v3 diagram details the various socio-technical and human factors that should be considered when implementing EPR systems in oncology. Table 6.6-1 presents a summary of the socio-technical factors affecting adoption of Onco-EPR. This table is provided for program managers to use in conjunction with the diagram. It offers summary-level guidance on key areas for deliberation when planning and initiating EPR programmes; conducting business analysis; and producing system design, configuration specifications, and detailed plans for implementation.

CICERO component	Factors affecting adoption and use of EPRs	Primary Source (Thesis chapter)	CICERO Recommendations
Organisational culture	Various studies have shown that organisational culture can directly influence the successful adoption and use of technology. Key to the success of Onco-EPR is a culture of clinical leadership, engagement, ownership, and team working.	Literature review	For EPR implementation to be successful, an open culture of multi-professional team-working is required.
Governance and risk	Whilst governance and (organisational) risk were not explicitly identified as central themes in the study, the literature review and experience in practice suggest that these are key factors for consideration.	Literature review (Chapter Two)	Successful EPR implementation requires a robust governance structure with clear reporting lines and escalation to Board level and full adherence to effective risk management policies and procedures.
Technology Acceptance	This study found that technology acceptance is influenced by the different ways that oncologists think about EPR systems, which anecdotally relate to the perceived value of computerised information and workflow processes.	Qualitative Study (Chapter Five)	EPR project sponsors and implementation teams should have knowledge of technology acceptance theories and principles.
Human-computer interaction	Usability of the EPR systems was found to be a significant factor in both stages of this mixed methods study. Good usability of EPR systems is critical to adoption and use.	Quantitative and Qualitative Studies (Chapters Four and Five)	EPR project sponsors and implementation teams should have knowledge of technology acceptance theories and principles.
Cross-organisational working	In a regional oncology service, cross-organisational working is a significant issue requiring particular focus and attention.	Qualitative study (Chapter Five)	Effective relationships should be established with Health Informatics Departments at other hospital sites where oncology clinics take place.
Change management	Clinical leadership and engagement; anecdotally, the clinicians who thought about EPR systems in the third category of description were more inclined to be involved in system design and implementation activities.	Qualitative study (Chapter Five)	An effective change management methodology.
Integration	Integration is highlighted in the CICERO diagram as one of the most significant factors affecting adoption and use of EPR systems.	Quantitative and Qualitative studies (Chapters Four and Five)	As illustrated in the UML2 version of the diagram, an integration engine is seen as a central component of the overall EPR system architecture.

CICERO component	Factors affecting adoption and use of EPRs	Primary Source (Thesis chapter)	CICERO Recommendations
Accessibility and availability	This dimension is also highlighted as a key area requiring careful attention during EPR implementation.	Quantitative and Qualitative studies (Chapters Four and Five)	EPR systems should be designed for easy access (e.g. single sign on) and high availability.
Usability	Many of the oncologists in this study alluded to poor usability of the EPR systems.	Quantitative and Qualitative studies (Chapters Four and Five)	CICERO recommends using participative design approach to configuring clinical workflow processes and extensive usability testing. EPR procurement should include evaluation of usability in addition to functional requirements.
Efficiency	Several oncologists commented on the negative impact of EPR system on their efficiency, citing examples of clinical tasks that took longer than on paper. Key examples were reviewing blood test results and ordering courses of SACT.	Quantitative and Qualitative Studies (Chapters Four and Five)	A recommended approach here is to identify the highest volume transactions undertaken in oncology and to measure their average duration before and after EPR implementation, to create an evidence base for change and gain buy-in.
Security	Security was identified as a key theme in the quantitative study but was not mentioned as a significant issue in qualitative study, other than with reference to difficulties of accessibility.	Quantitative Study (Chapter Four)	Security systems for protecting patient data in EPRs should be designed be effective but, at the same time, to support ease of accessibility.
Reliability	Several oncologists complained about the EPR systems not being reliable and having to use workarounds, citing this as a key factor affecting adoption and use.	Quantitative and Qualitative Studies (Chapters Four and Five)	The CICERO recommendation here is to ensure a very robust infrastructure including the EPR hosting platform and network resilience. With reference to industry standards, EPR systems should have 99.999% availability, and any unplanned downtime should be viewed in terms of impact on clinic time.
Training and Support	Training and support were identified as important areas that could impact on adoption and use of EPR systems. Oncologists have limited time and capacity for formal training.	Quantitative Study (Chapter Four)	EPR training for oncologists needs to be very flexible to accommodate varied and demanding work schedules.

Table 6.6-1 CICERO: Summary of socio-technical factors affecting adoption of Onco-EPR

In summary, CICERO is offered as a reference model for individuals and teams involved with a wide range of EPR-related initiatives in oncology, from both a research and practical implementation perspective, with the aim of ensuring a holistic view of the key considerations to ensure successful adoption and use of EPR systems. In practice, it is anticipated that the different elements of the model could be referred to with the aim of ensuring that design, development, and implementation plans are cognisant of all of the wide-ranging key factors for success.

6.7 Differentiation of the study from others in the literature

Using the FITT framework as the theoretical reference model for the qualitative study, the interviews revealed that some of the factors identified in the exploratory survey were more prominent than others. Of the three most important factors (interoperability, accessibility, and usability), two had not been highlighted in similar studies conducted in the field. Both Galligioni et al. (2009) and Sicotte et al. (2016) reported issues related to usability of the EPR systems in cancer treatment centres, but as their studies only focussed on a single software application within the organisational boundary of the treatment centre, they did not discover the problems related to interoperability and accessibility that were found in the present study.

Secondly, the use of phenomenography not only provided a unique and previously unused approach in oncology EPR systems research, in terms of a methodological contribution, but the results also provided a new contribution to knowledge by revealing that there are three different categories of oncologists, with regards to their position on EPRs. This contributes a nuanced socio-technical component that was not known about or recognised in earlier studies, but it supports the calls for more qualitative aspects to be taken into consideration in technology acceptance research.

The present study can be differentiated from others described in the literature review as it provides a unique combination of theoretical positioning, methodology, and presentation of results. Whilst the study is positioned from a theoretical viewpoint that is congruent with the general concepts of systems thinking and a socio-technical perspective, as described in section 2.9, it incorporates a more comprehensive and detailed technical scope and aims to reflect the need to give consideration to the complex interplay between human and computerised processes, as alluded to by Benbasat and Barki (2007).

Whereas Sicotte et al.'s study (2016) revealed a number of interesting issues related to the organisation of clinical tasks and workflow processes, it did not specifically highlight any issues

associated with integration or accessibility. With regards to integration and interoperability this may be due to the fact that the focus of the study was on one single software application, as opposed to multiple systems that collectively form the overall EPR system, as described by CICERO. Sicotte et al. (2016) acknowledged this limitation with their study, and it is argued therefore that a more holistic approach to evaluating the wider EPR eco-system in the present study has revealed more important factors than were not previously known, or at least were not extensively considered within a cancer care setting.

Similarly, Galligioni et al.'s study (2009) was focussed on a single EMR software application in a relatively self-contained setting. Whilst the regional treatment centre model at Clatterbridge Cancer Centre might be unique with regards to its operational model, the extent of cross-organisational working in healthcare is a well-known issue and there is, therefore, a strong case for more information systems research focussed in this area.

Galligioni et al. (2009) concluded that there were four key determinants of EPR system success. Firstly, user involvement in system design, which was also reported as an important issues in other EPR studies and is included as one of the key socio-technical features of CICERO. Secondly, flexible web technology, also reflected in CICERO in the form of a technical component that provides remote access (whilst non-vendor specific, it is assumed that any remote access solution would be a web browser-based application). The third important factor was functionality for total patient management, based on clinical end user's requirements – also an inherent feature of CICERO. The final important factor highlighted by Galligioni et al. (2009) was training and support. Although accessibility, usability, and interoperability were not terms that were specifically highlighted in Galligioni et al.'s (2009) results, it is arguably assumed that the flexible web technology referred to is favoured for reasons of accessibility and that the participative design approach is preferred due to an expectation that this will lead to improved usability.

The results from the present study are presented in two main ways. From thematic analyses of the interview transcripts and triangulation with the patient records survey, it was found that there were three prominent factors affecting the adoption and use of EPR systems. As noted previously, these factors were integration and interoperability, accessibility, and usability. Secondly, the results of phenomenographical analyses were presented in Chapter Five in the form of the outcome space, made up by three categories of description. To clarify the relationship between FITT and the phenomenographical approach, in this study phenomography was used as a qualitative method to complement FITT as a subject-specific (i.e. health informatics) framework. Positioned primarily within the individual dimension of FITT,

due to the focus on the oncologists' perceptions and experiences, phenomenography was used to explore how the oncologists felt about and experienced the specific technologies and tasks that were in scope of the other two dimensions.

Whereas the flexibility of FITT can be seen as advantage with regards to being able to select a particular methodology for use in conjunction with its high-level principles, it is suggested that this may also be a disadvantage from the point of view that different results might be generated and robust validation of the framework may prove difficult.

The FITT model was the chosen theoretical framework used to inform the study design, scope, and philosophical positioning with regards to the socio-technical systems perspective. Arguably the unique combination of these results from different angles of the study provide a novel addition to the existing research.

In summary, the outcome space from the phenomenographical analyses found that within the "individual" domain on Ammenwert et al.'s (2006) FITT model, there is variation in perspectives and thinking among any given community. This might mean that, for example, if another technology acceptance model was applied to only oncologists who were positioned in the first or third category of description, the results of conventional TAM predictive models could significantly vary from those that might be found in a study including only first or third category oncologists.

6.8 Overall study strengths and limitations

The limitations, strengths, and weaknesses for the individual empirical studies within this thesis were outlined in Chapters Four (4.6) and Five (5.7). This section summarises the strengths and weaknesses of the overall study.

Socio-technical thinking provided the overarching approach for investigating the complex issues associated with EPR implementation. The thesis applied a novel method of employing socio-technical analysis via application of the FITT model, investigating the factors that affect adoption and use of EPR systems in the context of the need for alignment of technology, tasks, and individuals. The two empirical studies each focused on particular aspects of EPR adoption and use, exploring the phenomena through the lens of clinical end users. As a broad concept, socio-technical thinking was used as the overarching framework for interpreting a varied and complex range of factors associated with EPR deployment.

In this study, detailed calculations of user acceptance using the conventional TAM approach

(Davis, 1989; Davis et al., 1989) were not conducted. This was partly due to the quality and completeness of data collected, but also because the researcher purposefully employed a mixed methods approach in which the second main phase of qualitative research aimed to investigate different factors relating to EPR acceptance in greater depth and in a more comprehensive manner than was possible in the initial quantitative phase. Whilst this method achieved the aims of the study, the researcher acknowledges that further research is required in order to measure the use of EPR systems more accurately, using a method similar to TAM, in order to derive any associations between different variables. Suggestions for further research are discussed in more detail in the final chapter (Chapter Seven, 7.9).

An additional limitation of this thesis is that only one case study site was included in the quantitative study. Whilst the sample included almost half of the oncologists working at the study site in a dedicated cancer centre environment, the case study site will undoubtedly have its own unique features and might not be fully representative of other cancer centres within or beyond the NHS in England. The results might also vary, therefore, if a national survey had been undertaken or if further dedicated cancer centres had been included. This approach was considered in the original research proposal but subsequently declined in favour of a more in-depth mixed methods case study. Additionally, other cancer centres might have had different response patterns if similar studies were carried out there. Supplementary research might assist with understanding whether similar themes and associations existed in other cancer centres.

The researcher's role as Head of Information Management and Technology at the study site has been explained previously, and whilst this was helpful for the research presented here due to the researcher's extensive knowledge and experience of the research topic, it should be acknowledged again here that even with appropriate mitigation through research training and careful efforts to ensure objectivity, this professional role may still have had some possible effect on the interactions with research participants.

In this research, the primary objectives were to analyse factors influencing clinical EPR users' attitudes towards using computerised information systems in cancer services, identifying the most prominent factors that might influence their attitudes and, in turn, their adoption and use. Therefore, the overall results were presented in relation to the whole sample on a case study basis. Further analyses are required in order to establish the relationships between these factors and oncologists' attitudes within various clinical environments and multi-organisational settings.

6.9 Conclusion

In this chapter, the outcomes of the quantitative and qualitative studies were further analysed and explained using triangulation. Additionally, different methods of triangulation (including data,

theory, and methods triangulation) were used to explain the research results. These triangulation methods demonstrated that both the quantitative and qualitative investigations contributed to establishing the confirmation and completeness of the findings.

The use of a mixed-methods approach added additional time to this study and extended its duration, but this approach was justified in that it facilitated an in depth-qualitative study built upon the foundations of themes identified during the quantitative study. Therefore, the application of both quantitative and qualitative methods in a single investigation is recommended for obtaining a deeper comprehension of the phenomena and research outcomes. However, it is acknowledged that the overall duration of the research may have had implications for the findings, given the extent of IT system developments that took place during the course of the study.

In the following final chapter of this thesis, the conclusions of this programme of research are presented with a summary of the results and an explanation of how they have made a novel contribution to the existing body of research in this subject area. Recommendations for how the research results could be used in practice are made, with suggestions for further related areas of research that could be advanced in future.

Chapter Seven: Conclusion

7.1 Introduction

This thesis describes a mixed-methods study that examined the various ways in which oncologists, and other clinical staff in a cancer centre, experience using information systems in their clinical work. It explored these variations in experience from a user-centred perspective in order to advance understanding of how EPR systems are used and perceived in cancer treatment services.

As noted in Chapter One (Section 1.7), the overall aim of this project was to inform future developments in cancer treatment services and health informatics, with a view to improving healthcare services for both clinicians and patients. Specifically, the study objectives of the study were to:

- Establish the most important factors that affect the adoption and use of EPR systems by oncologists working in comprehensive cancer centres.
- Establish the different ways that oncologists think about and experience the use of EPR systems and identify their perceptions of the barriers to successful implementation.
- Develop and refine a model for a customised, integrated, comprehensive electronic record system for oncology (“CICERO”) and to provide associated implementation guidance for use of this system in cancer services.
- Make recommendations for how oncology EPR systems are designed and developed, based on the requirements of oncologists.

This includes consideration of the human and environmental aspects of EPR systems, including their relation to working practices in oncology. This study is important because cancer treatment is a distinctively complex medical field, characterised by a wide range of diseases and specialised treatment options, multidisciplinary clinical work, and a focus on research and development. The effective and safe functioning of a cancer hospital therefore depends on EPR systems that enable clinicians and staff to integrate with one another across a complex range of clinical processes.

The literature review provided in Chapter Two of this thesis established the study’s theoretical underpinnings, describing the socio-technical paradigm in health informatics as well as the shift towards user-centred design of computerised information systems to improve technology acceptance. Chapter Two also presented and summarised empirical research that had implications for the development and implementation of EPR systems and highlighted how technology acceptance could be improved through a more comprehensive understanding of

users' views and experiences.

Since the early work on oncology EPR systems reported by Blum and Lenhard (1979) in the 1970s, numerous other studies have been of oncology workflow have been conducted; the majority of these focused on specific clinical applications, such as radiotherapy information systems (e.g. Brooks et al., 1997; Miller, 2003) or chemotherapy prescribing (e.g. Shulman et al., 2008; Levy et al., 2011). As reported in Chapter Two, the most comprehensive recent studies of EPR systems in oncology include Galligioni's (2009) longitudinal study of the development and daily use of an electronic oncological patient record for the "total management" of cancer patients in Italy and Sicotte et al.'s (2016) pre-post study of users' attitudes towards an electronic medical record that was highly integrated into clinicians' workflow in a Canadian cancer treatment centre.

Since most existing studies of EPR systems in oncology have primarily focused on the clinical aspects of oncology care delivery (e.g. the consequences of implementing CPOE for chemotherapy), this research makes a novel contribution by investigating the interrelatedness of individuals, technology, and tasks in a cancer centre, thereby addressing the gaps identified in the literature in Chapter Two. This thesis used an interpretive approach to research, and it has contributed to a growing body of knowledge in the broad subject area of health informatics by identifying factors that influence clinicians' perspectives and attitudes towards using EPR systems in cancer services (and, potentially, in other similar clinical settings). Specifically, this thesis identified two highly influential factors that had not been identified in previous studies: accessibility and interoperability.

It is essential to understand how the full range of functionality offered by electronic information systems can support patient care and clinical workflow processes in oncology. While a significant volume of research has examined socio-technical systems and technology acceptance in a range of different areas of healthcare, very few studies have applied mixed-methods approaches or used phenomenography to understand users' experiences and perceptions of EPR systems in depth. This thesis is the only study known to have applied this particular blend of methods to the full range of clinical work supported by computerised information systems at a cancer treatment hospital. In this research, both quantitative and qualitative methods were employed, and between-methods triangulation was conducted to augment the confirmation and completeness of the results. The outcomes of the research were also evaluated in relation to the main theoretical model used in the study, FITT (Ammenwerth, 2006), to facilitate comparison to other studies that used this same model in other clinical settings.

Having described the study and discussed the findings in previous chapters, this chapter

summarises the finalised version (v3) of the CICERO reference model as a visual, diagrammatical presentation of the research outcomes and explains how this model might be used in practice and further developed in future research. The purpose of this chapter is to draw conclusions from the research outcomes reported in the previous chapters of the thesis (Chapters Four, Five, and Six). Subsequent to this introduction, Section 7.2 explains the outcomes in relation to the research questions, Section 7.3 summarises the outcome space produced following phenomenographical analyses, and Section 7.4 explains how this outcome space was incorporated into the final version of the CICERO model. Section 7.5 explains how this thesis contributes to existing knowledge in the field of health informatics; Section 7.6 explains the study's implications for health informatics practice and the design, development, and implementation of EPR systems; and Section 7.7 suggests ideas for future research. Finally, Section 7.8 summarises and concludes this chapter and the thesis as a whole.

7.2 Research questions

The overarching research question stated in Chapter One is answered in this section: “What are the factors that influence the adoption and use of EPR systems in cancer services?” As explained in Chapter Four, four sub-questions were also developed during the exploratory phase of research in order to answer this overarching question in a more comprehensive manner. These sub-questions informed decisions about the specific staff groups to focus on for the more in-depth qualitative study:

- What are the key issues relating to oncology workers, EPR systems, and clinical tasks?
- What is the relationship between these issues (or “dimensions”)?
- What is the impact of these issues on users’ attitudes toward clinical information systems?
- What are the most important factors that influence oncology EPR users’ attitudes towards using computerised information systems in cancer services?

After these questions were partially answered following the exploratory research phase, the findings were then used to modify the original question by adding a more specific focus on clinicians’ perspectives, which were subsequently explored using phenomenography. The overarching research question therefore became, “What is the relationship between user characteristics and user perspectives regarding the following three topics: the ease of EPR use, the usefulness of EPR systems, and the impact of moving to fully electronic records?”

This section of the current chapter explains the findings of analysis conducted using the triangulation approach described in Chapter Six. These findings are structured in relation to the IBM user satisfaction survey conducted as part of the exploratory quantitative study and the key themes that emerged from that stage of the research from a multi-professional oncology EPR user perspective (7.2.1). Following that, this chapter presents the findings that emerged from investigating those key themes in detail during the qualitative study, as well as the outcome space that emerged from phenomenographical analyses of the qualitative data, specifically in relation to medical staff (7.2.2).

7.2.1 User satisfaction with EPR systems

The results of the IBM CUSQ analysis conducted as part of the quantitative study (reported in Chapter Four) indicated that, overall, almost two thirds of respondents (65%) were satisfied with the EPR systems in use at the time. A chi-squared test revealed that there was not a statistically significant association between staff groups and overall level of satisfaction with the EPR systems. This suggested that the level of satisfaction with the EPR systems was not directly related to the type of work undertaken by different healthcare occupations. Although analyses of the sub-scales for system usefulness (SYSUSE), information quality (INFQUAL), and interface quality (INTERQUAL) revealed that medical and nursing staff were somewhat less satisfied with the EPR system's usefulness and interface quality than other oncology staff groups, these differences were not statistically significant.

Nine main themes emerged from analyses of the reported positive and negative aspects of the EPR systems: integration; accessibility/availability; usability; patient safety; efficiency; security; reliability; functionality; and training/support. The themes that elicited the most comments overall were availability/accessibility and usability.

Individual Dimension

The individual dimension of an overall socio-technical perspective on EPR systems in oncology was explored in the patient records survey and then investigated further in the qualitative study. One key finding from the interviews was that oncologists have similar reasons for becoming doctors and for working in cancer services, with many reporting a preference for multidisciplinary work and clinical research activities. Information technology literacy was evaluated in the quantitative study, and it was found that this was not a particularly important factor in determining the adoption or use of EPR systems; the vast majority of oncologists felt competent in using computerised information systems and felt that any problems were primarily related to the

disjointed design and implementation of those systems. Furthermore, analyses of demographic features such as age, gender, and time spent in job role did not reveal any major factors that would directly affect adoption and use of EPR systems.

With regard to alignment with technology and task dimensions, the individual dimension had a better fit with both of these than the other dimensions did with each other. In other words, although the oncologists were well-aligned to use technology solutions that support their clinical work, and they were well-trained and competent to use computerised processes, the EPR systems were not well-aligned with the tasks that they were intended to support.

Technology Dimension

Within the technology dimension of FITT, several themes emerged from analysis and triangulation of the survey data and the interview data. The most prominent themes were accessibility and integration/interoperability, which suggests that these areas require careful consideration when designing, developing, and implementing EPR systems. When describing the ideal EPR solution for oncology, the vast majority of clinicians shared a common view that it should be a seamlessly integrated and easy-to-use system that would provide quick and easy access to key information.

As noted in the individual dimension, the alignment between oncologists and the technology solutions they used was generally good, but some problems related to usability, accessibility, and integration were evident.

Clinical Tasks Dimension

As discussed in Chapter Six, the clinical task dimension was found to be the most problematic area for oncologists, in relation to its alignment with the individual (user profiles and their requirements and perceptions) and technology (EPR systems) dimensions. This essentially means that the oncologists were generally aligned to using technology equipment and systems in their clinical work, but they experienced challenges due to the ways in which the technology was configured and implemented for specific tasks.

In summary, the majority of oncologists who participated in the qualitative interviews reported problems with the usability and efficiency of the EPR systems; this finding highlights concerns about how the software had been designed and configured. If EPR systems were designed more effectively, using approaches such as participative design and “Agile” methodologies to increase the involvement of clinical personnel, then this technology could be configured to better support the complex workflow requirements of clinical tasks. The application of more sophisticated

usability testing techniques could also be beneficial during the development of oncology EPR systems. Specific examples from this study are electronic prescribing of chemotherapy (which many oncologists regarded as cumbersome and time-consuming), as well as ordering of laboratory tests and distribution of test results (which participants also saw as a needlessly inefficient process requiring excessive mouse clicks). Because the EPR system software is technically capable of being configured to support clinical workflow processes in a more efficient manner, these problems constitute a misalignment of the clinical tasks domain with both individuals and technology.

7.3 The Oncology EPR outcome space

Chapter Three described the methodology used in this research and stated that phenomenography would be used as the overall approach to the main qualitative study. As explained in Chapter Three, the findings of phenomenographical analysis are presented in an “outcome space” that visually represents the hierarchy of research participants’ perspectives on a given phenomenon. For ease of reference, Figure 7.3.1 below re-presents the outcome space diagram that was previously displayed in Chapter Five as part of the qualitative study.

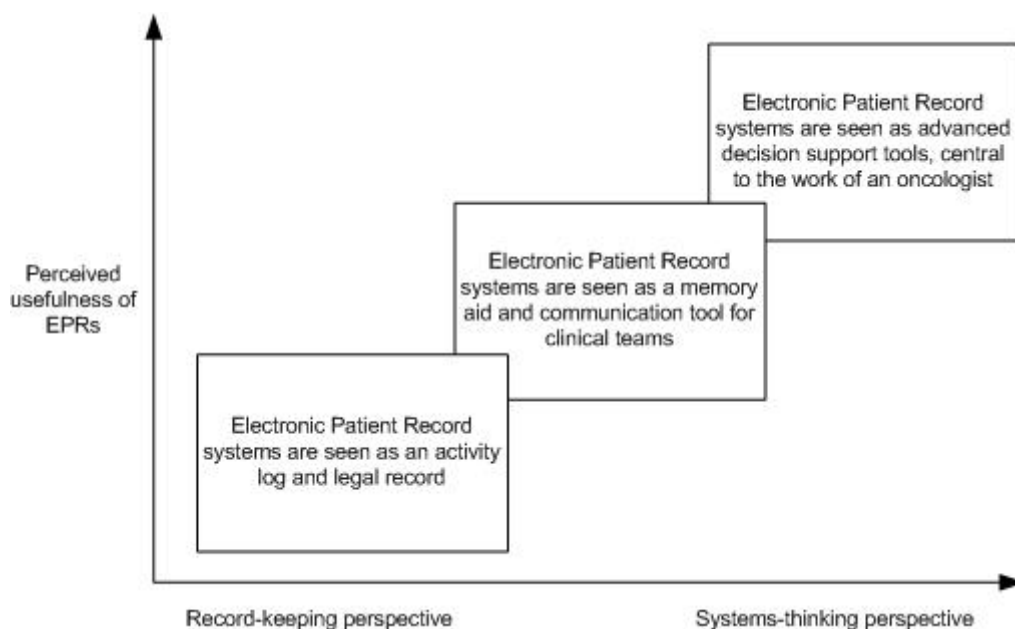


Figure 7.3.1 Oncology EPR outcome space

To summarise this aspect of the research findings, the outcome space includes three different groupings of oncologists’ perspectives on EPR systems. The majority of participants in this study

fell within the middle category on the diagram, with a smaller number in each of the other categories, and some participants corresponding to more than one adjacent category.

The rationale for deriving these categories in accordance with phenomenographical techniques was explained in Chapter Five. To summarise the key findings of the phenomenographical analysis, the outcome space suggests that clinicians hold a wide range of perspectives on EPR systems and that these perspectives are loosely related to the concepts of perceived usefulness and socio-technical systems thinking. In other words, it could be asserted that the more useful an oncologist thinks that EPR systems are, and the more that the oncologist adopts a systems-thinking perspective, the more likely they are to be thinking about EPR systems in the top-right category (where EPRs are regarded as much more than just a medical record). Further research could test this hypothesis in a more quantitative manner, but based upon this study's analyses of qualitative concepts, this conclusion appears to be warranted.

7.4 Final version of the CICERO model

Chapter Six explained how the CICERO model was updated following analyses of the qualitative study, triangulation with the exploratory quantitative study, and application of the FITT model. The final version, again re-presented below for completeness and ease of reference, attempts to integrate the key findings of this research with the features included in the original version produced following the literature review stage, as reported in Chapter Two. To summarise the changes and additions made to the model during the course of the research, the model has been converted from its original 2D block format into a 3D "infographic" version that reflects the multi-dimensional complexities of EPR system design and implementation in cancer services. The main components of the model still include the same range of functional modules or sub-systems, as well as the key design concepts included in the original version (e.g. single sign-on and remote access). However, the range of socio-technical factors for consideration has been extended by adding an additional layer to the model; this third area incorporates the variety of additional factors that were identified as important in this research. In addition, the application of FITT, which was described in the previous chapter, resulted in the creation of a diagram that emphasises the need to focus on achieving improved alignment in two areas: technology and tasks, and individuals and tasks.

While the model (Figure 6.6.3 in the previous chapter) is presented as a comprehensive picture of the key dimensions and factors for consideration when designing and implementing EPR systems in oncology, it is acknowledged that there are limitations to its use in its current form. For this model to become more useful in practice, a set of detailed guidelines could be developed to assist health informatics researchers and practitioners with advice on how and when to refer to the model. In essence, however, this model is presented to encapsulate the various

technology, individual, and task dimensions related to the specific topic of clinical information systems in oncology, with the overall purpose of conveying the scope, complexity, and interdependencies among these dimensions. Practical application of the model would involve EPR designers and implementation planners reviewing each individual component and considering whether any aspects of it are relevant and appropriate for inclusion in any plans for changes or developments. In other words, one potential use of CICERO is to provide a checklist for ensuring that important decisions about EPR systems are being made in the context of the whole socio-technical system, rather than by focusing on only one dimension in isolation from the others. By using this holistic approach, system developers can avoid the unintended consequences of changing components of the model without due consideration of their links to other components.

7.5 Validity and Reliability

This section discusses the validity and reliability of the mixed-methods study based on the principles summarised in Chapter Three (Section 3.11.2).

Internal Validity and Credibility

As explained in Section 3.11, analysing data produced from interviews usually involves interpretation, and the position of the researcher should be recognised within this process (Mason, 2002). The researcher has portrayed the various stages of data analysis and has highlighted the iterative nature of sorting and resorting the data in the study's early stages, before a static set of descriptive categories had been finalised. These categories were ultimately established through discussions with the researcher's doctoral supervisor, fellow PhD researchers, and work colleagues at CCC. It has also been illustrated (via the use of the oncologists' quotations throughout the reporting of the research results) that these categories of description originated from the data, as opposed to being determined by a pre-defined coding structure. Additionally, the trustworthiness of the results was strengthened by connecting the outcomes of the phenomenographical analyses to the theoretical and empirical research papers reviewed in Chapter Two. Nevertheless, it is acknowledged that a different researcher (or team of researchers), having gathered the same data, would be unlikely to generate identical analyses or categories of description.

External Validity and Transferability

This study did not intend to be representative of all oncologists' views or experiences of using EPR systems. Nonetheless, the rationale for why it was not representative (and therefore has

limited external validity) should be explained. One significant factor was that all participating oncologists were recruited from the same hospital, which specialises in cancer treatment services.

In accordance with the prescribed methods of phenomenographic research (Marton, 1988), the study site has been clearly described in Chapter One (Section 1.4). This study's focus on a single site ensured that experiential differences resulted from variation between and within participants, not from external factors related to the clinical settings where participants worked. Further research is therefore required to establish whether the findings are transferable to other cancer centres and could equally be important for other clinical workers in different oncology service areas. In addition to this, whilst similar studies have been conducted in Italy (Galligioni et al., 2009) and in Canada (Sicotte et al., 2016), further research could be undertaken in other countries to establish whether similar results would be found in an international context.

Furthermore, there was a possible response bias as the interviewees were self-selecting. There may be distinctive and significant differences between the views and experiences of oncologists who participated and those who did not. In phenomenography, therefore, as with other approaches to qualitative research, it is necessary to acknowledge that the data analyses and emerging conceptual findings can only accurately reflect the participants of the study, but that with caution, the findings may be more broadly applicable.

A further issue, as Berg (2009) proposed, is the pervasive difficulty with studies involving humans as research participants: some people simply choose not to participate (i.e., non-response bias). In the case of this study, these may include oncologists who were either uninterested in research that is not deemed to be clinical in its focus or who were just too busy to participate due to numerous competing demands on their time. The views of these individuals were thus excluded from the study. This may have limited the range of categories identified in the outcome space and the sociotechnical factors identified; specifically, the problem of being too busy may itself have implications for the acceptance, use, design, and/or implementation of EPR systems. If it had been possible to include these individuals' views, the study may have identified additional experiences that should be considered when trying to improve EPR systems for oncologists.

Pragmatic validity

The findings of the survey questionnaire study and subsequent phenomenographic analyses of interview transcripts have been transformed into recommendations for improving the design and implementation of EPRs via the CICERO model described in Chapters Two, Five and Six, thereby demonstrating this study's pragmatic validity (Akerlind, 2005).

Reliability

The categories of description were developed from the phenomenographical analysis, using verbatim quotes from oncologists. The process of developing these categories was explained in order to illustrate how the analyses developed from interviewees' own statements, thereby allowing the reader to assess the extent to which the results are reliable. As this research was completed for a PhD, a sole researcher undertook the data analyses. However, the researcher's supervisor provided feedback on several draft versions of each chapter, made recommendations, and raised questions that the researcher sought to address in subsequent drafts. Data analyses and the emergent findings were also discussed with the research supervisor; the analyses were completed through a series of iterations over a lengthy timescale and were only finalised during the production of the written thesis. In addition, the researcher discussed analyses and draft research chapters with colleagues at conferences and in research seminars. These exchanges also informed the emerging analyses, stimulating the researcher's thinking and assumptions, permitting queries to be raised about interpretation, and prompting further reflection and evaluation.

7.6 Strengths and limitations of the research

The limitations, strengths, and weaknesses of the two studies included in this research were discussed in Chapters Four, Five and Six. This section therefore outlines the limitations of the overall research undertaken for this thesis.

A socio-technical perspective provided a framework for investigating the multifaceted issues related to EPR implementation and use. The research utilised a novel method of applying a socio-technical approach, as the analyses of the individual, technology and tasks was conducted in two ways. Firstly, the two empirical chapters (Chapters Four and Five) both focused on a particular aspect of EPR systems usage and end user views and experiences. Secondly, phenomenography was used as a framework for interpreting the experiential aspects of oncologists' use of EPR systems.

In addition to exploring EPR systems from the individual, technology and task perspectives, Greenhalgh et al. (2010) argued that information systems should also be evaluated using both qualitative and quantitative methods. The combination of different methods utilized in this research is considered an additional strength, since it affords a more comprehensive view of EPR implementation into cancer treatment centres (Green & Thorogood, 2005). As explained in Chapter Six, triangulation is generally described as the "combination of methodologies in the study of the same phenomenon" (Denzin, 1970). Scholars encourage the use of triangulation for confirmation and completeness, especially when exploring multifarious phenomena with limited previous research (e.g. oncology EPR adoption) (Shih, 1998). The benefit of triangulating findings was illustrated in Chapter Five, where some contradictory answers to the survey questions (Chapter Four) were clarified by the qualitative data (generated and analysed in Chapter Five). For example, the survey questionnaire found some inconsistencies in the most

positive and negative aspects of EPR systems, and the qualitative data distinguished between users' different understandings and interpretations of the term "EPR." It was thought, therefore, that the triangulation of results within this research confirmed an accurate reflection of the complex phenomena of oncology EPR systems, with a particular focus on factors affecting their adoption and use.

The literature review undertaken in Chapter Two of this thesis led to the belief that this would be the first comprehensive study to investigate the history and previous research relating to implementation of oncology EPR systems in the context of NHS cancer treatment centres. In response to the literature search, which revealed that little research had examined the factors that influence adoption and use of EPR systems in this particular clinical setting, the study asked questions that exceeded the scope and depth of those raised in previous evaluations. Due to the limited guidance available, Chapter Two may be helpful for future research in this area; this chapter provides a description of how relevant literature was identified, selected, and critically analysed. Chapters Four and Five describe the first empirical studies of comprehensive EPR adoption and use in a regional NHS cancer treatment centre.

Furthermore, despite contemporary NHS policy directives that expect hospitals to become paper-free by 2020, this is one of a very limited number of studies to explore the factors that will affect the achievement of this target and to provide guidance for cancer treatment centres. Using the CICERO model to summarise and present the key findings, the study also generated a number of themes related to EPR functionality and deployment considerations, as well as categories of description relating to oncologists' views and experiences working with the systems. These themes and categories were included as an important way to disseminate the research outcomes and lessons learned for healthcare organisations, industry, and academia. Future studies could use, or adapt, the themes and categories developed from this study. A researcher seeking to conduct a similar study would not have to "start from scratch," so to speak, since this research has already created categories indicating what future researchers should look for, at least in the initial stages, based on the statements of oncologists who participated in this study. The CICERO model is an additional strength of the study, providing a valuable tool for future research.

The interviews with NHS oncologists reported in Chapter Five represent the first known study in England to investigate clinical end users' perspectives and experiences of the benefits, problems, and challenges involved in using EPR systems in cancer services. Due to the limited amount of UK evidence in this domain (as evidenced in Chapter Two), the chapter addresses substantial gaps in the literature and could thus be helpful for healthcare organisations as they produce business cases, implementation strategies, and benefits management plans relating to EPR systems.

Finally, the use of phenomenography as the approach to analysis and interpretation of the study's findings within Chapter Five provided an improved understanding of the data that went further than just a descriptive list of themes; this level of understanding could not have been

achieved through thematic analysis alone. The categories of description that emerged from the seven-stage phenomenographical analyses informed the application of the FITT model and also the development of CICERO, which may potentially assist others wishing to use this method.

Supplementary data collection methods (for example, focus groups or direct observation of participants using EPRs) might have strengthened the validity of the results by capturing the experiences of oncologists as they worked in real-time with the EPR systems. However, the process of securing permission to observe participants in their clinical work with patients would likely have raised more complex ethical issues. In addition, it would have been difficult to convene multiple oncologists with busy work schedules for focus groups.

7.7 Contribution to new knowledge

This contribution of this research to existing knowledge can be summarised in three significant ways. Firstly, while oncology information systems have been studied in prior research, as reported in Chapter Two, research to date has yielded limited understanding of the range of interrelated factors that influence the overall adoption and use of electronic patient records by practising oncologists. Several studies have applied technology acceptance models to study EPR use in oncology, but these studies were limited: most focused on only one area of clinical services (such as radiation oncology or SACT) or on only one dimension of technology acceptance (such as perceived usefulness or ease of use). In this research, a wider range of factors were identified, and the interrelations between these factors were explored in detail in the context of the full range of work undertaken by oncologists in a comprehensive cancer centre. One example of the factors identified that form a novel contribution to understanding is that usability, integration, and availability of systems may be thought about differently by different groups of oncologists; as such, there is a requirement to assess these areas with a broader representation of clinical end users, in the context of complex socio-technical system. The results of the analyses were incorporated into a unique and original conceptual reference model, CICERO, which provides an informative, visual representation of both the dimensions of the information systems in scope and the key factors that might impact the successful design, development, and deployment of EPR systems in oncology. Importantly, this model could also be considered for use in future evaluation and post-implementation review of EPR systems. The novel contribution to new knowledge provided by CICERO is a holistic, socio-technical systems scope of oncology information systems using phenomenographical analyses to establish the views and experiences of practising oncologists. Whilst similar studies have been conducted in Canada (Sicotte et al., 2016) and in Italy (Galligioni et al., 2009), neither of these studies used an in-depth qualitative approach such as phenomenography, and a study of this type has not previously been performed in a UK context.

Secondly, the application of between-methods triangulation facilitated an improved understanding of the factors that could affect oncologists' perspectives on using EPR systems. Previous research in this field has often been conducted via case studies, with minimal effort to incorporate theoretical frameworks. In contrast, this study applied theory triangulation to compare the results with relevant theories and socio-technical system frameworks such as FITT, and it also compared the findings with other similar studies using the same theoretical framework. The application of these theories enabled an improved understanding of the context in which EPR systems are used as part of a complex socio-technical environment.

Thirdly, the use of phenomenography in the qualitative study provided a unique insight from an oncologist's perspective, highlighting the key factors affecting oncologists' use of EPRs and the different ways they viewed and experienced them. This particular approach has not been reported as having been used before, specifically in this area of clinical service and in conjunction with the quantitative survey as part of a mixed-methods study. The outcome space produced in the qualitative study provides an original perspective on how oncologists think about issues related to the adoption and use of EPR systems. For example, the oncologists' views on the importance of the need for improved system integration and usability have not been highlighted to such a significant extent in any previous research studies. This is likely due to a combination of the fact that, firstly, a holistic perspective has not previously been applied with regards to the full range of system requirements in a large cancer treatment centre and, secondly, the fact that an approach like phenomenography has not been applied to this scope of staff group before either. No previous studies have identified, for example, the extent to which oncologists are frustrated by the lack of system integration and would benefit from regional-level integration of laboratory results reporting systems, similar to those that have developed in recent years for diagnostic imaging.

This study, therefore, not only contributes to the body of literature on EPR systems and technology acceptance domains; it also adds to the current literature and understanding by identifying and describing the complex interdependencies between clinicians, technology, and tasks. Examples of this from the research findings are electronic prescribing of chemotherapy treatments and ordering pathology laboratory (blood) tests. In order for medical oncologists to undertake their clinical work efficiently and effectively, they require the combination of process design, hardware, and software to be optimally designed and configured; at this study site, even with design teams with advanced knowledge and skills and technological capability, the IT solutions were still not optimal due to an overall lack of alignment. Participants reported their views and experiences of using EPR systems across a broad spectrum of awareness and appreciation of how these systems affect their clinical work as oncologists.

7.8 Implications for policy and practice

This research has highlighted a number of key themes and important areas for consideration by, for example, healthcare executives and informatics practitioners, when planning the future design, development, implementation, and support of clinical information systems in a hospital environment. The themes that emerged from the study were used to inform the CICERO model in an attempt to provide practical guidance for executives and practitioners in healthcare. The researcher's own experience in working with health informatics practitioners is that there is often a disconnect between the approaches recommended by academic researchers and the approach taken in practice in healthcare organisations.

The findings in the study were used to develop the CICERO model, and it is recommended that IT Directors (and other key practitioners involved in planning and implementing EPR systems) should refer to this model for guidance when developing business cases, programme plans, and system design documentation. While the model gives a high-level overview in its presentation as a rich picture diagram, its purpose is to visually represent the importance of a cohesive whole system approach. This thinking was validated by the oncologists interviewed in the main qualitative study, many of whom highlight the disjointed nature of existing systems and the difficulty of managing passwords for access to multiple systems used to support different clinical tasks.

Key questions that oncology EPR implementation teams should ask when reviewing the CICERO model include:

- If a cancer centre is following a “best of breed” strategy, where multiple specialist systems are used for different aspects of clinical work, can the systems be integrated at the user interface level to improve accessibility, efficiency, and experience?
- How well are the different components of the overall model integrated in our cancer centre?
- How could interoperability be improved to provide improved workflow efficiency?
- Has the requirement for remote access been fully considered with the latest technological solutions allowing secure access from any location?
- Does the overall EPR system architecture cater for both medical and clinical oncology with efficient data collection that will maximise opportunities for predictive analytics?
- In addition to technical solution design, have all of the relevant socio-technical aspects been fully considered for their importance and implications?

Whilst this is not intended as an exhaustive list, it provides examples of how the various CICERO components should be used to prompt a series of exploratory questions for investigation.

7.9 Implications for future research

The factors identified in this research offer a focal point for future studies in the field of health informatics. The research outcomes and CICERO model may be regarded as preliminary findings. Future research could further develop, validate, and modify these outcomes and the CICERO model by applying them to case studies in other cancer centres, locations, and clinical specialties outside of oncology. Additionally, researchers could adapt CICERO and examine/validate the findings within studies of healthcare systems outside of the UK, where EPR applications for clinical and management tasks might look very different, given differences in the funding and administration of medical systems.

While the EPR systems used by participating oncologists were representative of those used in other UK cancer centres, additional research is required to replicate this approach in other oncology settings, both in the UK and in other countries, in order to ascertain the external validity of CICERO and the oncology EPR outcome space. It is acknowledged that while the setting for this study was a large regional cancer centre, this setting differs from other comprehensive cancer centres in the UK, and possibly beyond, in that its services do not include operating theatres for surgery. As a non-solid tumour treatment centre, CCC may therefore be considered a tertiary centre, in contrast to specialist oncology hospitals, which include operating theatres for surgical removal of malignant tumours. Oncology surgeons, whose perspectives may differ from those of clinical and medical oncologists, could be included in future research studies. This could provide an even more comprehensive view of the socio-technical information system requirements and the factors affecting adoption and use of EPR systems in cancer services. Other healthcare workers, including General Practitioners in primary care and rehabilitation clinicians in tertiary care, could also potentially be included to develop an “end-to-end” view of the cancer pathway.

As the EPR systems at the case study site have been replaced and enhanced since the data collection stages of this research, a longitudinal study would provide very interesting information to determine the extent to which oncologists' views of EPR systems have changed over time. However, as the survey questionnaire was anonymised, only a cross-sectional pre-post study would be possible; there could also be ethical and logistical challenges associated with identifying and securing the same participants for follow-up interviews. This is not seen as a weakness in the design for this study, but rather as an issue for consideration in future research.

7.10 Conclusion

This chapter completes this thesis by summarising the key points of the study and confirming the answers to the research questions posed in Chapter One. Based on the outcomes of this study, the researcher recommends that several key factors should be considered in order to improve EPR systems in cancer treatment services, emphasising that clinicians' varying views and perspectives on these systems must be considered in order to improve clinical workflow and user experience. From an oncologist's perspective, the most important factors affecting EPR adoption and use are integration, accessibility/availability, and usability; consequently, these factors are highlighted in the CICERO model. With reference to the theoretical models applied in the study, the importance of improved alignment between technology and tasks was highlighted as a key finding, indicating that clinicians' intended and actual use of EPR systems is less of an issue than the requirement to improve the design, integration, and usability aspects of EPRs. Several implications for practice (7.6) and for future research (7.7) were presented in this final chapter. These included, for example, the use of CICERO as a reference guide for future EPR implementation projects and the further investigation of aspects of the model in other oncology user groups (e.g. surgeons) and in other cancer treatment centres.

Bibliography

- Abernethy, A. P., Etheredge, L. M., Ganz, P. A., Wallace, P., German, R. R., Neti, C., & Murphy, S. B. (2010). Rapid-learning system for cancer care. *Journal of Clinical Oncology*, *28*(27), 4268-4274. doi:10.1200/jco.2010.28.5478
- Adami, M. F., & Kiger, A. (2005). The use of triangulation for completeness purposes. *Nurse Researcher*, *12*(4), 19-29.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211. doi:10.1016/0749-5978(91)90020-T
- Akerlind, G. S. (2012). Variation and commonality in phenomenographic research methods. *Higher Education*, *31*(1), 115-127. doi:10.1080/07294360.2011.642845
- Åkerlind, G.S. (2005), "Phenomenographic methods: a case illustration", in Bowden, J. and Green, P. (Eds), *Doing Developmental Phenomenography*, RMIT University Press, Melbourne, pp. 103-127
- Albuam, G. (1993). Review of the book *Questionnaire design, interviewing and attitude measurement*, by A. N. Oppenheim. *Journal of Marketing Research*, *30*(3), 393-395. doi:10.2307/3172892
- Allam, O., Gray, A., McIntosh, S., & Morrey, D. (2004). A systems approach to a deeper understanding of a cancer care domain. *Health Informatics Journal*, *10*(3), 205-220. doi:10.1177/1460458204042234
- Allen, A., Hayes, J., Sadasivan, R., Williamson, S. K., & Wittman, C. (1995). A pilot study of the physician acceptance of tele-Oncology. *Journal of Telemedicine and Telecare*, *1*(1), 34-37. doi:10.1177/1357633X9500100107
- Alsop, G., & Tompsett, C. (2006). Making sense of 'pure' phenomenography in information and communication technology in education. *Research in Learning Technology*, *14*(3), 241-259. doi:10.1080/09687760600837058
- Alty, J. L. (1992). Can we measure usability? *Proceedings of the Advanced Information Systems 1992 Conference*.
- Ammenwerth, E., Gräber, S., Herrmann, G., Bürkle, T., & König, J. (2003). Evaluation of health information systems—problems and challenges. *International Journal of Medical Informatics*, *71*(2-3), 125-135.
- Ammenwerth, E., Iller, C., & Mahler, C. (2006). IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study. *BMC Medical Informatics and Decision Making*, *6*, 3-3. doi:10.1186/1472-6947-6-3
- Anol, B., & Naset, H. (2007). Physicians' resistance toward healthcare information technology: A theoretical model and empirical test. *European Journal of Information Systems*, *16*(6), 725. doi:10.1057/palgrave.ejis.3000717

- Araujo, M. T., Paiva, T., Jesuino, J. C., & Magalhaes, M. (2000). General practitioners and neurotelemedicine. *Studies in Health Technology and Informatics*, 78, 45-67.
- ASCO. (2009). Clinical Oncology Requirements for Electronic Health Records: CORE Project. Retrieved from [http://www.asco.org/ASCOv2/Practice+&+Guidelines/Practice+Management+&+Reimbursement/Electronic+Health+Records/Clinical+Oncology+Requirements+for+the+EHR+\(CORE\)](http://www.asco.org/ASCOv2/Practice+&+Guidelines/Practice+Management+&+Reimbursement/Electronic+Health+Records/Clinical+Oncology+Requirements+for+the+EHR+(CORE))
- Association of the British Pharmaceutical Industry. (2017). Survival. Retrieved from <http://cancercomparator.abpi.org.uk/survival.shtml>
- Audit Commission (2001). A Spoonful of Sugar: Medicines Management in NHS Hospitals.
- Baker, M. (2002). *The Organisation of Cancer Services*.
- Ballantyne, R., & Bruce, C. (Eds.) (1994). *Proceedings of phenomenography: philosophy and practice 7-9 November 1994*. Kelvin Grove, Australia: Centre for Applied Environmental and Social Education Research, Faculty of Education, Queensland University of Technology. Retrieved from <https://eprints.qut.edu.au/53908/>
- Balogh, E. P., Ganz, P. A., Murphy, S. B., Nass, S. J., Ferrell, B. R., & Stovall, E. (2011). Patient-Centered Cancer Treatment Planning: Improving the Quality of Oncology Care. Summary of an Institute of Medicine Workshop. *Oncologist*, 16(12), 1800-1805. doi:10.1634/theoncologist.2011-0252
- Barber, N., Franklin, B.D., Cornford, T., Klecun, E., & Savage, I. (2006). *Safer, faster, better? Evaluating electronic prescribing*. London, England: Policy Research Programme of the Department of Health. Retrieved from http://www.who.int/patientsafety/information_centre/reports/PS019_Barber_Final_report.pdf
- Barki, H., Titah, R., & Boffo, C. (2007). Information system use-related activity: An expanded behavioral conceptualization of individual-level information system use. *Information Systems Research*, 18(2), 173-192. doi:10.1287/isre.1070.0122
- Barnard, A., McCosker, H., & Gerber, R. (1999). Phenomenography: A qualitative research approach for exploring understanding in health care. *Qualitative Health Research*, 9(2), 212-226. doi:10.1177/104973299129121794
- Barnes, L. L., Khojasteh, J. J., & Wheeler, D. (2017). Cancer information seeking and scanning: Sources and patterns. *Health Education Journal*, 76(7), 853-868. doi:10.1177/0017896917717542
- Bate, S. P., & Robert, G. (2002). Knowledge management and communities of practice in the private sector: lessons for modernizing the National Health Service in England and Wales. *Public Administration*, 80(4), 643-663. doi:10.1111/1467-9299.00322
- Bath, P. A., Sen, B. A., Raptis, D. A., & Mettler, T. (2012). International perspectives on how information and ICT can support healthcare. *Health Informatics Journal*, 18(2), 79-82. doi:10.1177/1460458212442935
- Becker, S., & Bryman, A. (2004). *Understanding research for social policy and practice: Themes*,

- methods and approaches*. Bristol, England: Policy Press.
- Bell, D. (2004). UML Basics: The Component Diagram. Retrieved from <https://www.ibm.com/developerworks/rational/library/dec04/bell/index.html>
- Bell, J., Reed, S. C., Kim, K., Ngo, V., Wait, W., & Apesoa-Varano, E. (2016). Usability and acceptance of novel personal health technology to support early palliative care for patients with cancer and caregivers. *Journal of Clinical Oncology*, 34(26). doi:10.1200/jco.2016.34.26_suppl.73
- Benbasat, I., & Barki, H. (2007). Quo vadis, TAM? *Journal of the Association for Information Systems*, 8(4), 211-218. doi:10.17705/1jais.00126
- Bennett, J. L. (1984). *Visual display terminals: Usability issues and health concerns*. Upper Saddle River, NJ: Prentice-Hall.
- Bentzen, S. M., Heeren, G., Cottier, B., Slotman, B., Glimelius, B., Lievens, Y., & van den Bogaert, W. (2005). Towards evidence-based guidelines for radiotherapy infrastructure and staffing needs in Europe: the ESTRO QUARTS project. *Radiotherapy and Oncology*, 75(3), 355-365. doi:10.1016/j.radonc.2004.12.007
- Berg, B. L. (2007). *Qualitative research methods for the social sciences* (6th ed.). Boston, MA: Allyn & Bacon.
- Berg, M. (1999). Accumulating and coordinating: Occasions for information technologies in medical work. *Computer Supported Cooperative Work (CSCW)*, 8(4), 373-401. doi:10.1023/A:1008757115404
- Berg, M. (1996). *The multiple bodies of the medical record: Towards a sociology of an artifact*. Maastricht, the Netherlands: University of Maastricht.
- Berg, M. (2001). Implementing information systems in health care organizations: Myths and challenges. *International Journal of Medical Informatics*, 64(2-3), 143-156. doi:10.1016/S1386-5056(01)00200-3
- Bhattacharjee, A., & Hikmet, N. (2007). Physicians' resistance toward healthcare information technology: A theoretical model and empirical test. *European Journal of Information Systems*, 16(6), 725-737. doi:10.1057/palgrave.ejis.3000717
- Bjørnstad, C., & Ellingsen, G. (2019). Data work: A condition for integrations in health care. *Health Informatics Journal*. doi:10.1177/1460458219833114
- Black, T. R. (1999). *Doing quantitative research in the social sciences: An integrated approach to research design, measurement and statistics*. London, England: Sage.
- Black, A., Car, J., Pagliari, C., Anandan, C., Cresswell, C., Bokin, T., . . . Sheikh, A. (2011). The impact of eHealth on the quality and safety of healthcare: A systematic review. *PLoS Medicine*, 8(1), e1000387. doi:10.1371/journal.pmed.1000387
- Blaikie, N. W. H. (1993). *Approaches to social enquiry*. Cambridge, England: Polity Press.
- Blaxter, L. (2010). *How to research* (4th ed.). Maidenhead, England: McGraw-Hill/Open University Press.

- Blum, B. I., & Lenhard, R. E. (1979). An oncology clinical information system. *Computer*, 12(11), 42-50.
Retrieved from <https://www.computer.org/csdl/mags/co/1979/11/01658535.pdf>
- Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *International Journal of Methodology*, 36(4), 391-409.
doi:10.1023/A:1020909529486
- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. doi:10.1191/1478088706qp063oa
- Brewster, L., & Sen, B. (2011). 'Quality signposting': the role of online information prescription in providing patient information. *Health Information and Libraries Journal*, 28(1), 59-67. doi:10.1111/j.1471-1842.2010.00912.x
- Brooks, K. W., Fox, T. H., & Davis, L. W. (1997a). A critical look at currently available radiation oncology information management systems. *Seminars in Radiation Oncology*, 7(1), 49-57.
doi:10.1016/s1053-4296(97)80017-3
- Bruce, C. (1997). *The seven faces of information literacy*. Adelaide, Australia: Auslib Press.
- Bruce, C., Pham, B., & Stoodley, I. (2002). *The collective consciousness of information technology research. The significance and value of research projects. A. The views of IT researchers*. FIT Technical Reports. QUT.
- Brunjes, S. (1971). An anamnestic matrix toward a medical language. *Computers and Biomedical Research*, 4(6), 571-584. doi:10.1016/0010-4809(71)90035-8
- Bryman, A. (2006). *Mixed methods* (Vol. 1). London, England: Sage.
- Bryman, A. (2007). *Qualitative research 2. Vol. 4, Qualitative data analysis*. Los Angeles, CA: Sage.
- Bryman, A. (2008). *Social research methods* (3rd ed.). Oxford, England: Oxford University Press.
- Bryman, A. (2011). *Quantitative data analysis with IBM SPSS 17, 18 & 19: A guide for social scientists*. New York, NY: Routledge.
- Bürkle, T., Ammenwerth, E., Prokosch, H. U., & Dudeck, J. (2001). Evaluation of clinical information systems. What can be evaluated and what cannot? *Journal of Evaluation in Clinical Practice*, 7(4), 373-385. doi:10.1046/j.1365-2753.2001.00291.x
- Burns, N. (2005). *The practice of nursing research: Conduct, critique, and utilization* (5th ed.). St. Louis, MO: Elsevier/Saunders.
- Burns, F. (1998) *Information for health: An information strategy for the modern NHS*. London, England: NHS Executive.
- Burton, J., & Howse, J. (2017). The Semiotics of Spider Diagrams. *Logica Universalis*, 11(2), 177-204.
doi:10.1007/s11787-017-0167-2

- Calman, K., & Hine, D. (1995). *A policy framework for commissioning cancer services*. Retrieved from https://webarchive.nationalarchives.gov.uk/20080817211349/http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4071083
- Cancer Research UK. (2017). Types of cancer. Retrieved from <https://www.cancerresearchuk.org/what-is-cancer/how-cancer-starts/types-of-cancer>
- Carlsson, E., Carlsson, A. A., Prenkert, M., & Svantesson, M. (2016). Ways of understanding being a healthcare professional in the role of family member of a patient admitted to hospital. A phenomenographic study. *International Journal of Nursing Studies*, 53, 50-60. doi:10.1016/j.ijnurstu.2015.10.004
- Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, 41(5), 545-547. doi:10.1188/14.onf.545-547
- Castle, N. G., Brown, J., Hepner, K. A., & Hays, R. D. (2005). Review of the literature on survey instruments used to collect data on hospital patients' perceptions of care. *Health Services Research*, 40(6), 1996-2017. doi:10.1111/j.1475-6773.2005.00475.x
- Chamorro, T. (2001). Computer-based patient record systems. *Seminars in Oncology Nursing*, 17(1), 24-33. doi:10.1053/sonu.2001.20416
- Checkland, P. (2000). Soft systems methodology: A thirty-year retrospective. *Systems Research and Behavioral Science*, 17, S11-S58.
- Cherns, A. (1987). Principles of sociotechnical design revisited. *Human Relations*, 40(3), 153-161. doi:10.1177/001872678704000303
- Cibangu, S. K., & Hepworth, M. (2016). The uses of phenomenology and phenomenography: A critical review. *Library and Information Science Research*, 38(2). doi:10.1016/j.lisr.2016.05.001
- Clauser, S. B., Wagner, E. H., Bowles, E. J. A., Tuzzio, L., & Greene, S. M. (2011). Improving modern cancer care through information technology. *American Journal of Preventive Medicine*, 40(5), S198-S207. doi:10.1016/j.amepre.2011.01.014
- Cohen, M. R., Anderson, R. W., Attilio, R. M., Green, L., Muller, R. J., & Pruemmer, J. M. (1996). Preventing medication errors in cancer chemotherapy. *American Journal of Health-System Pharmacy*, 53(7), 737-746. doi:10.1093/ajhp/53.7.737
- Coiera, E. (2003). *Guide to health informatics*. London, England: Oxford University Press.
- Coleman, R. L., & Matulonis, U. A. (2016). Precision medicine. *Gynaecological Oncology & Reproductive Medicine*, 141(1). doi:10.1016/j.ygyno.2016.03.017
- Corbin, J. M. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Thousand Oaks, CA: Sage.
- Cornford, T., Dean, B., Savage, I., Barber, N., & Jani, Y.H. (2009). *Electronic Prescribing in Hospitals: challenges and lessons learned*. Leeds, England: NHS Connecting for Health. Retrieved from <http://discovery.ucl.ac.uk/1350233/>
- Cornford, T., Doukidis, G., & Forster, D. (1994). Experience with a structure, process and outcome

- framework for evaluating an information system. *Omega*, 22(5), 491-504. doi:10.1016/0305-0483(94)90030-2
- Corrao, N. J., Robinson, A. G., Swiernik, M. A., & Naeim, A. (2010). Importance of testing for usability when selecting and implementing an electronic health or medical record system. *Journal of Oncology Practice*, 6(3), 120-124. doi:10.1200/JOP.200017
- Creswell, J. (2010). Mapping the developing landscape of mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Sage Handbook of Mixed Methods in Social & Behavioral Research* (pp. 45-68). Thousand Oaks, CA: Sage.
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Los Angeles, CA: Sage.
- Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice*, 39(3), 124-130. doi:10.1207/s15430421tip3903_2
- Creswell, K., Slee, A., Sheikh, A. (2017). A survey exploring National Health Service ePrescribing Toolkit use and perceived usefulness amongst English hospitals. *Journal of Innovation in Health Informatics*, 24(2), 247-251.
- Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London, England: Sage.
- Dahlberg, K. (2006). The essence of essences: The search for meaning structures in phenomenological analysis of lifeworld phenomena. *International Journal of Qualitative Studies on Health and Well-being*, 1(1), 11-19. doi:10.1080/17482620500478405
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340. doi:10.2307/249008
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35(8). doi:10.1287/mnsc.35.8.982
- Dean, B. B., Lam, J., Natoli, J. L., Butler, Q., Aguilar, D., & Nordyke, R. J. (2009a). Use of electronic medical records for health outcomes research: A literature review. *Medical Care Research and Review*, 66(6). doi:10.1177/1077558709332440
- Debono, D. S., Greenfield, D., Travaglia, J. F., Long, J. C., Black, D., Johnson, J., & Braithwaite, J. (2013). Nurses' workarounds in acute healthcare settings: a scoping review. *BMC health services research*, 13, 175. doi:10.1186/1472-6963-13-175
- Delaney, G., Jacob, S., Featherstone, C., & Barton, N. (2003). *Radiotherapy in cancer care: Estimating optimal utilisation from a review of evidence-based clinical guidelines*. Collaboration for Cancer Outcomes Research and Evaluation (CCORE). Sydney, Australia: Liverpool Hospital. Retrieved from https://canceraustralia.gov.au/sites/default/files/publications/radiotherapyreport1_504af01e8daf0.pdf
- DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, 3(1), 60-95. doi:10.1287/isre.3.1.60

- DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, 19(4), 9-30. doi:10.1080/07421222.2003.11045748
- Denscombe, M. (2014). *The good research guide: For small-scale social research projects* (5th ed.). Maidenhead, England: Open University Press.
- Denzin, N. K. (1970). *The research act: A theoretical introduction to sociological methods*. Chicago, IL: Aldine Publishing.
- Department of Health and Social Care. (2018, October 17). *The future of healthcare: Our vision for digital, data and technology in health and care*. Retrieved from <https://www.gov.uk/government/publications/the-future-of-healthcare-our-vision-for-digital-data-and-technology-in-health-and-care>
- DesRoches, C. M., Agarwal, R., Angst, C. M., & Fischer, M. A. (2010). Differences between integrated and stand-alone e-prescribing systems have implications for future use. *Health Affairs*, 29(12), 2268–2277. doi:10.1377/hlthaff.2010.0557
- DeVellis, R. F. (1991). *Scale development: Theory and applications*. London, England: Sage.
- DeVita, V. J., Lawrence, T., & Rosenberg, S. (2008). *Cancer: Principles and practice of oncology* (8th ed.). Philadelphia, PA: Lippincott Williams and Wilkins.
- Dheensa, S., Lucassen, A., & Fenwick, A. (2018). Fostering trust in healthcare: Participants' experiences, views, and concerns about the 100,000 genomes project. *European Journal of Medical Genetics*. doi:10.1016/j.ejmg.2018.11.024
- Dick, R., & Steen, E. (1991). *The computer-based patient record*. Washington, DC: National Academy Press.
- Dimitrovski, T., Ketikidis, P., Lazuras, L., & Bath, P. A. (2013). Adoption of electronic health records (EHRs): A review of technology acceptance studies. In S. S. R. Abidi & P. A. Bath (eds.), *Proceedings of 16th International Symposium for Health Information Management Research (ISHIMR 2013)* Halifax, Canada: Dalhousie University.
- Dixon, D. R. (2000). The behavioural side of information technology. *Journal of Medical Informatics*, 56(1-3), 117-23. doi:10.1016/S1386-5056(99)00037-4
- Doll, W. J., & Torkzadeh, G. (1998). Developing a multidimensional measure of system-use in an organizational context. *Information & Management*, 33(4), 171-185. doi:10.1016/s0378-7206(98)00028-7
- Donaldson, M. S. (2005). Engineering tools and methods in the delivery of cancer care services. In P. Reid, W. D. Compton, J. H. Grossman, & G. Fanjiang (Eds.), *Building a better delivery system: A new engineering/health care partnership* (pp. 177-182). Washington, DC: National Academies Press.
- Dumasia, L., Harris, E., & Drelichman, A. (2006). Quality performance improvement with the implementation of standard chemotherapy order forms. *Journal of Oncology Practice*, 2(3), 104-107. doi:10.1200/jop.2006.2.3.104

- Easterby-Smith, M. (2002). *Management research* (2nd ed.). London, England: Sage.
- Edwards, P. J., Moloney, K. P., Jacko, J. A., & Sainfort, F. (2008). Evaluating usability of a commercial electronic health record: a case study. *International Journal of Human-Computer Studies*, 66(10), 718–728. doi:10.1016/j.ijhcs.2008.06.002
- Edwards, S. (2006). *Panning for gold: Information literacy and the net lenses model*. Adelaide: Auslib Press, 2006.
- Evans, M. D. C. (2005). *Radiation oncology physics: A handbook for teachers and students*: IAEA
- Fetterman, D. M. (1988). Qualitative approaches to evaluating education. *Educational Researcher*, 17(8), 17-23. doi:10.3102/0013189X017008017
- Fielding, N., & Schreier, M. (2001). Qualitative and quantitative research: Conjunctions and divergences. A new FQS-volume. *Historical Social Research*, 26(1), 187-221. Retrieved from <https://www.jstor.org/stable/20757853>
- Fink, A. (2003). *The survey handbook* (2nd ed.). Thousand Oaks, CA: Sage.
- Fitzpatrick, G., & Ellingsen, G. (2013). A review of 25 years of CSCW research in healthcare: Contributions, challenges and future agendas. *Computer Supported Cooperative Work*, 22(4), 609-665.
- Forster, M. (2013). A phenomenographic investigation into information literacy in nursing practice: Preliminary findings and methodological issues. *Nurse Education Today*, 33(10), 1237-1241. doi:10.1016/j.nedt.2012.05.027
- Forster, M. (2019), "'Ethnographic" thematic phenomenography", *Journal of Documentation*, Vol. 75 No. 2, pp. 349-365. <https://doi-org.sheffield.idm.oclc.org/10.1108/JD-05-2018-0079>
- Frisse, M. E. (1992). The health of the computer-based patient record. *Acad Med*, 67(7), 441–443
- Gagnon, M.-P., Desmartis, M., Labrecque, M., Car, J., Pagliari, C., Pluye, P., ... Legare, F. (2012). Systematic review of factors influencing the adoption of information and communication technologies by healthcare professionals. *Journal of Medical Systems*, 36(1), 241-277. doi:10.1007/s10916-010-9473-4
- Galliers, R. D. (1992). Integrating information-systems into business - Research at Warwick Business School. *International Journal of Information Management*, 12(2), 160-163.
- Galligioni, E., Berloffo, F., Caffo, O., Tonazzolli, G., Ambrosini, G., Valduga, F., . . . Forti, S. (2009). Development and daily use of an electronic oncological patient record for the total management of cancer patients: 7 years' experience. *Annals of Oncology*, 20(2), 349–352. doi:10.1093/annonc/mdn567
- Gans, D., Kralewski, J., Hammons, T., & Dowd, B. (2005). Medical groups' adoption of electronic health records and information systems. *Health Affairs*, 24(5), 1323–1333. doi:10.1377/hlthaff.24.5.1323
- García, R. M., Serrano, E. T., Quilis, J. D. S., Espert, I. B., Bonmatí, L. M., & Cubells, D. A. (2014). A systematic approach for using DICOM structured reports in clinical processes: Focus on breast cancer. *Journal of Digital Imaging*, 28(2), 132-145. doi:10.1007/s10278-014-9728-6

- Glaser, B. G. (1992). *Basics of grounded theory analysis: emergence vs. forcing*. Mill Valley, CA: Sociology Press.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York, NY: Aldine de Gruyter.
- Goldspiel, B. R., DeChristoforo, R., & Daniels, C. E. (2000). A continuous-improvement approach for reducing the number of chemotherapy-related medication errors. *American Journal of Health-System Pharmacy*, 57 Suppl 4, S4–9.
- Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, 8(4), 597-606. Retrieved from <https://nsuworks.nova.edu/tqr/vol8/iss4/6>
- Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly*, 19, 213-236.
- Goodwin, N., Perri, Peck, E., Freeman, T., & Posaner, R. (2004). *Managing across diverse networks of care: lessons from other sectors*. Report to the National Co-ordinating Centre for NHS Service Delivery and Organisation R&D (NCCSDO). Retrieved from <http://www.sdo.lshtm.ac.uk/sdo392002.html>
- Goutos, I., Cogswell, L. K., & Giele, H. (2014). Extravasation injuries: a review. *Journal of Hand Surgery (European Volume)*, 39(8), 808-818. doi:10.1177/1753193413511921
- Green, J. & Thorogood, N. (2013). *Qualitative methods for health research* (3rd ed.). Los Angeles, CA: Sage.
- Greenhalgh, T., & Russell, J. (2010). Why do evaluations of eHealth programs fail? An alternative set of guiding principles. *Plos Medicine*, 7(11). doi:10.1371/journal.pmed.1000360
- Greenhalgh, T., Potts, H. W. W., Wong, G., Bark, P., & Swinglehurst, D. (2009). Tensions and paradoxes in electronic patient record research: a systematic literature review using the meta-narrative method. *The Milbank Quarterly*, 87(4), 729–788. doi:10.1111/j.1468-0009.2009.00578.x
- Greenhalgh, T., Stramer, K., Bratan, T., Byrne, E., Mohammad, Y., & Russell, J. (2008). Introduction of shared electronic records: Multi-site case study using diffusion of innovation theory. *British Medical Journal*, 337. doi:10.1136/bmj.a1786
- Greenhalgh, T., Stramer, K., Bratan, T., Byrne, E., Russell, J., & Potts, H. W. W. (2010). Adoption and non-adoption of a shared electronic summary record in England: A mixed-method case study. *British Medical Journal*, 340. doi:10.1136/bmj.c3111
- Greenhalgh, T., Wherton, J., Papoutsis, C., Lynch, J., Hughes, G., A'Court, C., . . . Shaw, S. (2017). Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies. *Journal of Medical Internet Research*, 19(11), e367. doi:10.2196/jmir.8775
- Gross, A. H., Leib, R. K., Tonachel, A., Tonachel, R., Bowers, D. M., Burnard, R. A., . . . Bunnell, C. A. (2016). Teamwork and electronic health record implementation: A case study of preserving effective communication and mutual trust in a changing environment. *Journal of Oncology*

Practice, 12(11), 1075-1083. doi:10.1200/jop.2016.013649

Guba, E. G., & Lincoln, Y. S. (1982). Epistemological and methodological bases of naturalistic inquiry. *Educational Communication and Technology Journal*, 30(4), 233-252.
doi:10.1007/BF02765185

Gücin, N. Ö., & Berk, Ö. S. (2015). Technology acceptance in health care: An integrative review of predictive factors and intervention programs. *Procedia - Social and Behavioral Sciences*, 195, 1698-1704. doi:10.1016/j.sbspro.2015.06.263

Hains, I. M., Fuller, J. M., Ward, R. L., & Pearson, S. A. (2009). Standardizing care in medical oncology are web-based systems the answer? *Cancer*, 115(23), 5579–5588. doi:10.1002/cncr.24600

Hains, I. M., Ward, R. L., & Pearson, S. A. (2012). Implementing a web-based oncology protocol system in Australia: Evaluation of the first 3 years of operation. *Internal Medicine Journal*, 42(1), 57–64.
doi:10.1111/j.1445-5994.2010.02284.x

Hall, J. (2015). How to do it... EMR and billing integration. *McKnight's Long - Term Care News*, 36(9), 24.

Han, Y. Y., Carcillo, J. A., Venkataraman, S. T., Clark, R. S., Watson, R. S., Nguyen, T. C., . . . Orr, R. A. (2005). Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics*, 116(6), 1506-1512.
doi:10.1542/peds.2005-1287

Han, Y., Huh, S. J., Ju, S. G., Ahn, Y. C., Lim, D. H., Lee, J. E., & Park, W. (2005). Impact of an electronic chart on the staff workload in a radiation oncology department. *Japanese Journal of Clinical Oncology*, 35(8), 470–474. doi:10.1093/jjco/hyi129

Hancock, B. (Ed.) (1996). *Cancer care in the hospital*. Oxon, England: Radcliffe Medical Press.

Handler, T., Holtmeier, R., Metzger, J., Overhage, M., Taylor, S., & Underwood, C. (2003). *HIMSS Electronic Health Record Definitional Model Version 1.0*. Health Information Management Systems Society (HIMSS).

Happ, A. J. (1994). Usability foresight: Strategic usability planning: A special interest group meeting report. *ACM SIGCHI Bulletin*, 26(1), 17-21. doi:10.1145/181526.181527

Harland, J., Bath, P. A., Wainwright, A., & Seymour, J. (2017). Making sense of dementia: A phenomenographic study of the information behaviours of people diagnosed with dementia. *Aslib Journal of Information Management*, 69(3), 261-277. doi:10.1108/AJIM-08-2016-0141

Harland, J. A., & Bath, P. A. (2008). Understanding the information behaviours of carers of people with dementia: A critical review of models from information science. *Aging & Mental Health*, 12(4), 467-477. doi:10.1080/13607860802224300

Hartwood, M., Procter, R., Rouncefield, M., & Slack, R. (2003). Making a case in medical work: Implications for the electronic medical record. *Computer Supported Cooperative Work (CSCW)*, 12(3), 241-266. doi:10.1023/A:1025055829026

Häyrynen, K., Saranto, K., & Nykanen, P. (2008). Definition, structure, content, use and impacts of

- electronic health records: A review of the research literature. *International Journal of Medical Informatics*, 77(5). doi:10.1016/j.ijmedinf.2007.09.001
- Hede, K. (2009). Electronic medical records: Oncology practices take the plunge. *Journal of the National Cancer Institute*, 101(14), 976-983. doi:10.1093/jnci/djp215
- Hepler, C., & Segal, R. (2003). Preventing medication errors and improving drug therapy outcomes: A management systems approach. Boca Raton, Florida: CRC Press.
- Hesse, B. W., Hanna, C., Massett, H. A., & Hesse, N. K. (2010). Outside the box: Will information technology be a viable intervention to improve the quality of cancer care? *Journal of the National Cancer Institute Monographs*, 40, 81-89. doi:10.1093/jncimonographs/lgq004
- Highsmith, J. (2000). *Adaptive software development: a collaborative approach to managing complex systems*. New York, NY: Dorset House Publishing.
- Holden, R. J., & Karsh, B.-T. (2010). The Technology Acceptance Model: Its past and its future in health care. *Journal of Biomedical Informatics*, 43(1), 159-172. doi:10.1016/j.jbi.2009.07.002
- Holloway, I. (1997). *Basic concepts for qualitative research*. Oxford, England: Blackwell Science.
- Honekamp, W., & Ostermann, H. (2011). Evaluation of a prototype health information system using the FITT framework. *Informatics in Primary Care*, 19(1), 47-49. doi:10.14236/jhi.v19i1.793
- Hong, W., Chan, F. K. Y., Thong, J. Y. L., Chasalow, L. C., & Dhillon, G. (2013). A framework and guidelines for context-specific theorizing in information systems research. *Information Systems Research*, 25(1), 111-136. doi:10.1287/isre.2013.0501
- Huertas Fernandez, M. J., Baena-Canada, J. M., Martinez Bautista, M. J., Arriola Arellano, E., & Garcia Palacios, M. V. (2006). Impact of computerised chemotherapy prescriptions on the prevention of medication errors. *Clinical & Translational Oncology*, 8(11). doi:10.1007/s12094-006-0138-1
- Huffman, E. K. (1981). *Medical record management*. Berwyn, IL: Physicians' Record Co.
- Hurria, A., Naylor, M., & Cohen, H. J. (2013). Improving the quality of cancer care in an aging population: Recommendations from an IOM report. *JAMA*, 310(17), 1795-1796. doi:10.1001/jama.2013.280416
- Institute of Medicine. (2003). *Key Capabilities of an Electronic Health Record System: Letter Report*. Washington, DC: The National Academies Press. Retrieved from <https://www.nap.edu/catalog/10781/key-capabilities-of-an-electronic-health-record-system-letter-report>
- Jangland, E., Larsson, J., & Gunningberg, L. (2011). Surgical nurses' different understandings of their interactions with patients: A phenomenographic study. *Scandinavian Journal of Caring Sciences*, 25(3), 533-541. doi:10.1111/j.1471-6712.2010.00860.x
- Jiang, J. J., Muhanna, W. A., & Klein, G. (2000). User resistance and strategies for promoting acceptance across system types. *Information & Management*, 37(1), 25-36. doi:10.1016/s0378-7206(99)00032-4
- Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher* (33), 14-26. doi:10.3102/0013189X033007014

- Joishy, S. (2001). The relationship between surgery and medicine in palliative care. *Surgical Oncology Clinics of North America*, 10(1), 57-70. doi:10.1016/S1055-3207(18)30085-1
- Johnson, K. B., & Fitzhenry, F. (2006). Case report: Activity diagrams for integrating electronic prescribing tools into clinical workflow. *Journal of the American Medical Informatics Association*, 13(4), 391-395. doi:10.1197/jamia.M2008
- Jones, M. (2014). A Matter of Life and Death: Exploring Conceptualizations of Sociomateriality in the Context of Critical Care. *MIS Quarterly*, 38(3), 895. doi:10.25300/MISQ/2014/38.3.12
- Kaghan, W. N., & Bowker, G. C. (2001). Out of machine age?: complexity, sociotechnical systems and actor network theory. *Journal of Engineering and Technology Management*, 18(3), 253-269. doi:10.1016/S0923-4748(01)00037-6
- Kanas, G., Morimoto, L., Mowat, F., O'Malley, C., Fryzek, J., & Nurdyke, R. (2010). Use of electronic medical records in oncology outcomes research. *Clinicoeconomics and Outcomes Research*, 2, 1-14. doi:10.2147/CEOR.S8411
- Kaplan, B., & Harris-Salamone, K. D. (2009). Health IT success and failure: Recommendations from literature and an AMIA workshop. *Journal of the American Medical Informatics Association*, 16(3), 291-299. doi:10.1197/jamia.M2997
- Karsh, B. T. (2004). Beyond usability: Designing effective technology implementation systems to promote patient safety. *Quality & Safety in Health Care*, 13(5), 388-394. doi:10.1136/qshc.2004.010322
- Ketikidis, P., Dimitrovski, T., Lazuras, L., & Bath, P. A. (2012). Acceptance of health information technology in health professionals: an application of the revised technology acceptance model. *Health Informatics Journal*, 18(2), 124-134. doi:10.1177/1460458211435425
- Kijsanayotin, B., Pannarunothai, S., & Speedie, S. M. (2009). Factors influencing health information technology adoption in Thailand's community health centers: Applying the UTAUT model. *International Journal of Medical Informatics*, 78(6), 404-416. doi:10.1016/j.ijmedinf.2008.12.005
- Kirkpatrick, J. P., Yoo, S., Light, K., Antoine, P., Walker, R., Clough, R., . . . Willett, C. (2010). Implementing and integrating a clinically driven electronic medical record for radiation oncology in a large medical enterprise. *Frontiers in Oncology*, 78(3). doi:10.3389/fonc.2013.00069
- Klaus, T., & Blanton, J. E. (2010). User resistance determinants and the psychological contract in enterprise system implementations. *European Journal of Information Systems*, 19(6), 625-636. doi:10.1057/ejis.2010.39
- Kohn, L., Corrigan, J., & Donaldson, M. (1999). *To err is human: Building a safer health system*. Washington, DC: Institute of Medicine.
- Kroese, D. P., Brereton, T., Taimre, T., & Botev, Z. I. (2014). Why the Monte Carlo method is so important today. *Wiley Interdisciplinary Reviews: Computational Statistics*, 6(6), 386-392. doi:10.1002/wics.1314
- Krueger, R. A. (2009). *Focus groups: A practical guide for applied research* (4th ed.). London,

- England: Sage.
- Kumar, R. (2014). *Research methodology: A step-by-step guide for beginners* (4th ed.) Los Angeles, CA: Sage.
- Kushniruk, A. (2002). Evaluation in the design of health information systems: application of approaches emerging from usability engineering. *Computers in Biology and Medicine*, 32(3), 141–149. doi:10.1016/s0010-4825(02)00011-2
- Kvale, S. (2009). *Interviews: Learning the craft of qualitative research interviewing* (2nd ed.). Thousand Oaks, CA: Sage.
- Laerum, H., & Faxvaag, A. (2004). Task-oriented evaluation of electronic medical records systems: Development and validation of a questionnaire for physicians. *BMC Medical Informatics and Decision Making*, 4(1). doi:10.1186/1472-6947-4-1
- Laerum, H., Ellingsen, G., & Faxvaag, A. (2001). Doctors' use of electronic medical records systems in hospitals: A cross sectional survey. *British Medical Journal*, 323(7325), 1344-1348. doi:10.1136/bmj.323.7325.1344
- Lai, T., Leung, G., Wong, I., & Johnston, J. (2004). Do doctors act on their self- reported intention to computerize? A follow-up population-based survey in Hong Kong. *International Journal of Medical Informatics*, 73(5), 415-431. doi:10.1016/j.ijmedinf.2004.03.004
- Larsen, E., & Ellingsen, G. (2012). Establishing a Core Health Record ; a case study from Norwegian Healthcare. In *Coop 2012* (pp. 1–16).
- Larsson, I., & Gard, G. (2006). Conceptions of physiotherapy knowledge among Swedish physiotherapists: A phenomenographic study. *Physiotherapy*, 92(2), 110-115. doi:10.1016/j.physio.2005.12.001
- Larsson, I., Arvidsson, S., Bergman, S., & Arvidsson, B. (2010). Patients' perceptions of drug information given by a rheumatology nurse: A phenomenographic study. *Musculoskeletal Care*, 8(1), 36-45. doi:10.1002/msc.164
- Larsson, J., & Holmstrom, I. (2007). Phenomenographic or phenomenological analysis: Does it matter? Examples from a study on anaesthesiologists' work. *International Journal of Qualitative Studies on Health and Well-being*, 2(1), 55-64. doi:10.1080/17482620601068105
- Lee, A. S. (1991). Integrating positivist and interpretive approaches to organizational research. *Organization Science*, 2(4), 342-365. doi:10.1287/orsc.2.4.342
- Lee, Y., Kozar, K. A., & Larsen, K. (2003). The Technology Acceptance Model: Past, present, and future. *Technology*, 12, 752-780. doi:10.17705/1CAIS.01250
- Leech, N. L., & Onwuegbuzie, A. J. (2011). Beyond constant comparison qualitative data analysis: Using NVivo. *School Psychology Quarterly*, 26(1), 70-84. doi:10.1037/a0022711
- Leedy, P. D. (2010). *Practical research: Planning and design* (9th ed.). Boston, MA: Pearson Education International.
- Legris, P., Ingham, J., & Collette, P. (2003). Why do people use information technology? A critical

- review of the technology acceptance model. *Information & Management*, 40(3), 191–204.
doi:10.1016/s0378-7206(01)00143-4
- Lesselroth, B. J., Yang, J., McConnachie, J., Brenk, T., & Winterbottom, L. (2011). Addressing the sociotechnical drivers of quality improvement: A case study of post-operative DVT prophylaxis computerised decision support. *BMJ Quality & Safety*, 20(5), 381-389.
doi:10.1136/bmjqs.2010.042689
- Levit, L., Balogh, E., Nass, S., & Ganz, P. A. (Eds.) (2013). *Delivering high-quality cancer care: Charting a new course for a system in crisis*. Washington, DC: National Academies Press.
- Levy, M. A., & Rubin, D. L. (2011). Current and future trends in imaging informatics for oncology. *Cancer Journal*, 17(4), 203-210. doi:10.1097/PPO.0b013e3182272f04
- Levy, M. A., Giuse, D. A., Eck, C., Holder, G., Lippard, G., Cartwright, J., & Rudge, N. K. (2011). Integrated information systems for electronic chemotherapy medication administration. *Journal of Oncology Practice*, 7(4), 226-230. doi:10.1200/JOP.2011.000259
- Lewis, J. R. (1995). IBM computer usability satisfaction questionnaires - Psychometric evaluation and instructions for use. *International Journal of Human-Computer Interaction*, 7(1), 57-78.
doi:10.1080/10447319509526110
- Lobach, D. F., & Detmer, D. E. (2007). Research challenges for electronic health records. *American Journal of Preventive Medicine*, 32(5), S104-S111. doi:10.1016/j.amepre.2007.01.018
- Loomis, G. A., Ries, J. S., Saywell, R. M., & Thakker, N. R. (2002). If electronic medical records are so great, why aren't family physicians using them? *The Journal of Family Practice*, 51(7), 636-641.
- Ma, A., & Norwich, B. (2007). Triangulation and theoretical understanding. *International Journal of Social Research Methodology*, 10(3), 211-226. doi:10.1080/13645570701541878
- Majeed, A., Black, A., Car, J., Anandan, C., Cresswell, K., McKinstry, B., . . . Sheikh, A. (2009). The Impact of eHealth on the Quality and Safety of Healthcare. *Communications Infrastructure: Systems and Applications in Europe*, 16, 204-204.
- Manion, F. J., Harris, M. R., Buyuktur, A. G., Clark, P. M., An, L. C., & Hanauer, D. A. (2012). Leveraging EHR data for outcomes and comparative effectiveness research in oncology. *Current Oncology Reports*, 14(6), 494-501. doi:10.1007/s11912-012-0272-6
- Marsh, C. (1982). *The survey method: The contribution of surveys to sociological explanation*. London, England: Allen & Unwin.
- Marshall, C. & Rossman, G. B. (2011). *Designing qualitative research* (5th ed.). Thousand Oaks, CA: Sage.
- Marton, F. (1981). Phenomenography - Describing conceptions of the world around us. *Instructional Science*, 10(2), 177-200. doi:10.1007/bf00132516
- Marton, F., & Booth, S. (1997). *Learning and awareness*. Mahwah, NJ: L. Erlbaum Associates.
- Marton, F., & Dahlgren, L. O. (1976). Non-verbatim learning .3. Outcome space of some basic concepts in economics. *Scandinavian Journal of Psychology*, 17(1), 49-55. doi:10.1111/j.1467-

- Mason, J. (2002). *Qualitative researching* (2nd ed.). London, England: Sage.
- Mason, R.O. (1978). Measuring information output: a communication systems approach. *Information & Management*, 1(5), 219–34. doi:10.1016/0378-7206(78)90028-9
- Maun, A., Engstrom, M., Frantz, A., Bramberg, E., & Thorn, J. (2014). Effective teamwork in primary healthcare through a structured patient-sorting system - a qualitative study on staff members' conceptions. *BMC Family Practice*, 15, 189. doi:10.1186/s12875-014-0189-2
- Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (3rd ed.) Los Angeles, CA: Sage.
- McCarthy, M. e. a. (2007). *Measuring quality in cancer services - Report for the national co-ordinating centre for NHS service delivery and organisation*.
- McDonald, C. J., Weiner, M., & Hui, S. L. (2000). Deaths due to medical errors are exaggerated in Institute of Medicine report. *Journal of the American Medical Association*, 284(1), 93-95. doi:10.1001/jama.284.1.93
- McGinn, C. A., Grenier, S., Duplantie, J., Shaw, N., Sicotte, C., Mathieu, L., . . . Gagnon, M.-P. (2011). Comparison of user groups' perspectives of barriers and facilitators to implementing electronic health records: a systematic review. *BMC Medicine*, 9(46). doi:10.1186/1741-7015-9-46
- McKenna, H. (2017, December 13). Brexit: The implications for health and social care. *The King's Fund*. Retrieved from https://www.kingsfund.org.uk/publications/articles/brexit-implications-health-social-care?gclid=EAlaIQobChMI_93_h5aa3wIVIJ3VCh0N7wIKEAAYAiAAEglusPD_BwE
- McNeill, P. (2005). *Research methods* (3rd ed.). London, England: Routledge.
- Meadows, B. J. (2003a). Eliciting remote data entry system requirements for the collection of cancer clinical trial data. *Computers, Informatics, Nursing*, 21(5), 234-240. doi:10.1097/00024665-200309000-00010
- Menachemi, N., & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy*, 4, 47-55. doi:10.2147/RMHP.S12985
- Mertens, D. M., & Hesse-Biber, S. (2012). Triangulation and mixed methods research. *Journal of Mixed Methods Research*, 6(2), 75-79. doi:10.1177/1558689812437100
- Mikkelsen, G., & Aasly, J. (2001). Concordance of information in parallel electronic and paper-based patient records. *International Journal of Medical Informatics*, 63(3), 123-131. doi:10.1016/s1386-5056(01)00152-6
- Miller, A. (2003). Clinical information systems in oncology - Making a difference to patient outcomes. *Health Care Information Review Online*.
- Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research*, 1(1), 48-76. doi:10.1177/2345678906292462
- Morgan, S. L. (2007). *Counterfactuals and causal inference: Methods and principles for social*

- research. Cambridge, England: Cambridge University Press.
- Mumford, E. (2006). The story of socio- technical design: reflections on its successes, failures and potential. *Information Systems Journal*, 16(4), 317-342. doi:10.1111/j.1365-2575.2006.00221.x
- Munkvold, G., Ellingsen, G., & Monteiro, E. (2007a). From plans to planning: The case of nursing plans. In G. Munkvold (Ed.) (pp. 21-30).
- National Academy of Sciences. (2011). *Toward precision medicine: Building a knowledge network for biomedical research and a new taxonomy of disease*. Washington, DC: National Academies Press. Retrieved from <https://www.ncbi.nlm.nih.gov/books/NBK91503/>
- National Cancer Action Team (NCAT). (2010). *Manual for cancer services 2008: Psychological support measures*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/216678/dh_118819.pdf
- National Chemotherapy Advisory Group. (2009). *Chemotherapy services in England: ensuring quality and safety*. Retrieved from http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_104500
- National Chemotherapy Advisory Group. (2010). *Manual for cancer services: Chemotherapy*.
- National Institutes of Health, National Center for Research Resources (2006). *Electronic health records overview*. McLean, VA: National Institutes of Health.
- National Research Council. (2011). *Toward precision medicine: Building a knowledge network for biomedical research and a new taxonomy of disease*. Washington, DC: The National Academies Press. doi:10.17226/13284
- Neal, A. J. (2009). *Clinical oncology : basic principles and practice* (4th ed. ed.). London: London : Hodder Arnold, 2009.
- Neuman, W. L. (2006). *Social research methods: Qualitative and quantitative approaches* (6th ed.). Boston, MA: Pearson Allyn & Bacon.
- Neumann, L. (2010). Comparative Domestic and International EHR Adoption. Retrieved from http://www.ehcca.com/presentations/ehrsummit1/neumann_1.pdf
- Neville-Webbe, H. L., Carsen, J. E., Wong, H., Andrews, J., Poulter, T., Smith, R., & Marshall, E. (2013). The impact of a new acute oncology service in acute hospitals: experience from the Clatterbridge Cancer Centre and Merseyside and Cheshire Cancer Network. *Clinical Medicine (London, England)*, 13(6), 565-569. doi:10.7861/clinmedicine.13-6-565
- Newsom, D., & Haynes, J. (2004). *Public relations writing: Form and style*. Belmont, CA: Thomson Wadsworth.
- Nordin, A. (2007). Organisation of gynaecological oncology services. *Obstetrics, Gynaecology and Reproductive Medicine*, 17(3), 91-94. doi:10.1016/j.ogrm.2007.01.001
- Noseworthy, G. (2012). Infographic: Managing the big flood of big data in digital marketing. Retrieved

from <https://visual.ly/community/infographic/technology/managing-big-flood-big-data-digital-marketing>

- Nguyen, N., Hadgraft, N., Moore, M., Rosenberg, D., Lynch, C., Reeves, M., & Lynch, B. (2017). A qualitative evaluation of breast cancer survivors' acceptance of and preferences for consumer wearable technology activity trackers. *Supportive Care in Cancer, 25*(11), 3375-3384. doi:10.1007/s00520-017-3756-y
- Nykanen, P., Brender, J., Talmon, J., de Keizer, N., Rigby, M., Beuscart-Zephir, M.-C., & Ammenwerth, E. (2011). Guideline for good evaluation practice in health informatics (GEP-HI). *International Journal of Medical Informatics, 80*(12), 815-827. doi:10.1016/j.ijmedinf.2011.08.004
- Onwuegbuzie, A. J., & Johnson, R. B. (2006). The validity issues in mixed research. *Research in the Schools, 13*(1), 48-63. doi:10.1108/11766091111124694
- Orchard, M. C. (2009). Access to electronic health records by care setting and provider type: perceptions of cancer care providers in Ontario, Canada. *BMC Medical Informatics and Decision Making, 9*(38). doi:10.1186/1472-6947-9-38
- Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research, 2*(1), 1-28. doi:10.1287/isre.2.1.1
- Orlikowski, W. J., & Gash, D. C. (1994). Technological frames: Making sense of information technology in organizations. *ACM Transactions on Information Systems, 12*(2), 174-207. doi:10.1145/196734.196745
- Ornek, F. (2008). An overview of a theoretical framework of phenomenography in qualitative education research: An example from physics education research. *Asia-Pacific Forum on Science Learning and Teaching, 9*(2), 1.
- Orton, D. I., & Cruzelier, J. H. (1989). Adverse changes in mood and cognitive performance in house officers after night duty. *British Medical Journal, 298*, 21-23. doi:10.1136/bmj.298.6665.21
- Pai, F.-Y., & Huang, K.-I. (2011). Applying the Technology Acceptance Model to the introduction of healthcare information systems. *Technological Forecasting and Social Change, 78*(4), 650-660. doi:10.1016/j.techfore.2010.11.007
- Palys, T. (2008). Purposive sampling. In L. M. Given (Ed.), *The Sage Encyclopedia of Qualitative Research Methods*, Vol. 2 (pp. 697-698). Los Angeles, CA: Sage.
- Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.
- Payne, T. H. (1999). The transition to automated practitioner order entry in a teaching hospital: The VA Puget Sound experience. *Proceedings of the AMIA Symposium, 589-593*.
- Peters, D. (2014). The application of systems thinking in health: why use systems thinking? *Health Research Policy and Systems, 12*(1), 51. doi:10.1186/1478-4505-12-51

- Pipan, M., Arh, T., & Blažič, B. (2010). The evaluation cycle management-method applied to the evaluation of learning management systems. *Integrating usability engineering for designing the web experience: methodologies and principles* (pp. 58-80).
- Pitt, L. F., Watson, R. T., & Kavan, C. B. (1995). Service quality: A measure of information systems effectiveness. *MIS Quarterly*, 19(2), 173-187. doi:10.2307/249687
- Poulter, T., Gannon, B., & Bath, P. A. (2012). An analysis of electronic document management in oncology care. *Health Informatics Journal*, 18(2), 135-146. doi:10.1177/1460458211435514
- Presser, S. (2004). Methods for testing and evaluating survey questions. *Public Opinion Quarterly*, 68(1), 109-130. doi:10.1093/poq/nfh008
- Prosser, M., & Millar, R. (1989). The “how” and “what” of learning physics. *European Journal of Psychology of Education*, 4, 513-528. doi:10.1007/BF03172714
- Prosser, M., Trigwell, K., Hazel, E., & Waterhouse, F. (2000). Students' experiences of studying physics concepts: The effects of disintegrated perceptions and approaches. *European Journal of Psychology of Education*, 15(1), 61-74. doi:10.1007/BF03173167
- Punch, K. (2005). *Introduction to social research: Quantitative and qualitative approaches* (2nd ed.). London, England: Sage.
- Quantin, C., Coatrieux, G., Allaert, F. A., Fassa, M., Bourquard, K., Boire, J. Y. . . . Breton, V. (2009). New advanced technologies to provide decentralised and secure access to medical records: Case studies in oncology. *Cancer Informatics*, 7(7), 217-229.
- Rees, C. E., & Bath, P. A. (2001). Information-seeking behaviours of women with breast cancer. *Oncology Nursing Forum*, 28(5), 899-907. doi:10.1080/10810730500263638
- Reidl, C., Tolar, M., & Wagner, I. (2008). Impediments to change: The case of implementing an electronic patient record in three oncology clinics. Tenth Anniversary Conference on Participatory Design 2008, Indiana University, Indianapolis, IN.
- Reiser, S. (1978). The decline of the clinical dialogue. *The Journal of Medicine and Philosophy*, 3(4), 305-313. doi:10.1093/jmp/3.4.305
- Richardson, J. T. E. (1999). The concepts and methods of phenomenographic research. *Review of Educational Research*, 69(1), 53-82. doi:10.2307/1170644
- Ries, M., Golcher, H., Prokosch, H. U., Beckmann, M. W., & Bürkle, T. (2012). An EMR based cancer diary – utilisation and initial usability evaluation of a new cancer data visualization tool. *Studies in Health Technology and Informatics*, 180, 656-660.
- Ringborg, U., Pierotti, M., Storme, G., & Tursz, T. (2008). Managing cancer in the EU: The Organisation of European Cancer Institutes (OEI). *European Journal of Cancer*, 44(6), 772-773. doi:10.1016/j.ejca.2008.01.012
- Ritchie, J. (2014). *Qualitative research practice: A guide for social science students and researchers* (2nd ed.). Los Angeles, CA: Sage.

- Robertson, A., et al. (2010). Implementation and adoption of nationwide electronic health records in secondary care in England: qualitative analysis of interim results from a prospective national evaluation. *British Medical Journal*, 341, 1-12. doi:10.1136/bmj.c4564
- Roe, H., & Lennan, E. (2014). Role of nurses in the assessment and management of chemotherapy-related side effects in cancer patients. *Nursing: Research and Reviews*, 2014, 103-115. doi:10.2147/NRR.S41845
- Romano, M. J., & Stafford, R. S. (2011). Electronic health records and clinical decision support systems: Impact on national ambulatory care quality. *Archives of Internal Medicine*, 171(10), 897-903. doi:10.1001/archinternmed.2010.527
- Rosen, R., Smith, A., & Harrison, A. (2006). *Future trends and challenges for cancer services in England - A review of literature and policy*. Retrieved from <https://www.kingsfund.org.uk/publications/future-trends-and-challenges-cancer-services-england>
- Rossmann, G. B., & Rollis, S. F. (2003). *Learning in the field: An introduction to qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.
- Safi, S., Thiessen, T., & Schmailzl, K. J. (2018). Acceptance and resistance of new digital technologies in medicine: Qualitative study. *JMIR Research Protocols*, 7(12), e11072-e11072. doi:10.2196/11072
- Saleem, J. J., Haggstrom, D. A., Militello, L. G., Flanagan, M., Kiess, C. L., Arbuckle, N., & Doebbeling, B. M. (2011). Redesign of a computerized clinical reminder for colorectal cancer screening: A human-computer interaction evaluation. *BMC Medical Informatics and Decision Making*, 11(74). doi:10.1186/1472-6947-11-74
- Saljo, R. (1979). Learning about learning. *Higher Education*, 8(4), 443-451. doi:10.1007/bf01680533
- Samhan, B., & Joshi, K. (2015). Resistance of healthcare information technologies; Literature review, analysis, and gaps. In B. Samhan (Ed.), (pp. 2992-3001).
- Schnall, R., Cimino, J. J., & Bakken, S. (2012). Development of a prototype continuity of care record with context-specific links to meet the information needs of case managers for persons living with HIV. *International Journal of Medical Informatics*, 81(8), 549-555. doi:10.1016/j.ijmedinf.2012.05.002
- Schuler, D., & Namioka, A., eds. (1993). *Participatory design: Principles and practices*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Schwartzberg, L. S. (2005). Oncology EMR comes of age. *Community Oncology*, 2(2), 107. doi:10.1016/S1548-5315(11)70860-9
- Scott, P. J., & Briggs, J. S. (2010). STAT-HI: A socio-technical assessment tool for health informatics implementations. *The Open Medical Informatics Journal*, 4, 214-220. doi:10.2174/1874431101004010214

- Senge, P. M. (1992). *The fifth discipline: The art and practice of the learning organization*. London, England: Century Business.
- Serber, M., Mackey, R., & Young, C. (1980). The Sloan-Kettering information system for clinical oncology. *Proceedings of the Annual Symposium on Computer Application in Medical Care*, 5(2), 728-732.
- Shackel, B. (1981). The concept of usability. In *Proceedings of IBM Software and Information Usability Symposium, September 15-18, 1981* (pp. 1-30). Poughkeepsie, NY: IBM Corporation.
- Shackel, B., & Richardson, S. J. (Eds.) (1991). *Human factors for informatics usability*. Cambridge, England: Cambridge University Press.
- Shahrokni, A., Pinheiro, N., & Pournaki, S. M. (2015). The effect of age on technology acceptance by cancer patients. *Journal of the American Geriatrics Society*, 63, S65-S66.
- Sheikh, A., Cornford, T., Barber, N., Avery, A., Takian, A., Lichtner, V., . . . Cresswell, K. (2011). Implementation and adoption of nationwide electronic health records in secondary care in England: final qualitative results from prospective national evaluation in "early adopter" hospitals. *British Medical Journal*, 343. doi:10.1136/bmj.d6054
- Shih, F. J. (1998). Triangulation in nursing research: issues of conceptual clarity and purpose. *Journal of Advanced Nursing*, 28, 631-641. doi:10.1046/j.1365-2648.1998.00716.x
- Shrestha, R. B. (1998). *The patient information folder - An approach to the electronic patient record*. (Doctoral dissertation, University of London.)
- Shulman, L., Miller, R. S., Ambinder, E. P., Yu, P. P., & Cox, J. V. (2008). Principles of safe practice using an oncology EHR system for chemotherapy ordering, preparation, and administration: Part 1 of 2. *Journal of Oncology Practice*, 4(4), 203-206. doi:10.1200/JOP.0847501
- Sicotte, C., Clavel, S., & Fortin, M. A. (2016). A cancer care electronic medical record highly integrated into clinicians workflow: Users' attitudes pre-post implementation. *European Journal of Cancer Care*, 26(6). doi:10.1111/ecc.12548
- Silsand, L., & Ellingsen, G. (2016). Complex decision-making in clinical practice. (Vol. 27, pp. 993-1004).
- Silsand, L., & Ellingsen, G. (2016). The implication for organisation and governance through user-driven standardisation of semantic interoperable electronic patient record systems. (2016). *MCIS 2016 Proceedings*, 63. Retrieved from <https://aisel.aisnet.org/mcis2016/63>
- Silverman, D. (2000). *Doing qualitative research: A practical handbook*. London, England: Sage.
- Silverman, D. (2006). *Interpreting qualitative data: Methods for analysing talk, text and interaction* (3rd ed.). London, England: Sage.
- Simon, S., Jenter, C., Burdick, E., Bates, D., Crowley, R., Soran, C., & Volk, L. (2010). Actual use of electronic health records in a community-based EHR adoption intervention. *Journal of General Internal Medicine*, 25, 217-218. doi:10.13063/2327-9214.1019
- Sittig, D. F. (2006). Potential impact of advanced clinical information technology on cancer care in 2015.

- Cancer Causes & Control*, 17(6), 813-820. doi:10.1007/s10552-006-0020-z
- Sjöström, B., & Dahlgren, L. O. (2002). Applying phenomenography in nursing research. *Journal of Advanced Nursing*, 40(3), 339-345. doi:10.1046/j.1365-2648.2002.02375.x
- Sklarín, N. T., Granovsky, S., O'Reilly, E. M., & Zelenetz, A. D. (2011). Electronic chemotherapy order entry: A major cancer center's implementation. *Journal of Oncology Practice*, 7(4), 213-218. doi:10.1200/jop.2011.000266
- Skolarus, T. A., Zhang, Y., & Hollenbeck, B. K. (2012). Understanding fragmentation of prostate cancer survivorship care Implications for cost and quality. *Cancer*, 118(11), 2837-2845. doi:10.1002/cncr.26601
- Slee, A. (2005a). Cancer Services Electronic Prescribing System - Functional Specification for Immediate/Medium Term. Connecting for Health.
- Slee, A. (2005b). Summary Report of Oncology Prescribing System: June 2005 Benchmark. Connecting for Health.
- Small, M. D., Barrett, A., & Price, G. M. (2008). The impact of computerized prescribing on error rate in a department of oncology/haematology. *Journal of Oncology Pharmacy Practice*, 14(4), 181-187. doi:10.1177/1078155208094453
- Snyder, C. F., Wu, A. W., Miller, R. S., Jensen, R. E., Bantug, E. T., & Wolff, A. C. (2011). The role of informatics in promoting patient-centered care. *Cancer Journal*, 17(4), 211-218. doi:10.1097/PPO.0b013e318225ff89
- Spiegel, A. D. and Springer, C. R. (1997). Babylonian medicine, managed care and Codex Hammurabi, circa 1700 B.C. *Journal of Community Health*, 22(1), 69-89. doi:10.1023/A:1025151008571
- Stoodley, I. (2012). *Phenomenography health check*. Retrieved from <http://www.christinebruce.com.au/wp-content/uploads/2012/07/PhenomenographyHealthCheck-FINAL.pdf>
- Strauss, A. L. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.
- Svensson, L. (1997). Theoretical foundations of phenomenography. *Higher Education Research & Development*, 16(2), 159-171. doi:10.1080/0729436970160204
- Swindells, M. (2008). *Health informatics review*. London, England: Department of Health.
- Teddlie, C. & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative techniques in the social and behavioral sciences*. London, England: Sage.
- Tesch, R. (1990). *Qualitative research: Analysis types and software tools*. London, England: Falmer, 1990.
- Thorn, D. B., Sexton, M. G., Lemay, A. P., Sarigianis, J. S., Melita, D. D., & Gustafson, N. J. (1989). Effect of a cancer chemotherapy prescription form on prescription completeness. *American Journal of Hospital Pharmacy*, 46(9), 1802-1806. doi:10.1093/ajhp/46.9.1802
- Tichy, L., & Bascom, T. (2008). The business end of IT project failure. *Mortgage Banking*, 68(6), 28-35.

- Trueland, J. (2018). Special report: PACS. *Digital Health*. Retrieved from <https://www.digitalhealth.net/2018/02/special-report-pacs-2/>
- Tsiknakis, M., & Kouroubali, A. (2009). Organizational factors affecting successful adoption of innovative eHealth services: A case study employing the FITT framework. *International Journal of Medical Informatics*, 78(1), 39-52. doi:10.1016/j.ijmedinf.2008.07.001
- Ularu, E. G., Puican, F. C., Apostu, A., & Velicanu, M. (2012). Perspectives on big data and big data analytics. *Database Systems Journal*, 3(4), 3-14. Retrieved from <http://dbjournal.ro/archive/10/10.pdf>
- Van de Ven, A. (2007). *Engaged scholarship: A guide for organizational and social research*. Oxford, England: Oxford University Press.
- Van der Haak, M., Mludek, V., Wolff, A. C., Bulzebruck, H., Oetzel, D., Zierhut, D., . . . Haux, R. (2002). Networking in shared care – first steps towards a shared electronic patient record for cancer patients. *Methods of Information in Medicine*, 41(5), 419-425. doi:10.1055/s-0038-1634372
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46(2), 186-204.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478. doi:10.2307/30036540
- Verhoeff, R. P., Knippels, M.-C. P. J., Gilissen, M. G. R., & Boersma, K. T. (2018). The Theoretical Nature of Systems Thinking. Perspectives on Systems Thinking in Biology Education. *Frontiers in Education*, 3(40). doi:10.3389/educ.2018.00040
- Voeffray, M., Pannatier, A., Stupp, R., Fucina, N., Leyvraz, S., & Wasserfallen, J. B. (2006). Effect of computerisation on the quality and safety of chemotherapy prescription. *Quality & Safety in Health Care*, 15(6), 418-421. doi:10.1136/qshc.2005.016808
- Wachter RM. (2016) Making IT Work: Harnessing the power of health information technology to improve care in England. Report of the National Advisory Group on Health Information Technology in England.
- Wagner, S., Beckmann, M., Wullich, B., Seggewies, C., Ries, M., Burkle, T., & Prokosch, H. (2015). Analysis and classification of oncology activities on the way to workflow based single source documentation in clinical information systems. *BMC Medical Informatics and Decision Making*, 15, 107. doi:10.1186/s12911-015-0231-x
- Walker, C. (1998). Learning to learn, phenomenography and children's learning. *Educational and Child Psychology*, 15(3), 25-33.
- Wallace, P. J. (2007). Reshaping cancer learning through the use of health information technology. *Health Affairs*, 26(2), w169-w177. doi:10.1377/hlthaff.26.2.w169
- Walter, Z., & Lopez, M. S. (2008). Physician acceptance of information technologies: Role of perceived threat to professional autonomy. *Decision Support Systems*, 46(1), 206-215. doi:10.1016/j.dss.2008.06.004

- Ward, R., Stevens, C., Brentnall, P., & Briddon, J. (2008). The attitudes of health care staff to information technology: a comprehensive review of the research literature. *Health Information & Libraries Journal*, 25(2), 81-97. doi:10.1111/j.1471-1842.2008.00777.x
- Wenzell, L. (2017). What is commissioning and how is it changing? *The King's Fund*. Retrieved from <https://www.kingsfund.org.uk/publications/what-commissioning-and-how-it-changing>
- Wexler, J., & Bucci, K. (2010). The business of hospital charge capture. *Revenue-cycle strategist*, 7(9), 1-4.
- Whittaker, A. A., Aufdenkamp, M., & Tinley, S. (2009a). Barriers and facilitators to electronic documentation in a rural hospital. *Journal of Nursing Scholarship*, 41(3), 293–300. doi:10.1111/j.1547-5069.2009.01278.x
- Wilfried, H., & Herwig, O. (2011). Evaluation of a prototype health information system using the FITT framework. *Journal of Innovation in Health Informatics*, 19(1), 47-49. doi:10.14236/jhi.v19i1.793
- Winthereik, B. R., & Vikkelsø, S. (2005). ICT and integrated care: Some dilemmas of standardising Inter-Organisational Communication. *Computer Supported Cooperative Work (CSCW)*, 14(1), 43–67. doi:10.1007/s10606-004-6442-9
- World Health Organisation (WHO). (2018). Cancer. Retrieved from <https://www.who.int/cancer/en/>
- World Health Organisation (WHO). (2009). *World Health Statistics 2009*. Geneva: WHO Press.
- Williams, D. (2007). Medication Errors. *Journal of the Royal College of Physicians of Edinburgh*, 37(4), 343-346.
- Willis, A. S. (2018). The efficacy of phenomenography as a cross- cultural methodology for educational research. *International Journal of Research & Method in Education*, 41(5), 483-499. doi:10.1080/1743727X.2017.1283398
- Winthereik, B., & Vikkelsø, S. (2005). ICT and integrated care: Some dilemmas of standardising inter-organisational communication. *Computer Supported Cooperative Work (CSCW)*, 14(1), 43-67. doi:10.1007/s10606-004-6442-9
- Wise, J. (2018). Government takes steps to reduce annual burden of medication errors in England. *BMJ*, 360. doi:10.1136/bmj.k903
- Wyatt, J., & Keen, J. (1998). The NHS's new information strategy. *British Medical Journal*, 317(7163), 900.
- Yang, Z., Ng, B., Kankanhalli, A., & Yip, J. (2012). Workarounds in the use of IS in healthcare: A case study of an electronic medication administration system. *International Journal of Human-Computer Studies*, 70(1), 43-65. doi:10.1016/j.ijhcs.2011.08.002
- Yates, C., Partridge, H., & Bruce, H. (2012). Exploring information experiences through phenomenography. *Library and Information Research*, 36(112), 96-119.

- Yu, P. P. (2011). The evolution of oncology electronic health records. *Cancer Journal*, 17(4), 197–202. doi:10.1097/PPO.0b013e3182269629
- Yu, P., Gandhidasan, S., & Miller, A. A. (2010). Different usage of the same oncology information system in two hospitals in Sydney - Lessons go beyond the initial introduction. *International Journal of Medical Informatics*, 79(6), 422-429. doi:10.1016/j.ijmedinf.2010.03.003

Ethics Approval Letter NHS National Research Ethics Service (NRES)



National Research Ethics Service

NRES Committee North West - Liverpool

Barlow House
3rd Floor
4 Minshull Street
Manchester
M1 3DZ

Telephone: 0161 625 7816

18 May 2011

Ms Gill Sims
Research Manager - Governance & Administration
Clatterbridge Centre for Oncology
Clatterbridge Road
Bebington
Wirral
Merseyside
CH63 4JY

Dear Gill

Full title of project: Patient Records Survey

Thank you for seeking the Committee's advice about the above project.

You provided the following documents for consideration:

Document	Version	Date
Email		03/05/2011

This document has been considered by the Chair.

Our leaflet "Defining Research", which explains how we differentiate research from other activities, is published at: <http://www.nres.npsa.nhs.uk/rec-community/guidance/#researchoraudit>. Based on the information you provided, our advice is that the project is not considered to be research according to this guidance. It would appear to be service evaluation and therefore it does not require ethical review by a NHS Research Ethics Committee.

Although ethical review by a NHS REC is not necessary in this case, all types of study involving human participants should be conducted in accordance with basic ethical principles such as informed consent and respect for the confidentiality of participants. When processing identifiable data there are also legal requirements under the Data Protection Act 2000. When undertaking an audit or service/therapy evaluation, the investigator and his/her team are responsible for considering the ethics of their project with advice from within their organisation. University projects may require approval by the university ethics committee. It is the responsibility of the sponsor to decide if a project is research or not. You must therefore contact the sponsor/funder/care organisation where the work will be undertaken to ensure that they agree with this advice. You should also check with the Clatterbridge Centre for Oncology what other review arrangements or sources of advice apply to projects of this type. Guidance may be available from the clinical governance office.

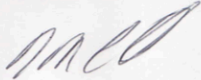
This Research Ethics Committee is an advisory committee to the North West Strategic Health Authority
The National Research Ethics Service (NRES) represents the NRES Directorate within
the National Patient Safety Agency and Research Ethics Committees in England

If you, your sponsor/funder or any care organisation feels that the project should be managed as research and/or that ethical review by a NHS REC is essential, please write setting out your reasons and we will be pleased to consider further.

This letter should not be interpreted as giving a form of ethical approval or any endorsement of the project, but it may be provided to a journal or other body as evidence that ethical approval is not required under NHS research governance arrangements.

Where care organisations have clarified that a project is not to be managed as research, the Research Governance Framework states that it should not be presented as research within the NHS.

Yours sincerely



Diane Catterall
Assistant Co-ordinator

E-mail: diane.catterall@northwest.nhs.uk

Patient Records Survey

CCO Patient Records Survey

Survey Eligibility

Please tell us whether you use patient medical records (in either paper or electronic format) in your role at the Trust.

If you do not use patient medical records in your job role you will not be eligible to take part in the survey, but thank you for looking.

*** 1. Do you deal with patient medical records in your job role?**

Yes

No

CCO Patient Records Survey

About You

Please tell us about your role and how long you have worked for Clatterbridge Centre for Oncology.

*** 2. Which staff group do you work in at the Trust ?**

- Medical
- Nursing
- Therapy Radiography
- Imaging Radiography
- Administration/Medical Records
- Physics
- Pharmacy
- Allied Health Professionals
- Senior Management
- Other (please specify)

*** 3. How long have you worked for the Trust?**

- Less than 1 year
- 1 – 5 years
- 6 – 10 years
- More than 10 years

CCO Patient Records Survey

Using Paper Medical Records

Please tell us how frequently you use paper-based patient medical notes.

*** 4. How frequently do you deal with paper-based patient medical notes to undertake your work?**

- On a daily basis
- Occasionally (e.g. on a weekly basis)
- Rarely (on an ad hoc basis, e.g. for audits)
- Never

CCO Patient Records Survey

Using Paper Medical Records

Please tell us about the tasks you complete using paper-based medical notes.

*** 5. What tasks do you use paper format patient medical notes for? (please tick all that apply)**

- To review the patients problems
- To seek out specific information
- To follow the results of a particular test or investigation over time
- To obtain the results from new tests or investigations
- To enter daily notes
- To obtain information on investigation or treatment procedures
- To answer questions concerning general medical knowledge
- For research purposes
- To conduct audits
- Clinical coding
- To file CCO documents
- To file documents from referring hospitals
- To obtain the results from clinical biochemical laboratory analyses
- To obtain the results from diagnostic imaging investigations
- To obtain the results from other supplementary investigations
- Subject access requests

Other (please specify)

6. Do you always have access to a patient's medical notes file whenever you need it?

- Yes
- No

CCO Patient Records Survey

Using Paper Medical Records

7. If a patient's file that you need is not readily available, how long on average do you have to wait to be able to see it?

- Less than an hour
- 1-2 hours
- 3-7 hours
- 1 day
- 2 days
- 3 days+

CCO Patient Records Survey

Using Paper Medical Records

8. On average how long do you keep patient's medical notes files in your possession?

- Less than an hour
- 1-2 hours
- 3-7 hours
- 1 day
- 2 days
- 3 days+

9. Do you ever suspect that a patient's medical notes file that you are working with are not fully up to date? (i.e. all letters not present or recent documents have not yet been filed)

- Yes
- No

CCO Patient Records Survey

Using Paper Medical Records

10. How frequently do you suspect that you are working with a patient's medical notes that aren't fully up to date? (e.g. with the latest letters and/or test results)

- On a daily basis
- On a weekly basis
- On a monthly basis
- Rarely

11. What do you do if a patient's medical notes are not available when you need them? (e.g. do you have workarounds to continue duties without the patient's file)

CCO Patient Records Survey

Using the Electronic Patient Record (EPR) system

*** 12. Do you use the current version of the MAXIMS Electronic Patient Record system at CCO?**

Yes

No

CCO Patient Records Survey

Using the Electronic Patient Record (EPR) system

*** 13. How frequently do you use the EPR system to perform the following tasks?**

	Never	Rarely	Occasionally	Daily	Don't know
Register new patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Create clinical letters	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enter nursing assessments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Schedule radiotherapy appointments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Track patient journey/pathway status	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enter clinical information (e.g. tumour details)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Record patient contacts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Make internal referrals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dispose clinics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Produce appointment letters	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Prescribe chemotherapy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Record drug administration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Order pathology tests	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Review pathology test results	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Record admissions, discharges or transfers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Track case-notes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Review or update patient demographics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enter clinic trials information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Review information for clinical coding	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

CCO Patient Records Survey

Using the Electronic Patient Record (EPR) system

Please tell us about your experiences using the current EPR system at the Trust.

14. Please tell us what you think about the overall EPR system by indicating the extent to which you agree or disagree with the statements below.

	Strongly Disagree	Disagree	Don't know	Agree	Strongly Agree
Overall, I am satisfied with how easy it is to use this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is simple to use this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can effectively complete my work using this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to complete my work quickly using this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to efficiently complete my work using this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable using this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It was easy to learn to use this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe I became productive quickly using this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The system gives error messages that clearly tell me how to fix problems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Whenever I make a mistake using the system, I recover easily and quickly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information (such as online help, on-screen messages, and other documentation) provided with this system is clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is easy to find the information I need	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information provided for the system is easy to understand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information is effective in helping me complete the tasks and scenarios	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The organization of information on the system screens is clear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The interface of this system is pleasant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like using the interface of this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
This system has all the functions and capabilities I expect it to have	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall, I am satisfied with this system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Please list the most negative aspect(s) of the current EPR system:

1

2

3

16. Please list the most positive aspect(s) of the current EPR system :

1

2

3

CCO Patient Records Survey

IT Training Needs

We are keen to understand whether the provision of IT training for staff at the Trust is adequate or if further IT training should be provided to enable improved use of electronic patient record systems.

17. Please tell us how competent you feel in using computer systems.

	Very competent	Competent	Unsure	Some further training required	Significant additional training needs	N/A
Do you feel competent in using a computer to access and record information?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. Would you like to have the option to complete some clinical systems training courses via eLearning? (e.g. training courses which you can access and complete on your computer)

- Yes
- No

CCO Patient Records Survey

The impact of moving to fully Electronic Patient Records

The Trust's strategy is to replace paper-based patient medical notes with fully electronic records. This will mean that paper-based medical notes will no longer be available and all information will be accessed in a new version of the EPR system, which will include a module for accessing electronic versions of all documents which are currently filed into medical notes (paper documents will be scanned to create electronic copies).

Please tell us how you think this will impact on your job role at the Trust.

19. How do you think it will affect your work when all paper-based medical notes are replaced with a fully electronic patient record system?

	Strongly Agree	Agree	Don't know	Disagree	Stongly Disagree	N/A
I will be more concerned about the security of patient information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It will have a negative impact on how I interact with patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will not be able to work as efficiently as I do now	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clinical information will be more up-to-date	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It will improve patient care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will make clinical decisions that are more informed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It will take longer to complete some tasks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will spend less time searching for information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Comments

CCO Patient Records Survey

Survey Complete

20. Thank you for taking the time to complete this questionnaire. If you have any general comments about the use of patient casefiles or development of the Trust's Electronic Patient Record system please enter them here.

University Research Ethics Application and Letter of Approval



Application 002195

Section A: Applicant details

Date application started:
Thu 13 November 2014 at 13:51

First name:
Thomas

Last name:
Poulter

Email:
lip09tvp@sheffield.ac.uk

Programme name:
INFR21 Information Studies

Module name:
Health Informatics
Last updated:
28/01/2015

Department:
Information School

Applying as:
Postgraduate research

Research project title:
Factors influencing the adoption and use of EPR systems in cancer treatment services

Has your research project undergone academic review, in accordance with the appropriate process?
- not entered -

Similar applications:
- not entered -

Section B: Basic information

Supervisor

Name	Email
Peter Bath	p.a.bath@sheffield.ac.uk

Proposed project duration

Start date (of data collection):
Thu 1 January 2015

Anticipated end date (of project):
Thu 30 November 2017

3: Project code (where applicable)

Project code
- not entered -

Suitability

Takes place outside UK?

No

Involves NHS?

Yes

Human-interventional study?

- not entered -

ESRC funded?

No

Likely to lead to publication in a peer-reviewed journal?

- not entered -

Led by another UK institution?

No

Involves human tissue?

No

Clinical trial?

No

Social care research?

No

Involves adults who lack the capacity to consent?

No

Involves research on groups that are on the Home Office list of 'Proscribed terrorist groups or organisations'?

- not entered -

Indicators of risk

Involves potentially vulnerable participants?

No

Involves potentially highly sensitive topics?

No

Section C: Summary of research

1. Aims & Objectives

The overall aim of this project is to develop an improved understanding of the specific issues and requirements affecting the development, implementation and use of electronic patient record (EPR) systems within cancer treatment services. The over-arching question that this research asks and will endeavour to answer is:

"What are the factors that influence the adoption and use of EPR systems by clinicians in cancer services?".

It is anticipated that answering this question will provide theoretical, methodological and practical research contributions to the field of health informatics and will, potentially, help to provide recommendations for future developments in cancer treatment services, with a view to improving healthcare services for both clinicians and patients. The exploratory phase of the study used a comprehensive literature review and the results of an initial survey questionnaire at the case study site, to develop and refine a conceptual model for a customised, integrated, comprehensive electronic record system for oncology ('CICERO'), which will be used as a reference model to define the scope of the research area and act as a guide to inform the main phase of the study, enabling the following key objectives of the study to be met:

Identify and explore the potential benefits of EPRs for clinicians and patients in cancer services

Establish the main facilitators and barriers to acceptance and adoption of EPR systems in cancer services, from a clinical end user's perspective

By achieving these objectives it is expected that a contribution will be made to the existing bodies of research within the fields of cancer services development, health informatics, socio-technical systems and technology adoption. Furthermore, the study may help to ensure

that oncology EPR systems are designed, developed and implemented based on validated user requirements and known organisational factors, which in turn could contribute to improvement in the longer term success rates of future IT system development and implementation programmes in the NHS.

2. Methodology

This research is the second and main phase of a mixed-methods PhD study. It builds upon an initial survey questionnaire conducted in 2011, about the use of electronic patient records in an NHS cancer treatment centre. The overall approach to this phase of the study is interpretative phenomenography, using a technology acceptance model called FITT as the theoretical framework. FITT is a healthcare technology acceptance model concerned with the fit between individuals, technology and tasks (Ammenwerth, 2006).

The main reason for using phenomenography as the research methodology is to develop an in-depth understanding of what oncology clinicians think about the EPR systems that they use in their jobs roles and how well they support the clinical tasks they need to perform, in order to gain new insights into EPR technology adoption and use in a cancer treatment centre setting, viewing the issues from the perspective of the system users.

In phenomenography a fundamental distinction is made between two perspectives. From the first-order perspective we aim at describing various aspects of the world (in this research, oncology-focused EPR systems) and from the second-order perspective we aim at describing people's experience of various aspects of the world (in this research, oncologists' experiences of using EPR systems to perform clinical tasks).

"Phenomenography is focused on the ways of experiencing different phenomena, ways of seeing them, knowing about them and having skills related to them. The aim is, however, not to find the singular essence, but the variation and the architecture of this variation by different aspects that define the phenomena" (Walker, 1998, p26).

The outcome of the preliminary research and a comprehensive literature review were used to inform the development of the detailed research design and methodology that is described in the draft PhD thesis. To summarise this for the purposes of requesting ethics approval, the researcher plans to conduct a series of semi-structured interviews with oncology clinicians at the primary research site, the Clatterbridge Cancer Centre NHS Foundation Trust (the researchers employing organization and sponsor of the PhD project).

The interviews will be used to obtain in-depth information about what oncology clinicians think about the information systems that they use in their day-to-day work, the benefits they provide and the difficulties they create. It is anticipated that approximately 20 – 30 interviews will be required to reach data saturation. Initially it is only intended to interview Specialist Registrars and Consultant Oncologists, but if necessary the scope of the data collection will be expanded to include other healthcare professionals working in cancer treatment services, such as nurses, radiographers, pharmacists and physicians.

Participants will be interviewed using an interview guide comprising eight main questions. Relevant follow up questions will be asked during the interviews when appropriate and the final list of questions to be asked will be confirmed following three or four pilot interviews.

The data will be transcribed verbatim, proofread and loaded into a qualitative research software program (QSR NVIVO 10) to assist with phenomenographical analysis. This particular method of thematic analysis will involve several key stages including : familiarisation; compilation of answers; condensation, or reduction of the individual answers; preliminary grouping or classification of similar answers, preliminary comparison of categories; naming of categories; and finally, assigning a metaphor to each category of description.

The final outputs from the data analyses will explain the "outcome space" related to the adoption and use of EPR systems in cancer services, which will be reported in the final PhD thesis.

Please note that NHS Health Research Authority guidance has been reviewed and although this study is classed as research within the NHS, because it doesn't involve patients and is not a clinical trial, NHS Research Ethics Committee (REC) approval is not required for the study. For reference an output from the NHS HRA decision support tool, displaying the answers that were given to the questions about the study to determine whether or not NHS REC approval is required, is attached to this ethics application.

References :

Ammenwerth, E., Iller, C., and Mahler, C. (2006). IT- adoption and the interaction of task, technology and individuals: a fit framework and a case study. BMC Medical Informatics and Decision Making, 6:1–13

Walker, C. (1998). Learning to learn, phenomenography and children's learning. Educational and Child Psychology, 15, 25-33.

3. Personal Safety

Have you completed your departmental risk assessment procedures, if appropriate?

- not entered -

Raises personal safety issues?

No

- not entered -

Section D: About the participants

1. Potential Participants

The participants in this research will be oncology clinicians working at the primary study site, The Clatterbridge Cancer Centre NHS Foundation Trust, where the researcher works as Head of Information Management and Technology.

Initially data collection will be focused on medical staff who are employed at the treatment centre and routinely use the EPR systems at the study site to undertake their clinical work. The medical staff to be included will be either specialist registrar or consultant oncologists, specialising in either medical oncology or clinical (radiation) oncology. A current list of all medical staff and an associated email distribution list is maintained at the treatment centre and this will be validated against a report from the Human Resources (HR) IT system to ensure it is a complete and up-to-date list of potential participants.

There are approximately 60 oncologists at the study site and it is anticipated that approximately 20 to 30 of them will be interviewed for this research. Initially it is only intended to interview Specialist Registrars and Consultant Oncologists, but if necessary the scope of the data collection will be expanded to include other healthcare professionals working in cancer treatment services, such as nurses, radiographers, pharmacists and physicists. If the scope is increased beyond medical staff, other potential participants working in these different oncology professional job roles will be identified via a report from the centre's HR system. It is acknowledged that the inclusion of additional oncology clinical job roles will impact on the ethnographic aspect of the phenomenographical approach and if required the data analyses will consider whether other health professionals can be considered part of the same ethnographic group as medical staff and/or if they are different and used as a comparator group in the analyses.

It is anticipated that approximately 20 to 30 interviews will be conducted in total in order to achieve data saturation.

2. Recruiting Potential Participants

Following ethics approval a small selection of potential participants (three or four) will be approached via email, directly by the researcher, to request that they participate in a pilot interview. The pilot interviews will be used to test and then refine the interview questions as appropriate, to ensure that relevant data is being obtained. Follow up questions to the main interviews questions will also be validated or amended as appropriate.

Once the pilot stage has been completed a request to participate in the study will be sent to all potential participants via email. A covering letter on University headed paper will be issued from the researcher, with the accompanying participant information sheet and consent form. With a view to achieving a good response rate, the letter and associated documents will be emailed to potential participants from the Medical Director at the cancer centre, confirming his approval and support of the research study.

The senior manager conducting this study is doing so in his capacity as a PhD student at the University of Sheffield and not as a senior manager at the Trust. Potential participants in the study are senior medical staff working in a different Department of the hospital to the researcher, and the researcher has no direct management influence or control over the participants. To ensure that no-one feels under any undue pressure to take part in the study, for example, due to the researcher's role at the study site, it will be emphasised that participation is completely voluntary and potential respondents will not feel obliged to take part for any reason other than their personal and/or professional interest in helping to achieve the study's aims and objectives. This has been made clear in the information sheet.

2.1. Advertising methods

Will the study be advertised using the volunteer lists for staff or students maintained by CiCS? - *not entered* -
- *not entered* -

3. Consent

Will informed consent be obtained from the participants? (i.e. the proposed process) Yes

When potential participants respond to the invitation to attend an interview they will be emailed an electronic copy of the consent form for them to review in advance of the interview. Two paper copies of the consent form will be taken to each interview and the participant will be asked to read and sign them before the interview commences. Participants will retain one signed copy of the form and following the interview the other signed consent form will be scanned and stored securely in electronic format and the original paper version will be kept in project folder in a locked cabinet in the researchers office.

4. Payment

Will financial/in kind payments be offered to participants? No

5. Potential Harm to Participants

What is the potential for physical and/or psychological harm/distress to the participants?

There is no potential for any physical and/or psychological harm or distress to participants in this study and there are no other foreseeable risks or discomforts that may be associated with the interviews other than the possibility that some participants may feel uncomfortable voicing their opinions due to the researcher working as a senior manager in the organisation.

How will this be managed to ensure appropriate protection and well-being of the participants?

Participants will be reassured that the research is being conducted completely independently of the health informatics services provided to them within the cancer treatment centre or wider NHS and any participation or non-participation will not have any impact on the services they receive. It will be up to individual participants how much detail they wish to discuss and they will be free to discontinue involvement at any time by notifying the researcher.

Section E: About the data

1. Data Confidentiality Measures

All data will be treated in a way that protects the confidentiality and anonymity of the participants involved in the study. No patient identifiable information will be collected or used at any stage during the study and interviews will only be conducted with explicit consent from participants after they have reviewed an information sheet about the study. A basic demographic information sheet will be completed for each participant in the study to establish a profile of respondents necessary for data analyses e.g. duration working in job role, age etc., but this will not include name, date of birth or any other personal details.

If any named individuals are mentioned by respondents during the interviews the relevant data will be anonymised before being analysed and reported by the researcher.

Because there are very few cancer treatment centres, such as Clatterbridge in the UK, it is not possible to completely anonymise the Trust, and it would be disingenuous to pretend that this was happening. However, the researcher will ensure that the identity of participants cannot be revealed by anonymising any details within quotations that are used, and when reporting the staff group alongside direct quotations that this is suitably general to prevent anyone being recognised, e.g., "senior manager", "clinician". Thus, in no reports will it be possible to identify individual participants.

2. Data Storage

The researcher will take full responsibility for the control of, and will act as the custodian for, all of the data generated by this research study.

The interview data will be captured using an electronic audio recording device (an Apple Macbook Pro). To mitigate any risk of data loss a second device (iPhone) may also be used to record each interview as a backup in case of recording error, hardware problem or issues with battery power etc.. The electronic voice files will be transferred from the recording device(s) immediately after each interview and stored in a password protected folder on an encrypted hard drive. Once the files have been transferred to the primary storage location they will be permanently deleted from other devices and storage locations (i.e. the iPhone). The primary storage location for the voice files will be a Macbook Pro laptop owned by the sponsoring organisation (Clatterbridge Cancer Centre NHS Foundation Trust), allocated as a personal work laptop to the researcher. Apple's FileVault 2 encryption system is used for full disk encryption on the Macbook, protecting the data with XTS-AES 128 encryption. A backup of the data will be stored on a password protected and encrypted external hard drive.

Only the researcher will have access to the data generated by the project, unless a professional transcriber is employed to assist with transcribing the interview data into text documents. If a third party is used to undertake this work they will be professionally qualified with suitable references and will be required to sign a confidentiality agreement before being given temporary access to a secure location to access the audio files. They will not be permitted to retain any copies of the audio files or transcriptions and all data will be deleted upon completion of the PhD thesis.

The only other person who may have access to anonymised data during the course of this study is the PhD supervisor who may at times advise on matters relating to data analyses. The supervisor will only see anonymised data and will not store any copies of the data.

As the data will be stored on NHS equipment belonging to the sponsoring organisation, in addition to data protection legislation and University policies, the data will also be stored and managed in accordance with the requirements of the NHS Information Governance toolkit and any other relevant local NHS policies concerning the management and use of both the data and the equipment that is used to store and process it.

Section F: Supporting documentation

Information & Consent

Participant information sheets relevant to project?

Yes

[Document 004883 \(Version 1\)](#)

[All versions](#)

Consent forms relevant to project?

Yes

[Document 003919 \(Version 1\)](#)

[All versions](#)

Additional Documentation

[Document 003750 \(Version 1\)](#)

[All versions](#)

NHS REC approval not required

External Documentation

- not entered -

Section G: Declaration

Signed by:

Thomas Poulter

Date signed:

Tue 27 January 2015 at 23:22

Official notes

- not entered -



Downloaded: 26/11/2018
Approved: 28/01/2015

Thomas Poulter
Registration number: 90263871
Information School
Programme: INFR21 Information Studies

Dear Thomas

PROJECT TITLE: Factors influencing the adoption and use of **EPR** systems in cancer treatment services
APPLICATION: Reference Number 002195

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 28/01/2015 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 002195 (dated 27/01/2015).
- Participant information sheet 004883 version 1 (27/01/2015).
- Participant consent form 003919 version 1 (08/12/2014).

If during the course of the project you need to [deviate significantly from the above-approved documentation](#) please inform me since written approval will be required.

Yours sincerely

Matt Jones
Ethics Administrator
Music

Qualitative Interviews Preparation and Schedule

Background

Following on from phase 1 of this PhD study, which involved quantitative analyses of data obtained via a patient records survey questionnaire, some important factors that potentially influence EPR system acceptance were identified, such as accessibility, security and integration. The mixed methods approach has been designed so that these factors can be explored further in this second phase of the study, in which qualitative semi-structured interviews will be conducted in the context of the “FITT” theoretical framework (Ammenwerth, 2006) and an overarching phenomenographical approach to the data collection and analyses.

The design and methodology are explained in detail in the draft thesis chapter but are summarised here to assist with planning the pilot stage of phase 2 and to help with reviewing and finalising the interview schedule.

Approach

In addition to reviewing guidance on qualitative interviewing techniques (e.g. Marshall and Rossman, 1999; Mason 2002; Green and Thorogood, 2004; Berg, 2009), data collection methods used in similar previous studies were analysed and specific guidance on phenomenographical data collection issues considered.

Yates et al. (2012) refer to phenomenographical interviews as a specialised type of qualitative interview and list a number of shared features with other types of qualitative interviews. To distinguish phenomenographic interviews from other types of interview, the aim is to investigate the variation in the way that the interviewee experiences or perceives the phenomenon of interest (Yates et al., 2012). Consequently, the focus of the interview is on the relationship between the interviewee and the phenomenon of interest, rather than the phenomenon itself (Bruce, 1997).

In phenomenography interviews are semi-structured in nature and involve exploring the participant’s thoughts about the phenomenon in question at increasingly greater depths, but without being led by the interviewer (Trigwell, 2000).

According to Trigwell (2000), when participants are describing their experiences, they should be afforded time to reflect and the questions asked of them should not be influenced by presumptions about the respondents or the phenomenon being investigated, but should emerge as the interviewee explains their experiences in more detail.

The investigator’s interviewing skills should be continually evaluated during the study and adjusted when needed. For example, oratorical traits or body language that may prevent or reduce a respondent from providing a full description should be identified and then avoided in future interviews (Trigwell, 2000).

Developing the interview questions

In a similar format to the approach taken by Ammenwerth (2006), creator of the FITT technology acceptance model, the semi-structured interviews follow on from a survey questionnaire but the pre-planned questions will be deliberately high-level and open-ended, in accordance with the phenomenographical approach, allowing the participants to talk freely about the issues that they think about in relation to the overall topic of interest (i.e. their use of EPRs and other clinical information systems).

It should be noted that participants in phase 2 may or may not have completed the survey questionnaire in phase 1. With reference to the FITT model, the interview will be structured into three main areas as presented in the table below.

Topic	In this study	Purpose / Aim	Data to be collected
Individual	Oncologist	<p>To describe the characteristics of the sample.</p> <p>To find out whether different oncologists have different experiences and conceptions of EPRs and if any particular features they have as individual clinicians affect the fit between them and the technology they use and the tasks that they perform.</p> <p>To collect this basic demographic information so that you can describe the sample, e.g., age, gender, type of oncologist, years, etc., (will use a structured data collection template for this and use the same for everyone.)</p>	<p>Individual features :</p> <p>Could you tell me about your background and your medical training?</p> <p>Type of oncologist? (clinical/medical)</p> <p>Years of experience (?)</p> <p>Attitude towards technology?</p> <p>IT training (?)</p>
Technology	EPR systems	<p>To find out which clinical information systems are used by oncologists and what their views are of the systems – what are their strengths and weaknesses, how well do they support the work of the oncology clinician, what do they think are the barriers to adoption and acceptance of the systems?</p> <p>To understand what systems they are using in relation to the other questions. Need to collect this information to be able to add meaning to the responses to other questions.</p>	<p>Which clinical information systems are used in your work? (please include all systems used here at Clatterbridge but also the systems that you use at other hospital sites).</p>
Task	Clinical tasks related to oncology	<p>To investigate the range of clinical tasks that are performed by oncologists and to understand the extent to which respondents feel that they are helped or hindered by technology</p> <p>e.g. ordering blood tests, CT scans, ordering chemotherapy treatment and planning radiotherapy treatment etc.</p>	<p>Examples of specific work activities and tasks that you use the EPR systems for</p> <ul style="list-style-type: none"> - which tasks are best supported by the systems? - which tasks are not supported or not supported very well? <p>(probe at deeper level to obtain meaningful data)</p>

Pilot Sample

The draft invitation to participate in the study and information sheet was issued via email to all SpRs based at the study site and a small random selection of Consultant Oncologists, asking

if they would be willing to assist with the pilot study. Five interviews have been arranged for the pilot stage as follows :

SpR Oncologist 1 : 11am Thursday 5th February 2015
SpR Oncologist 2 : 1.30pm Thursday 5th February 2015
SpR Oncologist 3 : 10am Friday 5th February 2015
Consultant Oncologist 1 : 12pm Wednesday 11th February 2015
Consultant Oncologist 2 : tbc

Schedule

I. Opening

Interview Schedule for Oncology Clinicians

1. (Establish Rapport) [shake hands] My name is Tom Poulter and as you will have seen from the information sheet and invitation to the interview, I'm a part-time PhD student with the Health Informatics Research Group at the University of Sheffield and I'm conducting a research study about EPR systems in cancer treatment services. I'm really interested to find out about your experiences and your thoughts about EPR systems from a clinician's perspective.
2. (Purpose) I would like to ask you some questions about your background, your role as an oncologist, the experiences you have had using EPR information systems, and your thoughts about how well they support your clinical work. The questions I'm going to ask are grouped into three main sections that relate to a theoretical model I'm using in my research. I won't go into the details of this but to briefly explain it is technology acceptance model developed for use specifically in a clinical environment and it is used to help analyse the fit between individuals, technology and tasks – applied in this study this means the fit between individual oncology clinicians, EPR systems and the clinical tasks that you need to perform.
3. (Motivation) I plan to use this information to help identify the factors that influence the adoption and use of EPR systems in cancer services and ultimately, I hope that the outcomes of my research will help to improve the development of information systems that oncology clinicians use.
4. (Time Line) The interview should take about 30 minutes in total so we'll probably spend around 10 minutes on each of the 3 areas, but if you have more time available and there are more things to talk about, we can continue for longer.
5. (Consent and bio-sheet) Before I begin the interview, please could I ask you to sign the consent form and if you could also complete the basic information sheet, I would very much appreciate it. This is just some demographic information that I am collecting for all respondents to help with my analysis (gender, age, job title/role, number of years in role/at trust). I will then start the interview, which I will make an audio recording of, if that's OK with you, thank you.
6. (Clarification) One thing I just wanted to briefly clarify before we start is that in asking you about EPR systems I am using this term in a broad sense, in that it includes not just the main EPR system in use at Clatterbridge today but other clinical IT systems such as PACS, Evolve, ePrescribing, radiotherapy planning and treatment systems etc. and the electronic information systems that you use at other hospital sites too.

(Transition:[press record on iPhone and Macbook] OK, so let me begin by asking you some questions about your role as an oncology clinician)

II. Body

- A. (Topic) Individual : respondent's role as an oncology clinician

- Question 1. Could you just briefly tell me a little bit of background about yourself and explain why you decided to become an oncologist?
- Question 2. Please could you describe your job role to me and explain your professional and clinical responsibilities?
- Question 3. Could you describe the different clinical environments that you work in and talk me through a typical day in your job role?
- Question 4. What are your views and thoughts about information technology generally, in your life outside of work?

Potential follow-on questions :

- Did you receive any formal training in information management and using IT systems as part of your medical training or later when you were working?
- How would you describe your personal level of IT literacy?

(Transition to the next topic)

B. (Topic) Technology : EPR systems

- Question 5. Please could you describe the different information systems that you use in your clinical work and tell me what you think about them?
- Question 6. In what ways do you think that oncology has unique information system requirements compared to other clinical specialities, or do you feel that it is broadly similar? How is it special/different?
- Question 7. Do the EPR systems have any impact on your relationship and interaction with patients, if so, in what way?

Potential follow-on questions :

- In what ways do you think that medical/clinical oncologists have different experiences of using clinical IT systems, due to the different type of clinical work involved in radiotherapy and chemotherapy?
- How do you think the systems that you use could be improved?

(Transition to the next topic)

C. (Topic) Tasks : Clinical Tasks undertaken in Oncology

- Question 8. Please could you describe the range of tasks that you undertake in your clinical work and tell me about which of them are well supported by EPR systems and which aren't?
- Question 9. Can you think of any clinical tasks that are still manual or paper-based but would benefit from being undertaken as part of an electronic clinical workflow process?

Potential follow-on questions :

- Which tasks would you say are best supported by clinical IT systems? (Why?)
- Which tasks are most problematic when using EPR systems? (Why?)

(Transition: Well, it has been a pleasure finding out about your views on these issues. Let me briefly summarise the information that I have recorded during our interview).

III. Closing

A. (Maintain Rapport) Thank you very much, I really appreciate the time you have given me for this interview. Is there anything else you think would be helpful for me to know, in terms of your thoughts on the use of EPR systems in cancer services?

B. (Debrief) Before we finish, do you have any questions that you wanted to ask me? In terms of the next steps, the interview recording will be transcribed and then the transcription will be analysed along with those from other interviews. The final results may not be available for several months and I will let you know when the results are due to be published.

C. (Action to be taken) I should have all the information I need. Would it be ok to contact you if I have any more questions? Thanks again. I look forward sharing the final results of my research with you in due course.

[stop audio recording]

For the pilot, the researcher will then ask the participants questions about the interview experience. What worked well? Did they understand everything the researcher was trying to get at, was there anything that could be improved?

The researcher will then reflect on each interview and make notes.

Transcription and Analysis

Once each of the interviews has been completed the audio recording will be securely made available to a professional transcriber and the transcription returned for review and analysis.

Following discussions with the PhD supervisor, the interview schedule may be adjusted before the invitation to participate in the study is sent to the whole of the sample group.

Review of pilot interviews

The process of conducting phenomenographic interviews requires skill from the interviewer and the ongoing development and improvement of their interviewing. It is helpful, therefore, to evaluate the handling of the pilot stage interviews (Trigwell, 2000). In previous phenomenographical studies, analysis of interview techniques considered the different types of questions asked. They were categorised as follows:

- question asked from the prompt list;
- question asked as a follow-up to what the individual had said; and
- confirmatory response or expression of interest.

This highlighted any propensity to dictate the interview or to not follow through on the interviewees' responses sufficiently. Furthermore, Trigwell (2000) reported that some questions just did not 'work' in other studies. For example, certain questions might fail to generate a natural response from the oncology questions and their answers may seem forced or lacking commitment. These issues will be carefully considered when reviewing the recordings and transcripts of the pilot interviews.

Invitation to Participate in Qualitative Study



The
University
Of
Sheffield.

INFORMATION SCHOOL

F.A.O. SpRrs and Consultant Oncologists

The Clatterbridge Cancer Centre
NHS Foundation Trust

Health Informatics Research Group

Regent Court
211 Portobello Street
Sheffield
S1 4DP

xxth January 2015

Telephone: +44 (0) 114 222 2630

Fax: +44 (0) 114 278 0300

Email: dis@sheffield.ac.uk

Website: www.sheffield.ac.uk/is

Dear Colleague

Invitation to participate in PhD study about oncology EPR systems

We are writing to invite you to take part in a study being conducted by the University of Sheffield and Clatterbridge Cancer Centre NHS Foundation Trust, as part of a PhD project. You have been identified as a potential participant as you work as an oncology clinician using electronic patient records (EPRs) and clinical information systems within a cancer treatment centre.

The aim of the study is to gain an improved understanding of the factors that influence the adoption and use of EPR systems in cancer treatment services. Further details about the study can be found on the information sheet enclosed with this letter.

If you decide to participate in the study please e-mail Tom Poulter, PhD student at the University of Sheffield and Head of IM&T at Clatterbridge Cancer Centre, and he will contact you to discuss the study further and to arrange a date, time and location for a confidential interview.

Taking part is voluntary and whether or not you decide to take part in the study will not affect your work at the Trust in any way. If you have any questions about this study please contact Tom Poulter at thomas.poulter@clatterbridgecc.nhs.uk or on 07795 377917.

Mr Thomas Poulter
PhD student, University of Sheffield
Head of IM&T, Clatterbridge Cancer Centre

Professor Peter Bath
Professor of Health Informatics
University of Sheffield



Participant Information Sheet

Study Title

"Factors influencing the adoption and use of electronic patient record (EPR) systems in cancer treatment services".

What is the purpose of the study?

The overall aim of this study is to develop an improved understanding of the specific issues and requirements affecting the development, implementation and use of EPR systems within cancer treatment services. The over-arching question that this research asks and will endeavour to answer is:

"What are the factors that influence the adoption and use of EPR systems by clinicians in cancer services?"

There are 2 main objectives as follows :

1. Identify and explore the potential benefits of EPRs for clinicians and patients in cancer services
2. Establish the main facilitators and barriers to acceptance and adoption of EPR systems in cancer services, from a clinical end user's perspective

Why have I been chosen?

You have been invited to participate in the study as you have been identified as a healthcare professional working in cancer treatment services and your role involves using computerised information systems to access patient information and undertake clinical tasks.

Do I have to take part?

No, participation is completely voluntary. If you decide to participate your views will be very helpful in progressing the overall programme of research, but there is no obligation to take part and if you chose not to be involved this won't have any impact on you personally or your job role at the Trust. If you do decide to take part but change your mind you can withdraw from the study at any time before the final results are published.

What do I have to do?

If you agree to participate you will be contacted to agree a mutually convenient date, time and location to attend a 1:1 interview with the researcher.

After confirming your consent to participate and providing some basic demographic details you will be asked a series of questions about how you use EPRs and clinical information systems to undertake your work as an oncology clinician and what your views and experiences are relating to oncology information systems. Interviews are expected to last approximately 30 minutes in total.

Will taking part be confidential?

Yes, the interviews will be completely confidential. The interviews will be conducted in a private office or meeting room and only the researcher will be in attendance with individual

participants. All interview transcriptions will be anonymised and any information, views or opinions that you provide during the interview will be treated in strict confidence.

Will I be recorded, and how will the recorded media be used?

Yes, the interviews will be audio recorded. The audio data files will be stored securely at all times. The audio recordings of your comments made during this research will be transcribed into written text that will be used only for analysis and for illustration in conference papers and the findings reported in the PhD thesis. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings. The only people who will have access are the named researcher and a professional transcriber, who will be required to sign a confidentiality agreement.

What will happen to the results?

You will be sent a summary of the results of the analyses of the interview data when it is available. The results will form part of a PhD thesis, which will eventually be published and available in hardcopy format from the University library and as an electronic version from authorised providers of research publication databases. A summary of the results may also be presented at health informatics conferences and published in peer-reviewed journals.

Who is organising and funding the research?

This research is being conducted as part of a PhD project being undertaken by Tom Poulter, Head of Information Management and Technology at the Clatterbridge Cancer Centre NHS Foundation Trust. Tom is a part-time PhD student in the Health Informatics Research Group within the Information School at the University of Sheffield.

The project is funded by the Clatterbridge Cancer Centre NHS Foundation and is being supervised by Peter Bath, Professor of Health Informatics, Head of the Health Informatics Research Group at the University of Sheffield and Director of the Centre for Health Information Management Research (CHIMR).

Who has reviewed and approved the study?

The University of Sheffield Research Ethics Committee (UREC) has reviewed and approved this study.

As this study does not include any interaction with or direct impact on patients or involve the use of patient identifiable data, current policy and procedures as stipulated by the NHS Health Research Authority do not require ethics approval to be obtained from within the NHS for this type of study.

Who should I contact if I have any questions about the research study and/or interviews?

Any questions should be directed in the first instance to Tom Poulter either via e-mail or telephone : thomas.poulter@clatterbridgecc.nhs.uk or 07795 377917.

If you have any queries or concerns about the supervision or conduct of this research please contact Professor Peter Bath either via e-mail or telephone : p.a.bath@sheffield.ac.uk or 0114 222636.

Thank you for considering taking part in the study and for taking the time to read this information sheet.

Member Checking : Summary Report

1. Group of people interviewed

A total of 36 oncologists were interviewed during the main phase of data collection, with the duration of the interviews ranging from 25 to 70 minutes (mean = 42 minutes). The overall response rate from the group of eligible participants in the qualitative study was exactly 50%.

2. Individual Dimension

- The main reasons why doctors chose to specialise in this particular field of medicine were the research-focused nature of clinical work in oncology, the continuity of care and on-going relationship with patients and being part of a multi-disciplinary team (MDT).
- A range of professional and clinical responsibilities were described including delivering chemotherapy treatment; clinical trials; seeing new patients; radiotherapy planning; participating in MDT meetings; providing acute oncology services; clinical education for junior doctors; and management (i.e. non-clinical) tasks.
- Within the CCC site the following clinical environments were mentioned: the outpatients department; the chemotherapy day case unit; inpatient wards; and radiotherapy treatment sets. The clinical environments at other hospital sites included outpatient departments, inpatient wards and chemotherapy treatment clinics.
- The most common format of a typical week for the oncologists interviewed was for around two or three full days to be spent on clinical work, with an MDT meeting for the relevant disease group taking place at the start of the day, followed by a busy outpatient clinic seeing new patients and reviewing follow up patients.
- Several respondents specifically mentioned iPhones and iPads as the main type of technology that they use outside of the workplace and one third stated that information technology (IT) was either “vital”, “critical”, “essential” or that it was “impossible to live without”. The majority of participants made statements to the effect that IT was an essential part of their lives, indicating an acceptance that technology will be used increasingly in the workplace and in their job roles as oncologists.
- Commenting on their own level of IT literacy a third of doctors said they felt it was “average”, “intermediate” or “adequate”. Only one participant said that they felt they had a low level of IT literacy.

3. Technology Dimension

- Several different systems were discussed including the Maxims core EPR, Ascribe ePrescribing, Evolve, and Carestream PACS. A small number of oncologists were satisfied with the current EPR systems used at the trust and felt that they were fit for purpose, but the majority felt there were various problems and concerns that prevented the systems from fully supporting their clinical work activities. Key themes to emerge were: accessibility and remote access; software functionality; interoperability and integration with other hospital systems; usability; and availability and completeness of clinical information in EPRs.
- The ideal oncology solution was described by participants as being a highly intuitive application similar to how “Apps” work on an iPad, with easy access, good usability and workflow support. Accessibility should be quick and easy, without compromising security, and the system would recognize the user logging in and instantly provide information about clinics and patients due to be seen. Several oncologists described various task (“to do”) lists, indicating a requirement for the system to provide prescriptive workflow support, enabling them to work more efficiently. When using the EPR system in patient context, the patients record should be presented in a “flow sheet” format with all relevant clinical information displayed in one place. The ideal system would automatically collate relevant clinical history and allow patient records to be flagged for discussion at MDTs. SACT prescribing functionality would include intuitive multi-cycle capability, allowing a full course of treatment to be prescribed and easily amended if required. The system would also include a messaging function so that messages about individual patients can be exchanged between clinicians and recorded directly into the patient’s record. Another feature that would be included in the ideal oncology EPR system is alerts. An example of this was provided where if a patient is on medication that is contra-indicated when radiotherapy is being given it would automatically flag this up to the clinician when they enter the patient’s details into the system. Many oncologists used the phrase “one system” and explained the need for improved system integration. In addition to improved interoperability and information sharing

with EPR systems used at other hospitals one doctor explained that ideally the EPR systems at Clatterbridge would also be seamlessly integrated so users wouldn't have to come out of the core EPR system to access to PACS, e-prescribing or EDMS. Another oncologist was very specific in stating that it should take no longer than 15 seconds to locate and view any clinical information about the patient. Several interviewees suggested that a regional laboratory ordering and results system would be highly beneficial for oncology services. This was described as being the pathology labs equivalent of the global worklist solution that is used for regional sharing of diagnostic images and radiology reports in Merseyside and Cheshire.

- Due to the nature of medical oncology work in cancer services electronic prescribing was specifically discussed and participants described functional requirements including: multi-cycle prescribing; integration with appointment scheduling; dose-banding; integration with laboratory systems; and advanced clinical decision support. With regards to clinical safety, interviewees were asked whether they thought electronic prescribing is safer than paper-based systems. There were mixed responses to this question and whilst many oncologists recognized the potential safety improvements offered by electronic systems several of them pointed out that there is still potential for human-error and if a fault occurs or a mistake is made in an electronic prescribing system this could potentially have an adverse impact on many patients, whereas prescribing errors in a paper-based system would usually only ever affect one individual patient. Overall there seemed to be a consensus that electronic prescribing should be safer but that currently available software applications are not as advanced as they could be in terms of usability, functionality and clinical decision support.
- When asked about their views on providing patients with access to their own medical records most of the oncologists interviewed were of the opinion that the patient's record belongs to them and that they would be happy for them to have direct access to it. However, some oncologists raised concerns about the potential for misinterpretation of information that could cause distress to patients and their families and suggested that some form of mediated access to medical records might be needed, whereby clinicians screen information first before it is approved for addition to the patient-facing version of the medical record. Some oncologists were also concerned that if the information made directly available to patients wasn't controlled it could generate a lot of queries and additional workload for clinical teams to deal with.

4. Tasks Dimension

- Participants reported a number of tasks that are well supported by clinical IT systems that aren't part of the core EPR, including radiotherapy planning, PACS image sharing and digital dictation.
- When asked which clinical tasks were most problematic the interviewees referred to ordering laboratory tests as a difficult issue, as the existing EPR functionality was inefficient to use, requiring too many clicks. Laboratory tests ordered at peripheral clinics were also problematic due to delays in getting the paper-based results sent out and scanned into the oncology EPR system. Some oncologists referred to the process of scanning other paper-based information into the Evolve system as a particular problem due to the time lag.
- Other problematic tasks were electronic prescribing, in relation to the time impact (the process takes longer than paper-based prescribing) and the lack of multi-cycle functionality and integration with appointments scheduling (as discussed in the technology dimension); and clinical noting, for which the current systems don't provide adequate, easy to use features.
- When asked what they thought the main purpose of EPR systems are in oncology, many doctors interviewed referred to "safety", with statements such as "EPR is a clinical record that allows for safe and effective clinical practice". Some interviewees thought that the main purpose was to prevent the loss of medical records and others referred to information security, efficiency and information sharing.

5. Oncology EPR Outcome Space

The results of phenomenographical analyses are presented as "categories of description" and an "outcome space". Analyses of the interview transcripts identified that there are three main categories of description that explain how oncologists think differently about and experience using EPR systems, as explained in the table below.

Category No. / Name	Category of Description	Explanation
C1. EPR = activity log	EPR systems are seen as a simple legal record of a patient's care and treatment.	Oncologists who think about EPR systems as a simple collection of records that are primarily required for logging information for legal/record-keeping purposes. Their experience of using the EPR systems is not seen as central to their role as a clinician and maintaining patient records is incidental, with little perceived benefit or added value derived from the records. When thinking of the benefits of EPR systems they tend to think in terms of preventing data loss and saving paper.
C2. EPR = communication aid	EPR systems are seen as a means of providing information to aid memory and communication.	In this category oncologists also think of the EPR systems and patient records as being a log of what has happened to the patient, in terms of their diagnosis, treatment and clinical indications, but they think that the purpose of recording this information is not just for legal record keeping, but it is of benefit to the patient's care as it assists clinical teams with communication and sharing information.
C3. EPR = decision support tool	EPR systems are seen as advanced tools for clinical workflow, decision support and interoperability.	Oncologists who think about EPR systems in this category see the systems as being the central focus and an integral part of their clinical work in cancer services, viewing the system as an essential tool to aid their communication, decision making and clinical workflows.

NVivo Coding Structure Example

The screenshot displays the NVivo software interface for a project named 'Toms PhD Project (NVivo 11)'. The interface is divided into several sections:

- Top Menu:** File, Edit, Create, Data, Analyze, Query, Explore, Layout, View, Window, Help.
- Toolbars:** Home, Create, Data, Analyze, Query, Explore, Layout, View. Includes icons for Open, Get Info, Edit, Paste, Copy, Merge, Format, Paragraph, Styles, Select, Find, Insert, and Delete.
- Left Panel (Navigation):**
 - SOURCES:** Internals (Audio Files, Interview Transcripts), Externals, Memos.
 - NODES:** Nodes (Categories of Description (themes): EPR as a communication tool, EPR as an activity log, EPR as an advanced CDS tool; Interview questions; Participant Case Nodes; Themes; Cases; Node Matrices).
 - CLASSIFICATIONS, COLLECTIONS, QUERIES, MAPS:** (Collapsed)
- Table (Sources):**

Name	Sources	Referen...	Created On	Created...	Modified On
● Avoiding use of EPR - workarounds	2	5	11 Dec 2017 at 17:01	TWP	12 Dec 2017 at 09:41
● Avoiding using EPR when seeing patients	1	1	11 Dec 2017 at 21:28	TWP	11 Dec 2017 at 21:28
● Centralised information	4	4	10 Mar 2018 at 11:49	TWP	10 Mar 2018 at 12:12
● Don't like computers	1	1	10 Mar 2018 at 11:39	TWP	10 Mar 2018 at 11:39
● Don't trust computer information	2	2	11 Dec 2017 at 15:22	TWP	10 Mar 2018 at 12:22
- Node View (Avoiding use of EPR - workarounds):**
 - Summary:** 4 references coded, 3.58% coverage
 - Reference 1: 1.31% coverage**
eah, so that would be—if you have thirty patients—half an hour. So what I have done to avoid having to do this is I decide with summary boxes. I update them regularly, and the last letter is in the clinic notes so I know everything I need to know for the vast majority of patients without actually accessing the electronic system, and so I just read last letter and then if need be, I access whatever other information I need to deal with the care
 - Reference 2: 0.64% coverage**
I do. I happen to have a very good memory and that beats any computer but at the speed, is certainly a bit quicker than they are. So staff say to me, ooh it's unsafe, and I think it's presumably safer than anything else.
 - Reference 3: 0.75% coverage**
Well, my memory would make errors but it's presumably safer than anything else. It certainly gets me through my day. So I use my skill, if you so like, which equals IQ and memory; memory and my brain for the kind of tedious bits which have been invented.
 - Reference 4: 0.88% coverage**
Well I try not it to have any impact so that's why I minimise my interaction with the electronic system when I see patients, because my brain needs to be on the job rather than on some sort of process on my computer and that's why—you know, it's like any human being, you can do one thing normally well.