Implementation of Healthcare IT Solutions: What are some common difficulties and some possible solutions?

Gary Corcoran

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

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Gary Corcoran

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Abstract

In this paper, common difficulties that occur during the implementation of healthcare IT solutions have been evaluated. Healthcare IT solutions such as EHR (Electronic Health Record) or EMR (Electronic Medical Record) are becoming a factor for many healthcare providers. There are government supported funding initiatives being provided on a large scale in the US (HITECH) to support the implementation and development of this technology.

Healthcare IT solutions are available on the Irish market and are available to healthcare providers across the globe. Healthcare IT solutions provide support to administrative and clinical staff within healthcare provider organisations. This research has evaluated some potential difficulties that may be experienced during the implementation phase. This phase will consist of initial installation, initial setup and training/go live period. This research will discuss this phase and where the problem fits in to the software development life cycle(Rouse, 2016).

This dissertation has reflected on the healthcare IT solutions currently available based on a search of the literature. The literature was reviewed and a list of common difficulties has been established. The questionnaire was then developed based on the common difficulties established in the literature, this was then distributed and feedback on the difficulties and solutions established was gathered.

The research methods were evaluated and the top five common difficulties based on the literature was used to review possible solution for the selected top five common difficulties. Both literature review findings and questionnaire feedback was used in this section of the discussion.

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Abbreviations

ACT	Advancing Care Together
EDIS	Emergency Department Information System
EHR	Electronic Health Record
EMR	Electronic Medical Record
GDPR	General Data Protection Regulation
HIS	Health Information System
HITECH	The Health Information Technology for Economic and Clinical Health Act
HL7	Health Link 7
IS	Information System
ISO	International Organization for Standardisation
IT	Information Technology
PC	Personal Computer
PDF	Portable Document Format
ROI	Return on Investment
SAAS	Software as a Service
SAS	Statistical Analysis System

Glossary

Anti-Malware	Security measure to prevent and remove malware.
Anti-Virus	Security measure to prevent and remove viruses.
Cloud	Shared web-based computing resource.
Common Difficulties	Issues or barriers identified in several instances that prevent or slow the progress or a project.
Domiciliary Care	Supporting people in their homes who require additional assistance.
Encryption	Way of converting data so that it cannot be accessed by an unauthorised person.
Firewall	Security measure to control access to the IT network.
Health IT	Technology used to support providing health care.
Individuals	Person or persons receiving care.
Patient	Person or persons receiving care.
Physicians	Medical Professional.
Primary Care	Care provided to an individual outside of hospital setting.
Role Base	Access levels for users.
System Implementer	Person(s) or organisation implementing an IT Solution
User	Person or persons interacting with an IT Solution.

Chapter 1 Introduction

1.1 Introduction

In this chapter an introduction to the background of the researcher is presented. The research question is introduced and examined to establish what work will be carried out. Following on, the goals and objectives are discussed to show the direction of the research and how it is aimed to answer the research question. This chapter will form the basis of the background of the research and identify the direction of the research.

1.2 Researcher Background

The background to this research is related to the researcher's role as a Technical Solutions Specialist with Valentia Technologies Ltd. This role involves, among several project management duties, supporting users of domiciliary and other healthcare IT solutions during all stages of the project, including support for users during the implementation phase of the development life cycle.

Within this role, it is possible to establish a one-sided view of system implementation, but by developing the research based on literature and participant feedback via questionnaire it is aimed to develop a rounded picture of this research topic.

1.3 Researcher Domain

Following on from the researcher background, this section will look to give a description to the area of work the researcher is in and to establish personal motivation for the research.

The researcher is employed as a Solutions Specialist; this role involves supporting clients and some project management duties. In supporting clients in multiple disciplines, for example some clients are domiciliary care providers, ambulatory service providers and primary care providers. Each discipline requires a system that can support their needs and at the same time be interoperable with other systems and allow for easy communication with other providers in the same or other disciplines.

Each client will have their own set of requirements and difficulties based on the type of service they provide. The researchers' role is to align the system available to the client requirements and reduce or eliminate any difficulties for the user. This is made possible by understanding the

systems and their capabilities in detail along with investing time in getting to know the users and their organisation to support the users as much as possible.

The systems available range from off the shelf packages to bespoke systems specifically designed for some organisations. With each system, the users will need to implement and learn the system, the researcher will support the users through this and offer continued support after implementation. Similar to the way the case study in Appendix 1 looks to monitor the implementation and continuously track the progress after implementation, the researcher will monitor the system rollout and resolve issues as they arise.

1.4 Research Question and Study Aims

The research question is constructed to identify difficulties and solutions in the complex area of system implementation. The research question is as follows;

Implementation of Healthcare IT Solutions:

What are some common difficulties and some possible solutions?

1.4.1 Goals of this research

The researcher's goal is to establish a set of possible solutions to common difficulties during the implementation phase. The possible solutions can then provide support and allow organisations or system users, during the implementation phase, to make informed decisions based on other user experience and literature.

To establish the main goal, the researcher will marry the objective with minor goals, set out in Table 1, that have been used as part of the ongoing project plan. This process was implemented to ensure the research is structured and can be managed with a set of objectives that have been applied to support the minor goals to construct the complete dissertation.

1.4.2 Objective vs Goal Matrix

In this section the plan for the research is outlined, the plan is structured based on seven key questions derived from the research question. The questions are set out to constructively develop the research question in an informed manner, see the matrix of this in Table 1.

Each question was then married to an objective to advise on what the purpose of asking the question is and a goal to establish how it will be known that the question is complete, this is available in the matrix in Table 1.

Table 1 Objective vs Goal

	Question	**Objective**	**Goal**
1	What is a healthcare IT solution?	Establish definition of Healthcare IT solution	Define healthcare IT solutions
2	What are the phases of such an IT solution?	Research IT Solution development phases	Establish what are 'Implementation' phases
3	What is the term 'Common Difficulty'?	Establish what the term means	Establish understanding of the term
4	Are there any existing case studies of similar system implementation?	Review case studies	Outline some examples of current implementation
5	What are some common difficulties noted in the literature and recommended solutions?	Complete literature review	From literature establish examples of common difficulties and where possible solutions to these where possible
6	What are the questionnaire participant's experience and possible solutions to some common difficulties?	Complete questionnaire	From questionnaire discuss common difficulties and where possible solutions to these where possible
7	Implementation of Healthcare IT Solution: What are some common difficulties and some possible solutions?	Establish common difficulties and some solutions	Based on common difficulties established, evaluate some possible solutions

1.4.3 The Implementation Phase

The implementation phase follows on the design and development of the initial system. Following the system design, testing and user acceptance it can then be made available to the users. In this stage the initial demonstrations of system configurations can be done followed by training and integration (Hussung, 2016, Alwan, 2009, Rouse, 2016).

1.5 Motivation for the Research

The research will focus on the implementation phase of healthcare IT solutions; this is the phase following initial design and development. The phase encompasses initial training; system roll out, initial follow up and system reconfiguration where required(Alwan, 2009, iden and Eikebrokk, 2013).

In this research, the problem is highlighted from the perspective of the organisation(person(s) or healthcare service provider that will become the end user of the system) and the vendor (person(s) or company that is providing the system or service). From the literature, current knowledge is not widely understood or documented in detail in relation to system implementation from a healthcare IT perspective (Melin and Axelsson, 2014) and the common difficulties are not as openly defined as success stories to allow for further improvements for such implementations.

The problem in this research is that a clear understanding of difficulties in this arena are not researched or documented as a detailed stand-alone entity. Difficulties are often mentioned but not evaluated as openly as the benefits.

1.6 Overview of the Research

The research carried out aims to establish the common difficulties within the literature. To do this, research terminology has been established to generate a list of common difficulties which has been collated and sorted. It is aimed that by reviewing the literature, the common difficulties can be established and then ranked based on the frequency the difficulties appear in the literature.

Building on the list established in the literature, the questionnaire was developed based on the most frequent difficulties found in the literature. The feedback provided in the questionnaire was used to develop possible solutions with the aid of further literature searches.

1.7 Overview of the Dissertation

The dissertation will be built on the results found in the research. This list will outline what is believed to be the most common issues system implementers may encounter while implementing a healthcare IT Solution.

Chapter 1 introduction, this chapter of the dissertation will introduce the topic and establish the background of the research.

Chapter 2 methodology, this chapter of the dissertation discusses the purpose and research strategy deployed. This chapter also outlines the search terms deployed and rational for using the selected search strategy. Also, the description of the problem is discussed in this chapter.

Chapter 3 literature review, this chapter of the dissertation discusses the items established in the literature relevant to the research. In this chapter the common difficulties established are discussed.

Chapter 4 questionnaire design and results, this chapter of the dissertation introduces the questionnaire and outlines how the questionnaire was generated and distributed. Furthermore, the results from the questionnaire are discussed.

Chapter 5 discussion, this chapter of the dissertation evaluates the research and discusses the solutions identified to the top five most common difficulties.

Chapter 6 conclusion and future work, this chapter of the dissertation concludes the research and identifies strengths and weaknesses of the research.

Chapter 7 references, this chapter contains all references linked in the dissertation.

Chapter 8 appendices, this chapter contains all the appendices mentioned in the dissertation.

1.8 Conclusion of Introduction

In this section, the research question has been established and a constructive set of goals and objectives have been established to direct the research. It is also understood the direction of the research was developed from the researcher's background as a Technical Solutions Specialist, to give an insight into the development of the research idea. This chapter has also discussed that the literature has been reviewed to establish the common difficulties and a questionnaire was deployed based on the difficulties established in the literature. The purpose of developing and distributing the questionnaire was to identify some possible solutions to these difficulties.

Furthermore, the use of project planning tools such as a Gannt chart (see project Gannt chart in Appendix 23) was used to constructively plan and monitor the dissertation. The use of Google Drive (See Google Drive backup in Appendix 24) was used to ensure all data was backed up and to save the participant feedback in a secure, password protected location.

Chapter 2 Methodology

2.1 Introduction to Methodologies

The focus of this research is to establish how the implementation phase of healthcare IT solutions is done and to establish the difficulties experienced during this phase. In this chapter, building from the goals and objectives from chapter one, the research terminology and system terminology discovered and deployed while researching is discussed. The initial constructs of the literature searches will be discussed and important ideas in the searches such as 'Healthcare IT solutions' and 'Common Difficulties' definition will be presented.

Following the establishment of the understanding of healthcare IT solutions, the literature was reviewed. This was to establish within the literature, what is believed to be some common difficulties that are highlighted during the implementation stage of healthcare IT solutions. In doing so it was believed that this information can be used as a basis to establish some possible solutions to these difficulties. A case study (See Appendix 1) was identified that identified some of the difficulties experienced and discussed some possible solutions for system implementers during the implementation phase.

The results from the literature research was used as a basis to construct the questionnaire. The questionnaire was structured to establish from system implementers and systems users what are some common difficulties experienced and possible solutions during the implementation phase.

The research will develop in a quantitative and qualitative format. The quantitative part of this research uses results from the literature to establish the common difficulties and then uses Microsoft Excel to list and rank the common difficulties. The qualitative part of this research will be based on the discussion from the literature results, feedback from questionnaire participants and discussion of possible solutions.

2.2 Research Background and Purpose

The background to this research is an understanding of healthcare IT solutions and the identification that the literature is mainly positive result focused. The research carried out has provided information of healthcare IT solution implementers and the difficulties that have

experienced during implementation of various types of healthcare IT solutions. The purpose of the research is to support further research in this area and to develop, based on some of the common difficulties established in the literature, some possible solutions to support implementers at a crucial and challenging stage of the system life cycle.

The research carried out will support system implementers or system users of healthcare IT solutions. The research will support system implementers and system users to have a better understanding of the areas that may need additional attention or support when implementing a system and allow for further research in this topic.

2.3 Research Strategy

This section outlines the multiple searches carried out to identify literature and other sources of information in relation to the research.

2.3.1 Research Strategy – Identifying Where the Problem Fits In

An initial search was carried out to identify the system life cycle and phases of the cycle to identify where the problem fits in (See search terms applied to identify where the problem fits in in Table 2 below). The process of identifying the search terms, followed by searching using multiple search tools was used. Following this the researcher reviewed the content and if relevant to the research it was included as a reference.

Table 2 Problem Fits in Search Terms

Search Term
System Life Cycle
System Phases
System Implementation

2.3.2 Research Strategy – Identifying Difficulties

The search terms (See search terms applied to identify difficulties in Table 3 below) were applied to multiple searching tools to identify relevant literature. This literature was reviewed based on the abstract and where relevant to the research, it was printed and reviewed. During the review stage, research results were reviewed by manually highlighting terms or themes that identified as difficulties or barriers to the implementation of healthcare IT solutions.

The terms identified were noted and listed using Microsoft Excel (See example literature notes in Appendix 2 and web source notes in Appendix 3). This allowed for cataloguing of the research papers and to combine notes from internet and other sources to create a combined list of notes on the items evaluated.

The catalogued items were then coded (See example coded notes in Appendix 4) manually by the researcher by highlighting the key term or themes and noting this against each item. The coded term remained generic so that it could be applied to other similar items in the research. This supported generating the final list of coded terms identified, following the coded terms being identified a pivot table (See count of coded notes using pivot table in Appendix 5) was created to outline a list of the common terms (common terms meaning the difficulties established in the literature). Then the coded terms were ranked based on their frequency of appearing in the literature, this list can then illustrate the common difficulties established in literature.

Below is the list of research terms (See Table 3 Search Terms) used during research. The terminology has been compiled from peer review journal articles, some web resources and other noted sources.

Table 3 Difficulties Search Terms

Search Term
Common Difficulties Health IT
Domiciliary Health IT
Barriers Health IT
EHR Implementation
EHR Barriers
EHR Difficulties
EMR Implementation
EMR Barriers
EMR Difficulties
EDIS Implementation
EDIS Barriers
EDIS Difficulties
HIS Implementation
HIS Barriers
HIS Difficulties
IS Implementation
IS Barriers
IS Difficulties
Recommended Resources
Barriers Health IT

2.3.3 Research Strategy – Identifying Solutions

Once the terms relating to difficulties were found, the most common of them formed the basis of the third search to review some possible solutions in the literature (See search terms applied to identify some possible solutions in Table 4). The terms selected were based on initial ranking of some of the common difficulties established in the literature, some of the top difficulties were identified to search for solutions to the top five difficulties. A similar process took place of identifying items in the literature and then reviewing the abstract before including as a reference.

Table 4 Solutions Search Terms

Search Term
Cost
Ease of Use
Interoperability
Planning
Security
Infrastructure
Change
Human Resources

2.4 Important Terms and Similar Research Terminology

What is meant by healthcare IT solutions in the context of this research is a technological solution deployed in supporting or proving healthcare services, in any healthcare discipline such as domiciliary care.

What is meant by common difficulties in the context of this research is any issue or obstacle that can arise during the implementation phase of a healthcare IT solution. The issues identified can be from variety of sources, they could be from people centric problems to IT technical issues.

It is understood that to conduct a literature review other terminologies must also be searched to give a rounded picture of the issue. During literature review other terms such as 'barrier' in relation to the difficulties faced were identified. Also, terms such as 'deployment' or 'adoption' in relation to the implementation phase itself were established as alternative terms.

2.5 System Terminology

Please see below the types of systems (See table 5 System Terminology) that were searched during research, each system abbreviation is defined and a description on each system is provided.

During research, several system types have been established to be related to or an alternative for healthcare IT solutions. Each system has been included in the relevant literature search to identify difficulties or barriers that may also be relevant to this research.

Table 5 System Terminology

Abbreviation	System Description
EHR	Electronic Health Record
EMR	Electronic Medical Record
EDIS	Emergency Department Information System
HIS	Health Information System
IS	Information System

2.6 Rational of Using Research Method

This research method was deployed to cross search based on terms established during initial searches and allow the additional terms to be included based on further research. Applying this method ensured that with continued researching it would be possible to generate results for difficulties in healthcare IT and to establish further research terms. Thus, allowing for more search terms to be included for future research.

2.7 Conclusion

In conclusion of this chapter the background and purpose of this research has been established to develop the common difficulties during the implementation of a healthcare IT Solution. In this chapter the problem has been identified and a research strategy has been outlined on how the research was carried out and how it was possible to complete the research.

At this point, it has been discussed that building on from the difficulties established some possible solutions to these difficulties has been identified to be further discussed in later chapters. Also, the idea of healthcare IT solutions and common difficulties was reviewed and an understanding of how it is applied within this research has been established.

Healthcare IT solutions in relation to this research includes technological solutions for providing healthcare and common difficulties in context of this is the difficulties experienced while implementing the healthcare IT solution.

Furthermore, the research terms and relevant system terms have been outlined. At this point the rational for using this research method was clarified to ensure that the common difficulties could be established. Furthermore, to allow for further searches to be created on an ongoing basis for future research.

Chapter 3 Literature Review

3.1 Introduction to Literature Review

In this chapter the literature was reviewed to establish where the problem fits in and to review the system life cycle. Following on from this how each of the searches deployed to gather information from the literature is discussed. Furthermore, the results from the literature search to establish the common difficulties is discussed in this chapter.

3.2 Literature Review

3.2.1 Literature Review - System Life Cycle and Where the Problem Fits In

The system life cycle consists of several phases. These stages allow for tracking and monitoring of the project and how far it is progressed (Iden and Eikebrokk, 2013). In this research the focus is only on the implementation phase; point four in Figure 1 below(Hussung, 2016).

It is during the implementation phase this research is focused, as difficulties experienced at this phase can prevent successful roll out stopping or delaying the project in this phase. See below diagram of system life cycle in Figure 1 and the description of the stages in Table 6.

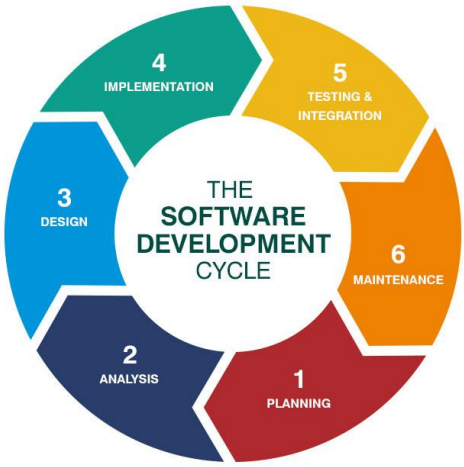


Figure 1 The Software Development Life Cycle (Hussung, 2016)

Table 6 Software Life Cycle (Hussung, 2016, Alwan, 2009, Rouse, 2016)

Stage	Description
1.Assess Needs	Before the system is implemented the needs of the system must be evaluated to determine what the system must do and be capable of.
2. Design Specification	Before development can begin the system must be designed based on the needs set out.
3. Design / Develop / Test Software	The system can then begin development. Once development is completed and the system is ready it can be tested and verified.
4. Implement Systems	Once the system is developed and signed off it can be put in place for users. At this stage the system may experience minor changes and users can be supported and provided training. During this phase initial roll out will take place. This could be in staged roll outs or a 'big bang' approach. Here the system implementers must support the users and ensure the system smoothly rolls out and to continue to support the users so that the system meets the needs requested and specified.
5. Support Operations	Once the system has been implemented and stabilised, users may want continued support.
6. Evaluate Performance	Once the system is in place for some time both the provider and user can evaluate the system performance and evaluate if it is meeting the requirements set out at the beginning or have new requirements been identified after implementing the system.

The implementation phase follows on the design and development of the initial system. Following the system design, testing and user acceptance it can then be made available to the users. In this stage the initial demonstrations of system configurations can be done followed by training and integration (Hussung, 2016, Alwan, 2009, Rouse, 2016).

Each step is important to ensure a smooth roll out, by completing each step, this will then support better user acceptance when the system is provided(Hussung, 2016). Depending on the system, basic configuration will be carried out and if requested detailed individualised configuration may also be completed. This is to allow the system to align with the business needs and further support the end users (Hussung, 2016).

Training may also be carried out to demonstrate and coach users in the system features and functionalities. This will allow users to have a confident start to the system, ensure that the tasks they require the system to do, are met, and to reduce the workload when going live (Hussung, 2016, Alwan, 2009, Rouse, 2016).

The system integration will also need to take place when the system is installed and prepared for go-live to make the system available to users (Alwan, 2009, Hussung, 2016, Rouse, 2016). Once the system is ready, go-live can happen, where the users are given access to the system and will now use the live system as part of their normal everyday work(Alwan, 2009, Hussung, 2016, Rouse, 2016).

The research has focused on the implementation phase as it is relevant to the researcher's background and allows for future research.

3.2.2 Literature Review – Off the Shelf Healthcare IT Solutions

It has been established that technologies implemented are not a one size fits all (Lindzon, 2015). It can also be understood that systems can also be standardised to be able to share information between applications, making the systems functions be interoperable (ec.europa.eu, 2017). Systems can be designed as a standard package to allow users to purchase a standard system, an example of this is a SAAS package (Software as a Service) (hitinfrastructure, 2017). An example of IT solutions that is developed and an off the shelf product is Microsoft Word.

Technologies such as health link (Project, 2017) or technological standards such as HL7 (Rouse, 2015) can be used to support this interoperability. This can support open data (ehealthireland, 2017)for healthcare IT systems share important data about the individual, if required, to other systems in use by the individuals doctor, community nurse or hospital.

3.2.3 Literature Review – Bespoke Healthcare IT Solutions

Healthcare IT systems can be designed to support the individual user or organisation in various settings while receiving care such as hospital, ambulatory or with their general practitioner care. An example of this is domiciliary health IT systems are designed to support an individual to live independently and ensure they receive adequate care. The system can be designed to capture specific relevant data to the organisation or have customised workflows built in.

3.2.4 Literature Review - Recording of failures is sparse

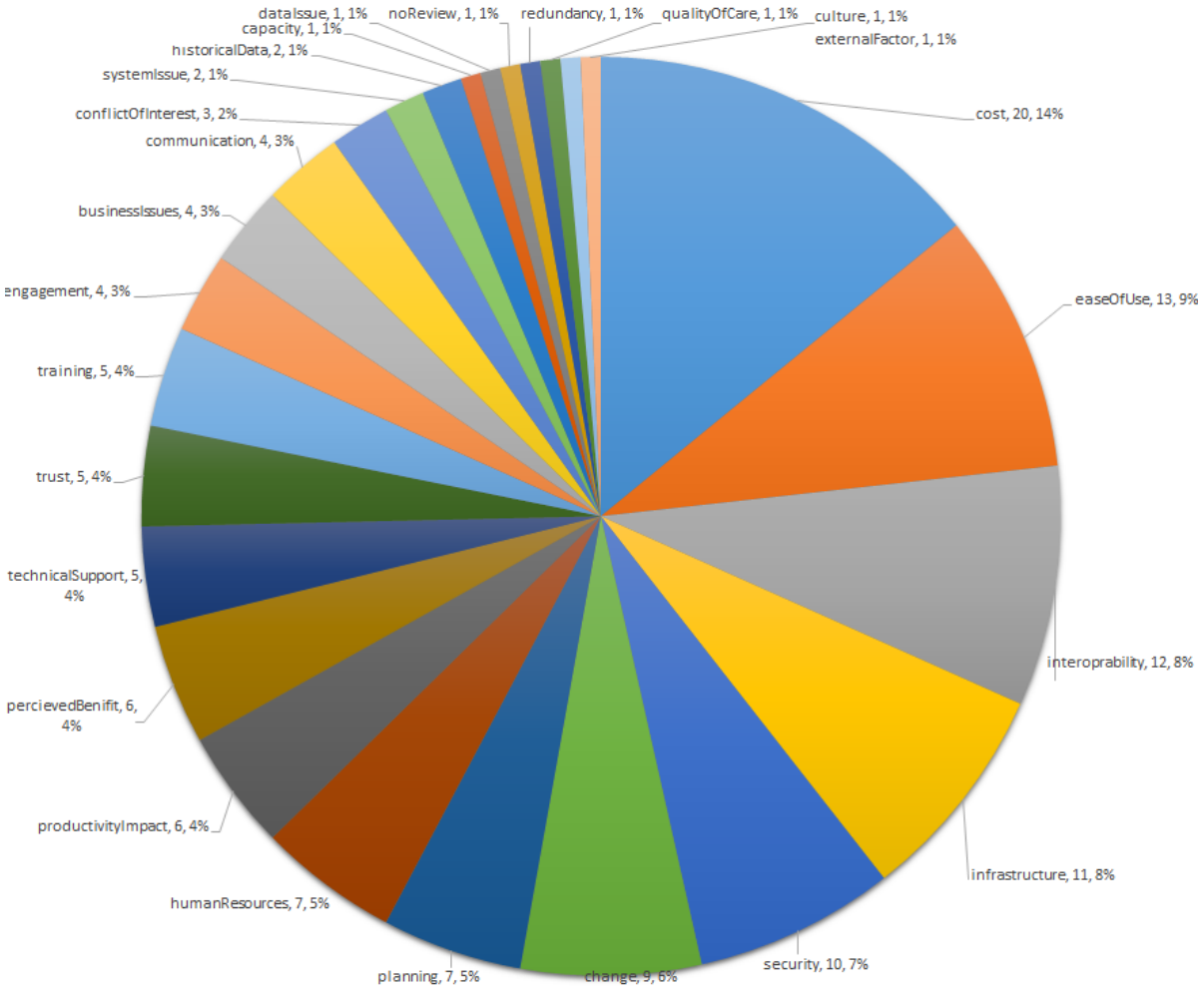
Within the literature there is discussion of how implementations are being recorded(Melin and Axelsson, 2014). It has been established that the success stories are readily available and that they are well documented (Melin and Axelsson, 2014). However, the follow up to the success stories is not well documented, it is difficult to establish from the literature the continued success of such systems (Melin and Axelsson, 2014). The initial implementation of the system may have been successful, following this there may have been a drop off, of system uptake (Heeks, 2006). However, the focus of this research is to establish at the initial implementation what could be some common problems.

3.2.5 Literature Review - Common Difficulties Established

What can also be identified from the literature are some of the common difficulties. It can be established the common difficulties are sometimes recorded as barriers or failures. During research, several items have been identified as difficulties during the implementation of healthcare IT solutions. It is aimed to present/discuss common difficulties in relation to system implementation, however, it should be understood it can be difficult to research a single phase of the system life cycle in isolation and some literature resources discuss multiple topics and phases of the life cycle. Below is a diagram (See Table 7 Difficulties Established in Literature) to outline the difficulties established in literature during the implementation phase.

Difficulties Established in Literature

Table 7 Difficulties Established in Literature



3.2.5.1 Literature Review, Common Difficulties - Cost

Within the discussion it can be established that cost is a factor within the decision-making process in choosing such a system(Handel and Hackman, 2010). Before organisations get to implementation phase as outlined by the system life cycle (Alwan, 2009, Hussung, 2016, Rouse, 2016) they will establish what are the costs of healthcare IT solutions and at this point the organisations will need to establish what will be the ROI for the system (Handel and Hackman, 2010).

During the literature review a common key point in discussion of implementation of such systems is the initial cost of purchasing a healthcare IT solution, including domiciliary healthcare IT solutions. The adoption of such systems requires substantial financial investment (Poon et al., 2004, Sligo et al., 2017, Kruse et al., 2015, Ross et al., 2016, Kruse et al., 2016, Ludwick and Doucette, 2009, Handel and Hackman, 2010) along with other resource investments from the organisation. It is understood that funding from governments and other sources has aided this issue (Kern et al., 2015, Sligo et al., 2017, Kruse et al., 2015, Wang and Biedermann, 2012, Bruen et al., 2011, Ross et al., 2016, Clarke et al., 2015, Ben-Assuli et al., 2015). HITECH is an example of how governments have supported the implementation of healthcare IT solutions (Heart et al., 2016, Bruen et al., 2011, Blumenthal, 2010).In this example, the US government incentivised the uptake of EHR systems for general practitioners.

It must be understood however, regardless of the funding support provided, the organisation must still take on the initial investment and continue to support existing IT infrastructure(Blumenthal, 2010, Kruse et al., 2015, Ross et al., 2016). This is another valid point established in the literature, it is expensive to implement such a system, but it must also be understood that other IT resources cannot suffer in the face of a new system. Legacy systems (Poon et al., 2004)may also need to be supported and financial support must also allow for this. When implementing a healthcare IT solution, the practice will consider their financial constraints and react accordingly. Financial constraints(Oak, 2007, Wang and Biedermann, 2012, Beglaryan et al., 2017) were identified in several cases as a barrier to implementation or adoption. At this point organisations will also consider the ongoing costs of managing a system, this is a barrier identified in the literature that should be considered along with initial cost of implementation healthcare IT solutions (Cresswell, 2013).

Other financial constraints are not direct costs; indirect costs must also be considered e.g. staff training(Ludwick and Doucette, 2009). Training is another barrier to implementation and is an important factor in ensuring the positive uptake of the system. Furthermore, in relation to staff the cost of labour involved in implementing a system(Bullard, 2016, Li et al., 2015) should also be considered. This could relate to the man hours required for installations, configurations or

even the time spent supporting new users to ensure a successful implementation and the cost associated with additional payroll.

When discussing the implementation, it should also be considered the effect this will have on the organisation as a whole, both for administrative duties and clinical duties. A cost to consider should be the productivity(Heart et al., 2016) effected and the additional costs that may be incurred during this phase. Furthermore, in relation to the productivity and availability of the system, any downtime (Ludwick and Doucette, 2009, Heart et al., 2016) of the system may affect the staff work.

Although there are many financial constraints, some positive points in relation to the cost of implementing a system have also been noted. For example, examining ROI (Handel and Hackman, 2010) can show that in many cases the long-term savings outweigh the initial costs and that there are savings to be made in the long term.

3.2.5.2 Literature Review, Common Difficulties - Ease of Use

The term ease of use refers to the vendor making it easy for the organisation or the users. This term should encompass the ease of setting up and configuring a healthcare IT solution along with the use for the end users so they can complete their work using the system. Users must feel they are comfortable using the system(Melin and Axelsson, 2014), users with basic levels of IT skills may feel insecure when attempting to use the system and this may cause a negative uptake(Handel and Hackman, 2010, Gillies et al., 2001).

User resistance (Beglaryan et al., 2017) is also a factor that will make the implementation of a system more difficult, if the users are not willing to accept the system it may become difficult to embed as part of the daily work routine, this can be made further difficult if there is an increased workload (Beglaryan et al., 2017). Furthermore, understanding the system and its capabilities should be understood by the users. Managing user expectations (Kruse et al., 2016, Gagnon et al., 2014, Melin and Axelsson, 2014) so that they understand what they can do and be reassured there is a way to complete all the tasks they require on the system.

Ease of use from a user perspective should not be underestimated, it has been identified in the literature that implementing a system before users are ready to accept (Ludwick and Doucette,

2009) the system is an issue that has occurred in the past. This means implementing the system without the proper training or support to allow the users to accept the system. This could lead to issues in use or even system resistance.

Ease of use from a system perspective is an important factor to consider. Being able to use the system and ensuring users can take it to the next phase of the lifecycle is important. Underestimating this can lead to slow adoption of systems leading to further strained resources. Alert messages (Gagnon et al., 2014) have been identified as a way in which systems get in the way of user work, if the alerts that appear too frequently or with alerts that have little or no meaning it becomes a nuisance instead of a valid alert.

Further system issues that can cause difficulty for ease of use for users are complexity of systems (Ross et al., 2016, Kruse et al., 2016). Although systems should capture all the details required, if the system is complex to use then user acceptance and support will be difficult. Also in relation to system complexity, ensuring there is a useable (Bushelle-Edgehill et al., 2017, Tall et al., 2015) workflow through the system will ensure that users can complete their tasks without frustration. Complex workflows (Kruse et al., 2016, Meigs and Solomon, 2016, Bushelle-Edgehill et al., 2017) have been identified as a barrier, along with poor systems or system quality which will directly stand in the way of users being able to or wanting to use the system.

In relation to poor systems, within the case study (Summarised in Appendix 1) (Cifuentes et al., 2015) outlined earlier it was discussed how users were forced to duplicate work and they did not have specific fields available to accurately capture the information they required. When the field that is required is not available a user will record it somewhere else (Bushelle-Edgehill et al., 2017), this could be in or outside the system or in a field that is designed to record something else, thus devaluing the data that is recorded. Also, system availability (Ross et al., 2016) should be considered, if the system requires maintenance or suffers downtime this will be an issue for users attempting to log in.

3.2.5.3 Literature Review, Common Difficulties - Interoperability

Interoperability is the ability for systems to be able to share data between the systems and maintain the meaning and value behind the data (Press, 2017b), which can be an issue during

implementation (Kruse et al., 2015, Kruse et al., 2016, Devlin et al., 2016, Cifuentes et al., 2015). This is an important ability for a healthcare IT solution as the data captured here should be available to be shared with other health care providers. This can become a difficulty if the system is designed as a closed loop and does not consider the information that must be shared or is designed in a way that other systems cannot accept. Designing an institutionalised system (Heart et al., 2016) will limit its interoperability capabilities. Furthermore, compatibility (Sligo et al., 2017) is a key consideration, compatibility is the ability for two of more systems to work together without difficulty (Press, 2017a).

As discussed in the literature and case study (Summarised in Appendix 1) ways in which interoperability issues can arise is from systems being provided on different platforms or versions (Cifuentes et al., 2015, Ross et al., 2016, Heart et al., 2016), or even support software/hardware on different versions that restrict communication (Meigs and Solomon, 2016) in some way. In this respect providing an interface that does not provide an adequate connection (Ross et al., 2016, Gagnon et al., 2014) can lead to interoperability issues. The data recorded on the systems can also cause interoperability issues if identified as a different value or priority on one system compared to another (Heart et al., 2016), this can lead to data transferred with one meaning and subsequently read with a different meaning.

It is understood that there has been strives for standardisation within health care communication, for example HL7 messages. It should be noted that different standardisation sets can also lead to the same issue stemming from a different set of protocols applied to a different version of the same protocol (Ross et al., 2016, Rezaeibagha et al., 2015). Vendors may be hesitant to implement standardisation as there may be a fear that this will reduce their market share (Devlin et al., 2016).

Interoperability allows for secondary use of the data that is available from the system, this means that additional users may have access to the data that is available (Beresniak et al., 2016). This poses an additional security risk (Rezaeibagha et al., 2015) from the way this data is shared among the secondary use system and once the data has been imported by a secondary systems it is not possible to manage rights restrictions on the data.

3.2.5.4 Literature Review, Common Difficulties - Security

Security has been identified as a difficulty in the literature in relation to system implementation. Healthcare IT solutions manage very sensitive data (Heart et al., 2016, Blumenthal, 2010) in relation to the people receiving care from the health care providers. This data must be securely saved and the correct rights restrictions (Beglaryan et al., 2017, Gagnon et al., 2014, Kruse et al., 2016, Djalai et al., 2015) in place so only the correct people can see the data.

To do this, the system must be advanced enough to manage secure access and the correct restrictions. In some cases users have opted for cloud based solutions (Heart et al., 2016) as the service provider is then responsible for securing the data within the cloud. However, data sharing, an important feature of modern healthcare systems, must also provide secure interactions with users and other systems. The networks and infrastructures (Blumenthal, 2010, Qiao et al., 2015) that the system functions cross is an important consideration when securing the data within the system.

To manage security across networks and within systems, the vendor can opt to use security standardisation (Rezaeibagha et al., 2015) which can then ensure the data within the system is secure. However, this could come at additional cost or difficulty in implementation. Furthermore, legal or governmental (Kruse et al., 2015) restrictions on the data could limit the way in which it is managed making security of the data more difficult.

Data protection legislation requires that data breaches (Dell, 2013) are notified to the appropriate persons. Data breaches can have both personal repercussions to the individual and for the business (Heart et al., 2016) if costs are incurred. It should also be understood that individuals can opt to not share any of their personal or medical information (Pyper et al., 2004) creating further data security management changes. To support system security the GDPT standard is being introduced, this will set out what security restrictions should be in place and increase fines if security standards are not met (Commissioner, 2017).

3.2.5.5 Literature Review, Common Difficulties - Infrastructure

A difficulty established during research is the infrastructure available to support healthcare IT solutions. The systems require hardware, supplementary software and network availability (Beglaryan et al., 2017, Wang and Biedermann, 2012, Oak, 2007). If these structures are not in

place or are not fully capable of supporting the systems, this will delay the implementation of the healthcare IT solution(Kruse et al., 2016, Sligo et al., 2017). The infrastructure may also be limited due to the hardware or software not being available (Blumenthal, 2010) or restrictions/limited capabilities (Gagnon et al., 2014). Scalability (Agbakoba et al., 2016) is also a concern with existing infrastructures, to allow organisations to scale up or down the systems the infrastructure must also be able to cope with changes.

If the infrastructure available is not suitable or capable to support the system requirements, the system organisations may need to reconfigure the infrastructure. Furthermore, organisations may need to invest in supplementary IT resources and they may need to retrofit (Bain, 2015) to upgrade the infrastructure to cope with the new system.

3.2.5.6 Literature Review, Common Difficulties - Planning

During implementation, not having a plan in place to structure the roll out and lack of support for the system have been identified as difficulties for some users (Kruse et al., 2015). Developing a complete project plan, from the literature areas such as business case (Ginsberg, 2016) to ensure not only the clinical needs of the organisation are met but also the organisation as a business, should complete a readiness assessment (Ginsberg, 2016) to ensure that users are ready to accept the system and complete analysis (Dell, 2013).

Following correct planning, other issues that can arise from the plan are poor leadership (Sligo et al., 2017) leading to ineffective implementation. Furthermore, time management or insufficient time(Kruse et al., 2016, Wang and Biedermann, 2012) being allocated for implementation can cause difficulties during this phase.

3.2.5.7 Literature Review, Common Difficulties - Change

Change in relation to healthcare IT solutions refers to the way in which implementing a new system influences the organisation and the users of the system, in some cases reluctant users (Kruse et al., 2016, Gagnon et al., 2014, Beglaryan et al., 2017). It is understood that a new system requires some training and additional work to fully understand and can use the system to its full potential, however, some new users feel that this change is not suited to their workload or the organisation and have negative feeling to the system or project (Beglaryan et

al., 2017). This can cause resistance from staff (Kruse et al., 2016, Poon et al., 2004). This has even been identified as 'Rebellion' (Poon et al., 2004) in the literature.

This resistance is rooted in the routine in which people work and encouraging them into the unfamiliar (Beglaryan et al., 2017) can cause a negative attitude, including user insecurity. The cultural change (Kruse et al., 2015) can be very difficult to overcome. However, it has also been identified in the literature that this change is a barrier, in some cases it is also a reason to implement a new system to promote a change in culture (Kruse et al., 2016).

Other changes to consider from a technical viewpoint, is the need for change to improve the system. To improve and secure the system going forward the vendor may be required to make changes to the system (Clarke et al., 2015), this can result in downtime or require users to need additional training. It can also be understood that users purchase a system but do not fully understand the concept of a system that is never complete (Clarke et al., 2015). For example, in purchasing a system as a service (SAAS) model, the vendor may continually update the system with back end upgrades and further upgrade the functionality changing the way the system works or looks. This can confuse and frustrate some end users.

3.2.5.8 Literature Review, Common Difficulties - Productivity Impact

Productivity (Kruse et al., 2016, Heart et al., 2016) can be effected when implementing a new system. During the implementation phase users are learning how to use the new system and working out their new workflows. This transition period (Handel and Hackman, 2010) can cause users to work less quickly and in different ways (Handel and Hackman, 2010) that cause the workflow to initially take longer or change. Furthermore, the workload required on users may increase (Handel and Hackman, 2010, Meigs and Solomon, 2016, Beglaryan et al., 2017). The increased workload will have a negative effect on the productivity of the staff.

Complex patient flows (Bushelle-Edgehill et al., 2017) can also influence productivity; this can cause users to find it more difficult to complete their required tasks thus increasing the time required. The time spent completing the same tasks prior to the system may also change, if the time per tasks increases (Beglaryan et al., 2017) this will have a negative effect on the regular workflow of the organisation.

How the organisation embraces the system is also a factor that can affect the productivity within the organisation. If the environment within the organisation is conducive to using the system effectively this will encourage improved productivity, however, if the environment is not suitable (Bushelle-Edgehill et al., 2017) for the system, users may find it difficult to complete their work. Furthermore, the organisations dependence on the system should be considered. If the organisation is overdependent (Handel and Hackman, 2010) on the system, this will affect the way users complete their work and effect the productivity if the system is not available.

3.2.5.9 Literature Review, Common Difficulties - Technical Support

During implementation, ensuring a smooth roll out is not a simple task. It is important to consider not only the system requirements but the support requirements too. Technical support can offer organisations a great resource to ensure the system needs are met and that users fully understand and can engage with the system. A barrier to this is the lack of technical support (Hamid and Cline, 2013, Kruse et al., 2016) or inadequate support offered, through poor service (Kilsdonk et al., 2017).

Furthermore, the resources available can make this difficulty more prominent if the in-house technical team (Blumenthal, 2010) in the organisation is unable to support the system or is unable to support the users in using the system. To alleviate this pressure organisations can implement super users (Bullard, 2016) to provide in-house support to users along with their normal roles within the organisation, however, for the super user this requires extra time and training to fulfil this role.

3.2.5.10 Literature Review, Common Difficulties - Human Resources

Human resources are an important factor during the roll out of healthcare IT solutions. The human aspect can become the most challenging barrier during this phase. Firstly, the consideration of training and additional man hours is a key factor in relation to people power. The cost of labour (Bullard, 2016) and additional hours required for training, support and initial roll out is a factor.

The resistance (Bushelle-Edgehill et al., 2017) of users to accept and use the system can also be a factor, furthermore the volume of staff (Kruse et al., 2016) can also be an issue. Ensuring the organisation has the correct number of staff (Kruse et al., 2015, Bullard, 2016) to complete the

tasks required, the organisation should take into consideration their workforce's capacity (Oak, 2007) before adding an additional task or consideration into the mix. Shortage of staff was outlined as a barrier in relation to this topic.

The organisation or system implementers must also ensure there is strong leadership to ensure the human resources available are utilised to their full potential and the work required of the staff is completed as efficiently as possible. Poor leadership (Sligo et al., 2017) has been identified as a barrier to implementing such systems. Furthermore, autonomy of physicians (Hamid and Cline, 2013) has been identified several times in the literature as a possible barrier to implementation. This is that physicians do not want to work collaboratively but rather work independently negating the purpose of the shared system.

3.2.5.11 Literature Review, Common Difficulties - Perceived Benefit

The perceived benefit of a healthcare IT solution refers to the users' outlook on the system; how the users feel the system will benefit them, their work, the individuals receiving care and the organisation as a whole. If this outlook is negative (Kruse et al., 2015) the users become reluctant to use the system and do not fully rely on the system in ways they should.

Users' perceptions (Kruse et al., 2015, Hamid and Cline, 2013, Kruse et al., 2016) has been identified several times in the literature to reinforce this difficulty, it can stem from personal perceptions such as age or personal skills (Kruse et al., 2015) to use the system or even an overall view that users cannot see the end benefit in using the system. The value derived (Gagnon et al., 2014) from the system for users, individuals and the organisation cannot be seen from the users' perspective or the improvements in care (Meigs and Solomon, 2016) in the long term are not understood by the user.

The end user expectations (Inokuchi et al., 2014) of the system can be too high and when the user uses the system they feel it does not meet the needs they have identified in their mind. Furthermore, it has been established in the literature that some individuals receiving care feel the system is taking away from their care and users are focused on the system (Kruse et al., 2015) and not the care provision.

3.2.5.12 Literature Review, Common Difficulties - Business Issues

In this section, the topic of business or organisational issues that stand as a difficulty to the implementation of healthcare IT solutions are discussed. The key point of organisational structure (Cucciniello et al., 2015, Devlin et al., 2016, Beglaryan et al., 2017) was highlighted in the literature in that the organisational structure can make it difficult to implement the system both physically and logically. Physically, if the organisation is spread over several hubs or is decentralised in some way, such as a consortium (Devlin et al., 2016). Another item on this topic identified is if the business has difficulties with the facilities (E.g. Organisation Premises) or internal resources (Kruse et al., 2015).

3.2.5.13 Literature Review, Common Difficulties - Engagement

User engagement is important during the implementation of a system; users must get on board to use and integrate the system into the organisations work routine (Cucciniello et al., 2015). If users do not fully engage (Sligo et al., 2017) with the system, implementers will find that this stage can take longer than anticipated. Users do not engage for several reasons; one main reason is a reluctance to change and they do not want to change their working pattern.

It also should be established that users can also go through three stages of engagement (Melin and Axelsson, 2014); inertia where they do not engage at all, application which is mild engagement, and change where users fully engage with the system. Initial engagement is important but continued engagement (Sligo et al., 2017) can be an issue where the system is adopted but then usage drops off and users later stop engaging with the system.

3.2.5.14 Literature Review, Common Difficulties - Communication

It is well versed that communication is supported by healthcare IT solutions, however, it has been identified in the literature that there are some cases where the system can be a barrier. For example, non-verbal (Rathert et al., 2016) communication cannot be replicated by the system and is difficult to record, furthermore when the physician (Rathert et al., 2016) is with the individual, if the system is disrupting the care then this will distract from any non-verbal communication.

In relation to this point it has also been reviewed when the physician is interacting with the system, what does the individual do? The individual can engage and use the information within

the system to ask questions or can disengage, such as check emails, causing the visit to not be as constructive as possible.

Another item identified in the literature and case study (Summarised in Appendix 1) is the change in communication channels (Cifuentes et al., 2015, Cucciniello et al., 2015) which can become a barrier. If users are not used to the communication methods or do not use them to their full extent, the value within the communication may be diminished.

3.2.5.15 Literature Review, Common Difficulties - Trust

A factor that may be overlooked is the patient or individuals trust in the system (Kruse et al., 2016). In the literature it has been established that 12% of a survey of 142 patients (Qiao et al., 2015) outlined that they have neutral or negative trust in an EHR.

Also, the user's trust in the system should be taken into account, the reliability and dependability (Gagnon et al., 2014) of the system should be confirmed prior to implementation as during implementation the system will be put under pressure from initial use. Users need to feel the system will not slow down (Gagnon et al., 2014) or have an outage while they are trying to do their work, especially in peak times.

3.2.5.16 Literature Review, Common Difficulties - Training

Training has been highlighted as a barrier to implementation. This means that users are not sufficiently trained or are not trained at all to use and operate the system (Kruse et al., 2016). This can lead to user dissatisfaction and misuse of the system. It is important that the correct technical training (Qiao et al., 2015) is provided to the users so that they can confidently use the system. The lack of training can enforce some of the other barriers and cause the system to have a slow uptake during implementation.

Another factor in relation to training is time, time to train the users (Kruse et al., 2015) and time to learn the system on the job. The time that can be allocated to training is important and can help reduce the barrier of understanding the system. If the training is not suitable for users, this can also become an issue in that the training completed has used the staff and organisation time but has not enabled the user to be confident in the system. Furthermore, the time the user spends learning the system on the job should not be diminished with or without training as it

may take time for users to be able to use the system quickly. Users will take time to learn a new system and include it in their normal routine as discussed by McLeod in relation to the 'Learning Curve' phenomenon (McLeod et al., 2008).

3.2.5.17 Literature Review, Common Difficulties - Conflict of Interest

Conflict of interest is where two parties have differing opinions or understandings. It has been identified in the literature that conflict of interest is a concern to healthcare IT solutions. This can be in the form of competitiveness (Oak, 2007) within the organisation that does not allow for the best implementation of the system. Furthermore, the socio-political and economic environment (Devlin et al., 2016) may not align with the organisation or project needs, for example if funding from another entity is initially agreed but is later pulled.

3.2.5.18 Literature Review, Common Difficulties - System Issue

Barriers related to the system directly have been (Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015)(Kruse et al., 2015) identified (Kruse et al., 2015). How the system functions or fails to function causes the barrier. Furthermore, system or supplier immaturity is an issue where the system or the vendor has not been developed well enough (Poon et al., 2004) to meet the needs of the organisation.

3.2.5.19 Literature Review, Common Difficulties - Historical Data

Historical data allows for users of systems to examine trends and generate detailed reports. However, if the system implemented does not easily allow, or allow at all, the input of historical data (Kruse et al., 2016, Wang and Biedermann, 2012) this will be a difficulty for users trying to get meaningful data from the system.

3.2.5.20 Literature Review, Common Difficulties - Culture

Organisational culture is also a factor that can become a difficulty when implementing a system. If the organisational culture (Cucciniello et al., 2015) does not allow for new ideas and change or if the organisation resists the system this will make implementation more difficult.

3.2.5.21 Literature Review, Common Difficulties - Redundancy

System redundancy is an important factor for every system. It must be considered that the system should back up data recorded and ensure that procedures are in place to ensure the

system will be available and secure. A possible way of supporting redundancy (Makowski, 2016) is implementing a cloud based solution rather than traditional locally installed system and database.

3.2.5.22 Literature Review, Common Difficulties - External Factor

External factors (Kruse et al., 2015) relate to any issues that affect the implementation of the system that is not routed from the organisation or system provider. Examples of this are inability to recruit the required or appropriate staff, lack of industry standards that limit the ability to compare the organisational progress or set standards for the system requirements. Furthermore, the location and impact of the organisation population are external factors that can affect the systems implementation (Kruse et al., 2015).

3.2.5.23 Literature Review, Common Difficulties - No Review

During implementation, it has been identified within the literature that implementers should continuously evaluate the progress and findings of the implementation. It has been identified as a difficulty when users do not continuously evaluate or do not review the progress to ensure the project remains on track (Sligo et al., 2017).

3.2.5.24 Literature Review, Common Difficulties - Quality of Care

It has been identified that the perceived quality of care (Beglaryan et al., 2017) following implementation is also a consideration. This can affect how the users, and in particular physicians, use and accept the system. If the belief is that the system will negatively impact care, physicians will be reluctant to use the system.

3.2.5.25 Literature Review, Common Difficulties - Data Issue

It has been identified in the literature that data integrity can be an issue, as identified by Kruse that missing data (Kruse et al., 2016) can be a barrier to implementation.

3.2.5.26 Literature Review, Common Difficulties - Capacity

It has been identified in the literature that technological capacity limitations can be a barrier to healthcare data sharing and access (van Panhuis et al., 2014), thus limiting healthcare IT solution capabilities. With limited capabilities, user uptake may be slower.

3.2.5.27 Literature Review, Common Difficulties - Count of Difficulties

See below count of common difficulties established in the literature in Table 8 below.

Table 8 Count of Difficulties

Difficulty	Literature
Cost	20
Ease of Use	13
Interoperability	12
Infrastructure	11
Security	10
Change	9
Planning	7
Human Resources	7
Productivity Impact	6
Perceived Benefit	6
Training	5
Technical Support	5
Trust	5
Communication	4
Business Issues	4
Engagement	4
Conflict of Interest	3
System Issue	2
Historical Data	2
Capacity	1
Data Issue	1
redundancy	1
Quality of Care	1
Culture	1
External Factor	1
No Review	1

3.3 Conclusion of Literature Review

In conclusion of chapter three, the common difficulties have been established based on the literature review. The common difficulties allowed for discussion on the topic and to establish a basis for the questionnaire. With the conclusion of the research results it is possible to confirm what are some of the common difficulties for healthcare IT solutions. Answering the first of the key points of the research question.

Chapter 4 Questionnaire Design and Results

4.1 Introduction to Questionnaire Design and Results

In this chapter the questionnaire creation, distribution and results will be discussed. Following ethical approval from Trinity College Dublin (See ethical approval in Appendix 15), then confirmation from Valentia Technologies (See Valentia Technologies confirmation in Appendix 16), it was possible to contact staff and clients of Valentia Technologies in relation to this research. Following the confirmation, the questionnaire was distributed via email.

4.1.1 Questionnaire - Introduction to Questionnaire

The questionnaire was structured based on the initial findings from the literature research. This led to the distribution of the questionnaire to twenty potential participants.

It was aimed the questionnaire would highlight if there were any differences between what the literature found to be the more common difficulties and to establish if there were any other areas that could be further researched. It also allowed for implementers and system users to outline how the implementation barriers could be overcome by drawing on their previous experiences.

4.1.2 Questionnaire - Overview of Questionnaire

Following the ethical approval process and questionnaire development phase, the questionnaire established led the way to support the research in discussing the possible solutions of the top five common difficulties established. The questionnaire was developed with the goals and objectives of the research in mind, see Table 9 below to illustrate this.

The questionnaire is composed of eight questions, the first seven reflect on different possible difficulties using the same question construct (see sample questionnaire in Appendix 17). The question eight allowed participants to rank the difficulties as they feel fit and allows participants to outline any other difficulties they have experienced or feel relevant. The questionnaire was structured this way to confirm if users had experienced this issue and using repetitive question construct, make the questionnaire easier for participants to provide feedback.

To gather the questionnaire results three emails were circulated, the initial to outline the questionnaire and research undertaken (see initial email sent in Appendix 11), this was a generic

group mail. All participants were Bcc to the email to ensure their anonymity. This included a copy of the questionnaire for participants to complete and return. The second was a reminder email (see reminder email in Appendix 12) to encourage participants to return any incomplete questionnaires. The third email was to again ask for participants to reply and include completed questionnaires (see follow up email in Appendix 13), this email was directly aimed at each participant individually.

The participants selected were implementers and system users of healthcare IT solutions. The participants were available to contact from the researcher's normal employment duties. Permission was sought and confirmed from the researcher's employer and via Trinity College Ethics before contacting any participants.

It was aimed to have a 50/50 split between participants from researcher's place of employment and external implementers/users. Results were returned from five participants; all participants were from the researchers place of employment. See Table 9 to illustrate how the research objectives marry with the questionnaire question and the research goals.

Table 9 Goal, Objective, Questionnaire and Correlation

Objective	Goal	Questionnaire Question	Correlation
Discuss common difficulties established in questionnaire and recommended solutions?	Complete questionnaire	Have you experienced difficulties in relation to (*Difficulty Identified)*? *Part A in Question 1-7*	This question is designed to establish if the participant has experienced the issue. This supports the objective by establishing if the difficulty has been experienced.
Discuss common difficulties established in questionnaire and recommended solutions?	Complete questionnaire	Please provide details of the difficulty below *Part B in Question 1-7*	Here the participant could outline their personal experience. This supports the objective by establishing how the difficulty has been experienced.
Discuss common difficulties established in questionnaire and recommended solutions?	Complete questionnaire	How did you try to resolve the difficulty? *Part C in Question 1-7*	Here the participant could advise on possible solutions. This supports the objective by establishing possible solutions to difficulties established.
Discuss common difficulties established in questionnaire and recommended solutions?	Complete questionnaire	From your experience, what are some common difficulties you experienced during the implementation phase of a healthcare IT solution? Please rank (1 being most difficult and continue to rank difficulties per importance) as they apply to your experience *Question 8, with list of difficulties established in literature and space to add additional difficulties experienced*	Here participants could rank based on difficulties experienced what they believe are the most difficult difficulties to overcome during system implementation. This supports the objective by allowing participants to identify what are the most common difficulties in their experience and add any difficulties not established in literature.

4.1.3 Questionnaire - Difficulties Established in Questionnaire

Following the collection and analysis of the questionnaire, it was possible to establish if the questionnaire participants agreed with the findings in the literature, how important they felt the difficulties were, and are there any other difficulties that can be included in future research.

To analyse the questionnaire results the researcher created a spreadsheet using excel to categorise the questions in a format that was anonymised (see anonymised data spreadsheet in Appendix 6) and could be included in the main research document (see participant results anonymised in Appendix 18, 19, 20, 21 and 22). The questions one to seven asked the participants if they have experienced the listed difficulty and to discuss this. In this section, we can see the results of this question and compare this to what was established in the literature.

In this section the results based on Part B of Question 1-7 of the questionnaire will be analysed.

4.1.3.1 Questionnaire, Difficulties Established - Question 1

'From the literature to date, the researcher has found 'Ease of Use' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Ease of Use' when implementing?'

Three out of four complete answers have experienced this issue, citing issues such as; system complexity, complexity level for non-technical end users, new features difficult to understand and unfamiliarity with IT.

4.1.3.2 Questionnaire, Difficulties Established - Question 2

'From the literature to date, the researcher has found 'System Cost' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'System Cost when implementing?'

Three out of five complete answers have experienced this issue citing issues such as; organisations working as non-profit limit the resources to implement sophisticated systems, cost is an important consideration but usually before purchasing a system, cost of hardware prohibitive, back end costs and mobile technologies that may have to be replaced every couple of years.

Noted that one participant confirmed not to have experienced this and mentioned that cost has not been an issue during implementation phase.

4.1.3.3 Questionnaire, Difficulties Established - Question 3

'From the literature to date, the researcher has found 'System Interoperability' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'System Interoperability' when implementing?'

Two out of five complete answers have experienced this issue citing issues such as; issue with legacy system approach to connection, technical difficulties and different vendors.

It is also noted that one participant outlined they have not experienced this issue but believe the issue arises from old systems that were built on new technology and vendors that hold onto data rather than supporting data sharing.

4.1.3.4 Questionnaire, Difficulties Established - Question 4

'From the literature to date, the researcher has found 'Security' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Security' when implementing?'

Two out of five complete answers have experienced this issue citing issues such as; evolving technology is available to new systems and hackers, security of patient record and access to from everywhere.

4.1.3.5 Questionnaire, Difficulties Established - Question 5

'From the literature to date, the researcher has found 'IT Infrastructure to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'IT Infrastructure' when implementing?'

Two out of five complete answers have experienced this issue citing issues such as; setting up environment. E.g. internet, firewall, pc, monitor and changing infrastructure based on project success.

It has also been noted by a participant that has not experienced this issue that this was an issue in the past but is no longer an issue.

4.1.3.6 Questionnaire, Difficulties Established - Question 6

'From the literature to date, the researcher has found 'Change Management' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Change Management' when implementing?'

Four out of five complete answers have experienced this issue citing issues such as; process changes that effect the organisation process or system process or both, internal system issue during roll out of new versions, training required after change and policy changes that can hold up work needing to be done.

Furthermore, as outlined above process changes can be an issue, one participant has outlined how this difficulty can occur, a process that looks simple can actually be very complex making it difficult to implement. Here are some ways this can occur.

1. Requirements of change are not fully understood

2. They are not properly documented and communicated

3. All stakeholders are not taken on board

4. Change is not broken down into smaller components and by the time it is available things have changed again

It has also been noted by one participant that resistance to change can also be an issue that can cause difficulty during implementation.

4.1.3.7 Questionnaire, Difficulties Established - Question 7

'From the literature to date, the researcher has found 'Technical Support' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Technical Support' when implementing?'

Three out of five complete answers have experienced this issue citing issues such as; users with little or no technical background will require more assistance, it can be hard to explain the issue in detail, communication and understanding the real underlying issue experienced.

4.1.3.8 Questionnaire, Difficulties Established - Question 8

It was possible to analyse the results of question eight to establish the ranking of the difficulties as per the questionnaire participants (See Question 8 results in Appendix 7).

To do this the average rank (see average calculate applied in Appendix 8) of each difficulty was calculated based on which participants ranked each difficulty. Each of the other difficulties established by the participants was included in this analysis. Based on the lowest average being ranked the most difficult to highest average being ranked the least difficult.

To calculate this the excel rank function (see rank formula applied in Appendix 9) allowed the researcher to see from the range of results where the average of each difficulty sat within the range. To review this the researcher created the chart below (see pivot chart to create ranking diagram in Appendix 10) to visualise the participants ranking. The pivot chart can be viewed from Table 10 below and the average result and ranked result for each difficulty can see in Table 11 below.

Please note due to the limited questionnaire participant it was difficult to draw any conclusions from this question.

Difficulties Ranked in Questionnaire

Table 10 Difficulties Ranked in Questionnaire

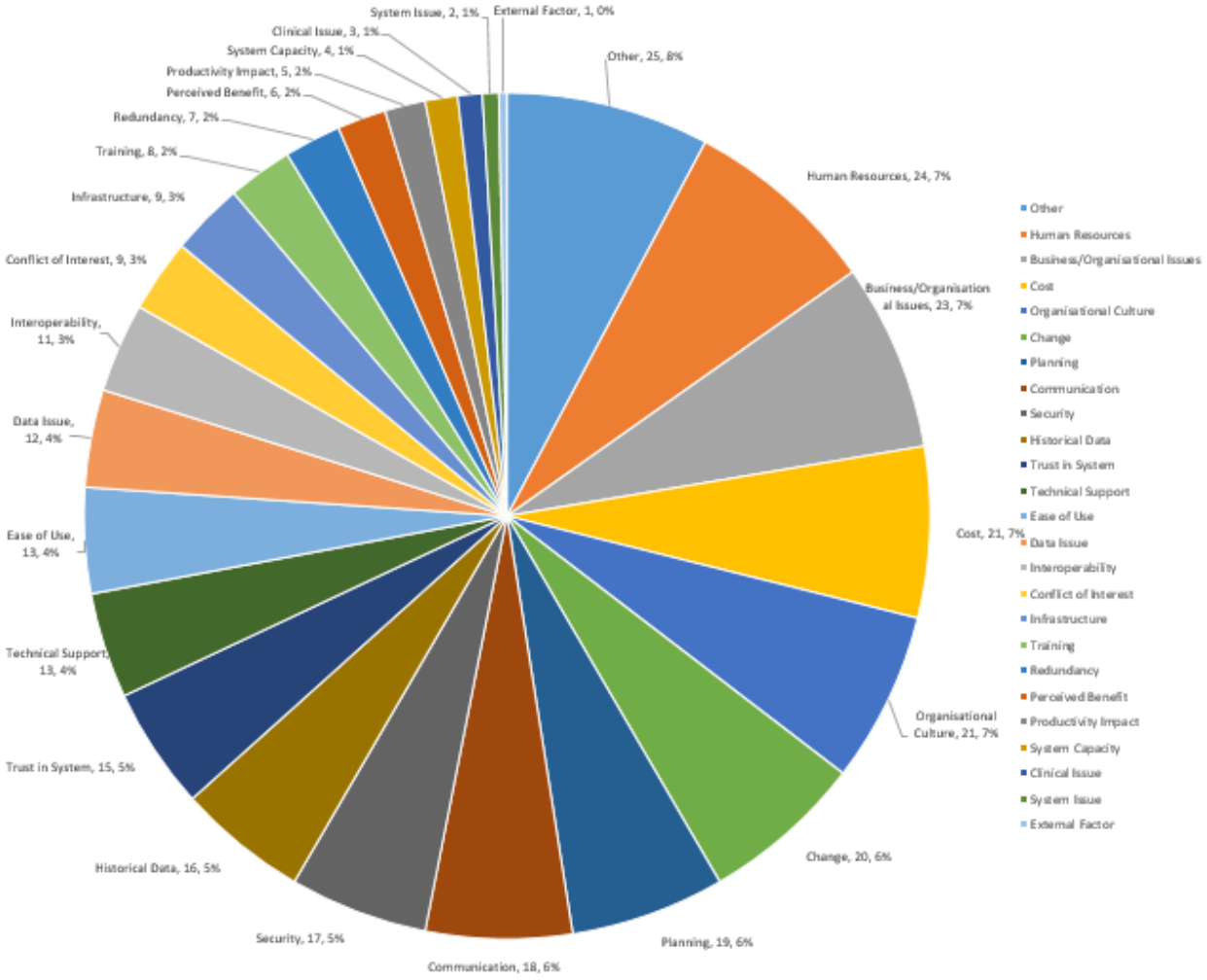


Table 11 Questionnaire Difficulty Average and Rank

Difficulty	Average	Rank
Business/Organisational Issues	2.6	23
Change	3.4	20
Clinical Issue	12.6	3
Communication	5.2	18
Conflict of Interest	8.8	9
Cost	3.2	21
Data Issue	8.4	12
Ease of Use	7.8	13
External Factor	14.6	1
Historical Data	6.8	16
Human Resources	1.4	24
Infrastructure	8.8	9
Interoperability	8.6	11
Organisational Culture	3.2	21
Other	0.2	25
Perceived Benefit	9.6	6
Planning	4.4	19
Productivity Impact	10.8	5
Redundancy	9.2	7
Security	6.4	17
System Capacity	12	4
System Issue	13.4	2
Technical Support	7.8	13
Training	9	8
Trust in System	7.6	15

4.1.4 Questionnaire - Feedback Established to Resolve Difficulties

The questionnaire was constructed not only to collect the experiences and knowledge of the participants on the difficulties they have experienced but to establish how they have or would recommend overcoming some of the common difficulties outlined (see participant results anonymised in Appendix 18, 19, 20, 21 and 22). In this section, questions one to seven will be evaluated based on the feedback provided by the questionnaire participants and question eight results will be displayed in Table 7.

In this section the results based on Part C of Question 1-7 of the questionnaire will be analysed.

4.1.4.1 Questionnaire, Feedback to Resolve Difficulties - Question 1

Question 1 - From the literature to date, the researcher has found 'Ease of Use' to be one of the most common difficulties.

Please provide details of the difficulty below

Participant 1 outlined the following points to help resolve ease of use issues.

"We try to handle such cases by applying different techniques. Some of which are as follows.

1. We try to keep the system processes aligned to the actual processes as much as possible.

2. We provide the users with tooltips and process workflows for easy navigation and understanding.

3. We provide the users with help material, video tutorials etc. to help them in using the system easily.

4. We divide the system into different sections so that if a person has to work only in a specific area then he doesn't feels overcrowded by other features of the system."

To summarise, by supporting the users and enabling the system to be easily accessible and understood the users are more likely to be comfortable using the system.

Participant 4 has outlined the following point.

"Training resolved most of these issues."

To summarise, by training end users this can ensure the system is accessible and understood by users.

4.1.4.2 Questionnaire, Feedback to Resolve Difficulties - Question 2

Question 2 - From the literature to date, the researcher has found 'System Cost' to be one of the most common difficulties.

Please provide details of the difficulty below

Participant 1 has outlined the following.

"We try to break the system into multiple iterations so that the organization doesn't have to bear the full cost of a system at once. We start with giving them the "Minimum viable Solution" so that they can run the core parts of their system. Further enhancements are then provided based on the budget of organization."

To summarise, the vendor provides a system based on the minimum requirements but allows the system to be enhanced if required with additional cost if the organisation chooses to do so.

Participant 2 has outlined the following.

"Negotiate with sales team on price"

To summarise, organisations can discuss and negotiate the costings of the system with the vendor to come to an agreement.

Participant 4 has outlined the following

"Difficulties with cost were reduced by highlighting the benefits of the system. Organisations that implemented the application found that they achieved substantial savings particularly in the first few years. The application allowed the organisation to operate much more efficiently and effectively. It improved organisational compliance, increased transparency and eased reporting requirements."

To summarise, understanding the benefits in the short and long term to reduce other organisational costs by using the system can overall reduce the organisations costs.

Participant 5 has outlined the following.

"Cloud services are providing more adaptable role out options for customers. This means infrastructure can be upgraded as required without incurring large costs. Also, the increase in mobile devices has given more options when making decisions."

To summarise, using cloud based systems or infrastructure can allow organisations to avoid large costs. Mobile devices can also give the organisation more options when planning purchases.

4.1.4.3 Questionnaire, Feedback to Resolve Difficulties - Question 3

Question 3 - From the literature to date, the researcher has found 'System Interoperability' to be one of the most common difficulties.

Please provide details of the difficulty below

Participant 1 has outlined the following.

"In cases where we do face this problem, we always try to follow standards. This helps in getting the implementation correct and future proof."

To summarise, if an issue with system interoperability is experienced system standards should be followed.

Participant 2 has outlined the following.

"Talk to support team to find best way normally we find out many way as system is open source communication protocol."

To summarise, the organisation should speak to the support team and they can advise on a way to overcome the issue.

Participant 4 has outlined the following.

"The system can integrate with most third-party systems."

To summarise, this issue has not been encountered by participant 4 but they believe the system they use can communicate with most other systems.

Participant 5 has outlined the following.

"These issues are become easier to resolve with experience and also using the systems using the recommended protocols."

To summarise, the issues experienced are becoming easier to resolve with increased knowledge of the issues occurring and by using recommended protocols there is a standards based approach to prevent these issues.

4.1.4.4 Questionnaire, Feedback to Resolve Difficulties - Question 4

Question 4 - From the literature to date, the researcher has found 'Security' to be one of the most common difficulties.

Please provide details of the difficulty below

Participant 1 has outlined the following.

"*There are multiple measures that we take to cater for the security threat.*

1. Use of latest technology

2. Do penetration testing before releases

3. Encryption

4. Firewalls

5. Anti-Virus

6. Anti-Malware"

To summarise, security can be provided to the system and infrastructure using tools available and to adequality test and secure the system before its use.

Participant 2 has outlined the following.

"Sometime get issues with password help desk resolve the issue"

To summarise, the vendor support team can help ensure adequate password security and distribution.

Participant 4 has outlined the following.

"No difficulties experienced. It is a fully secure, role based system. There is a full audit trail of all activity on the system."

To summarise, participant 4 has not experienced this issue but believes using a role base to control access levels and implementing an audit trail for monitoring can support a secure system.

Participant 5 has outlined the following.

"It's important to follow standards and recommended operating procedures for this such as ISO 27001 and 9001. Also, the GDPR coming into effect next year will assist companies in security compliance."

To summarise, using standards and accreditation procedures can support the organisation, vendor and system ensure security levels are adequate.

4.1.4.5 Questionnaire, Feedback to Resolve Difficulties - Question 5

Question 5 - From the literature to date, the researcher has found 'IT Infrastructure' to be one of the most common difficulties.

Please provide details of the difficulty below

Participant 2 has outlined the following.

"Talk to vendor on suggestion and help. They have always been very helpful."

To summarise, by discussing with the vendor the requirements of the infrastructure, this may prove helpful.

Participant 4 has outlined the following

"An internet connection was required as it is a cloud based system. It can run on most PCs."

To summarise, participant 4 has not experienced this issue however noted that cloud based systems do require an internet connection to operate. If this is available, cloud based systems should run on most PC's.

Participant 5 has outlined the following.

"Prevalence of Cloud computing platforms such as AWS and Azure can assist here and allow infrastructure to grow in relation to system requirements."

To summarise, cloud based platforms can allow flexibility for the infrastructure to grow based on the system requirements.

4.1.4.6 Questionnaire, Feedback to Resolve Difficulties - Question 6

Question 6 - From the literature to date, the researcher has found 'Change Management' to be one of the most common difficulties.

Please provide details of the difficulty below

Participant 1 has outlined the following.

"We embrace changes when they arise. We do the following to ensure that no or minimal rework is required.

1. Ensure that all stakeholders get a finalized document and sign it off.

2. We prioritize the changes so that the important changes are delivered first and we have control over the schedule of delivery, scope and budget."

To summarise, changes are accepted and ensuring agreement and control of the work to be carried out will reduce any unnecessary work.

Participant 2 has outlined the following.

"Vendor provide release notes, help material, videos etc."

To summarise, the vendor can support the users with system changes or during initial implementation by providing support documentation to identify and coach users with changes to the system.

Participant 3 has outlined the following.

"Lot of training use user manual."

To summarise, the vendor can provide training and support documentation when the system is being implemented or changed to support users.

Participant 4 has outlined the following.

"To assist with change management, it was important to provide adequate training and support. It was important to have a train the trainer approach to have an 'expert' on site at all times. Finding product champions within the organisation was important. it was also important to

highlight the benefits of the system to all stakeholders including employees (management, administrators and front-line staff), service users and the organisation. By highlighting the benefits a greater level of 'buy in' was achieved and this assisted with change management."

To summarise, providing training is important, it is also important that the approach to training taken to ensure users are adequately trained and have a user that is a system expert or system champion on site to support users locally. Furthermore, during training system features and benefits should be highlighted to encourage system uptake.

Participant 5 has outlined the following.

"This needs to be done through close collaboration with client. We are provided with the clients change management procedures before rollout so it is up to us to follow and make sure it doesn't become an issue."

To summarise, to support change management the organisation must be included in the change process and any plans should be shared by the vendor with the organisation to ensure they agree and understand the changes being made.

4.1.4.7 Questionnaire, Feedback to Resolve Difficulties - Question 7

Question 7 - From the literature to date, the researcher has found 'Technical Support' to be one of the most common difficulties.

Please provide details of the difficulty below.

Participant 1 has outlined the following.

"We resolve this by providing the end user with multiple levels of support. Some of them they can use themselves and if that doesn't work then they can always have a helpdesk to answer their questions.

1. User Manuals

2. Video tutorials

3. Troubleshooting Document

4. Level 1 Support provided by on site super users

5. Level 2 Support provided by Vendor."

To summarise, to resolve issue with technical support use multiple levels and multiple resource types to support the user. Provide on-site and remote support, furthermore use support documentation.

Participant 2 has outlined the following.

"Try to post everything on the helpdesk with screen shots"

To summarise, to support users with the queries the vendor requests all items are logged on a helpdesk, this ensures a transparent log of the issues and communication and ensures that the vendor has adequate information to investigate and resolve the issue.

Participant 4 has outlined the following.

"Support is provided by a help desk (call and email), online help manual and tutorials."

To summarise, participant 4 has not experienced this issue, however feels by providing a helpdesk that can accommodate calls and emails for open communication can support users. Furthermore, proper support documentation can support the users.

Participant 5 has outlined the following.

"Have someone from the client as the designated contact"

To summarise, outline to the organisation that the vendor requires a single point of contact for all issues. This will ensure that items are filtered down within the organisation and resolved within the organisation more and reduce overload of items to vendor or on helpdesk.

4.1.5 Questionnaire - Conclusion of Questionnaire

To conclude the questionnaire with the participants, each participant was contacted via email individually with a scanned copy of their questionnaire with the researcher's signature. Furthermore, a PDF attachment of how the anonymised feedback would be attached to the main document was also provided to each participant. Each participant was thanked for their

contribution and advised that following the completion of the research all copies of the questionnaires will be destroyed (see Appendix 14 for copy of conclusion email sent).

In conclusion, feedback was provided on each item in the questions. In some cases, participants went into good detail to explain their experiences to elaborate on the issues identified. Participants also were constructive in the feedback provided to understand the issue and find a solution to the issues identified. In some cases, the participants did not experience the issue but based on their experience in their role advised on possible solutions to further advance the research.

Participants ranking the list of issues identified, allowed the research to show perspective on items that system implementers or users may find more important even though it is not as well documented in the literature. This section also allowed users to outline other difficulties they have experienced or feel relevant to support a greater understanding of the topic and to support future research.

While the feedback received was constructive the main limitation to the questionnaire was the lack of responses, in particular from possible participants outside of the researcher's workplace. It was aimed to have a 50/50 split of participants from within the researchers work place and outside participants. Several outside participants did respond to outline they currently do not have sufficient time to complete the questionnaire. For future research to complete questionnaires an online form may allow for better accessibility to the questionnaire and be easier to circulate to a wider circle of participants to gain a larger pool or results.

4.2 Conclusion of Questionnaire Design and Results

In this chapter, it was discussed how the ethical approval and approval from Valentia Technologies Ltd. was gained to allow distribution of the questionnaire. Furthermore, this chapter also outlines how the common difficulties were used to create the questionnaire and the results from the questionnaires were presented.

While the top five solutions were discussed, the questionnaire was designed to include the top seven difficulties. This was to allow further discussion on the topic and ensure that participants could actively engage with at least some of the questions as not all may be relevant to them.

Chapter 5 Discussion

5.1 Introduction to Discussion

This chapter will review the two research methods of this dissertation. This section will review in detail the results based on the literature review and then subsequently the results based on the questionnaire feedback received. The discussion will consider the various ways in which data was collected and aim to pair the issues identified with possible solutions established.

5.2 Evaluation of Literature Research

The literature review allowed a basis for understanding the topic and supported further development of the ideas and difficulties established.

The literature was ranked based on the frequency that the difficulties appears in the literature, by establishing notes and coding these into categories the ranking was possible. The key terms used to research comprised of several healthcare IT solution terms and terms based on similar systems to provide a rounded picture of the difficulties that could be experienced during implementation.

The research has based the ranking on the frequency of the items being identified in the literature as this could be an indicator on more important or more frequently experienced difficulties.

The ranking of the literature from 1 to 20 (of 24 items) is set as 1 being the least frequent to 20 being the most frequently established in literature.

5.3 Questionnaire

The questionnaire supported further development and understanding of the issues identified in the literature research. The issues identified most frequently in the literature were used as questions 1-7 to allow questionnaire participants to provide their experience and recommend possible solutions. Furthermore, participants had the facility to identify other difficulties they have experienced that can be expanded upon in further research. Participants were also asked to rank the difficulties established in the literature by what they believe is most important.

The ranking of the questionnaire from 1 to 24 is set as 1 being the least frequent to 24.

5.4 Discussion of Five Most Common Difficulty Solutions

5.4.1 Common Difficulty Solutions - Cost

Based on the literature research, cost was the most common difficulty established. The cost considerations are from initial cost of purchase, ongoing costs, hardware costs so far as labour costs.

To overcome cost difficulties during implementation some plausible solutions have been identified. One solution identified by Participant 1 in question 2C, here the idea of providing the organisation with the 'Minimum Viable Solution' or as identified in the literature 'Minimum Viable Product (Techopedia, 2017). This is providing the organisation with a working system that has the functionality and capacity to provide the basic services they require. Following on from success with the basics vendors can then add additional features and functionality as required by the organisation. This provides a cost-effective system that meets the organisation's needs.

Another solution identified is to create a dialog between the vendor and organisation. This was identified by two participants. Participant 2 identified that the organisation should speak to the vendor sales team to discuss how to keep costs down. Alternatively, from a vendor perspective creating dialog to discuss the benefits of the system and long term saving was identified by Participant 4.

The final solution identified was the use of cloud based computing. This is to provide the system on a cloud base so users can access via the web or alternately host the organisations IT infrastructure on a cloud system. This allows for organisations to reduce initial costs and to manage ongoing costs by having fixed prices agreed with cloud system providers.

5.4.2 Common Difficulty Solutions - Ease of Use

Based on the literature, ease of use was identified as the second most common difficulty. This difficulty considered how easy the system was to access, how easy the system was to use, how ergonomically easy the system was to use and how easy it was for users to learn the system.

To overcome this barrier several solutions have been identified. The initial solution is to build into the design to make the process of the application match what the users do in their work. For example, Participant 1 has outlined in Question 1C the following, *"We try to keep the system*

processes aligned to the actual processes as much as possible.", Participant 1 has also identified *"We divide the system into different sections so that if a person has to work only in a specific area then he doesn't feels overcrowded by other features of the system"*, i.e. allow users easy access to the information they need and do not overcrowd the screen.

Another solution identified was to support the users during this phase, it is understood that initial training can give a lot of support to users during this phase, Participant 4 (Question 1C) has identified that ease of use issues is often resolved following training. Participant 2 (Question 1C) has also identified that system understanding issues are often resolved following the users contacting vendor support team.

Furthermore, to support the users and allow for ease of access and understanding of the system the vendor can provide support material. Participant 1 (Question 1C) has identified several help materials provided E.g. tooltips, process workflows, help material and video tutorials.

5.4.3 Common Difficulty Solutions - Interoperability

Based on the literature interoperability was identified as the third most common difficulty, this difficulty considers interoperability between internal organisational systems, interoperability between external systems to the organisation and compatibility of systems.

To overcome difficulties during implementation it has been advised that users contact the vendor support team, identified by Participant 2 in Question 3C, as they may be able to support or recommend a resolution to a specific technical interoperability issue. Participant 5 has identified that with experience, interoperability issues become easier to resolve, Question 3C.

Another solution to overcome interoperability issues is to use a 'standards based' approach. Using national or international standards can provide a basis for system communication, E.g. HL7 messages (Rouse, 2015). Furthermore, it can allow communication of systems or ensure the system is of a recognised standard so is compatible with other software and hardware. Participant 1 and 5 (Question 3C) identified standards as a good approach to preventing issues with interoperability.

5.4.4 Common Difficulty Solutions - Infrastructure

Based on the literature infrastructure was identified as the fourth most common difficulty established, infrastructure considers technical infrastructure, software/hardware limitations, scalability and local environment.

Some possible solutions identified are; ask for help, contact the vendor for support as they may be able to advise based on experience or understand system requirements from the infrastructure to support the system. Participant 2 has identified in Question 5C that talking to the vendor has *"…always been very helpful".*

Another solution identified is again to use a cloud based approach. This allows the organisation to place the burden of supporting and maintaining the infrastructure on the cloud solution provider. Also, by purchasing a cloud based infrastructure the organisations ability to grow is much simpler, as identified by Participant 5 in Question 5C *"Prevalence of Cloud computing platforms such as AWS and Azure can assist here and allow infrastructure to grow in relation to system requirements".* Although a consideration identified by Participant 4 (Question 5C) is the cloud based system will require an internet connection to allow access.

5.4.5 Common Difficulty Solutions - Security

Based on the literature, security has been identified as the fifth most common difficulty, taking into consideration; system security, network security, privacy concerns and data security. Although security concerns in recent times are at a new high with the onset to the WannaCry ransomware (Response, 2017) attacking health organisations and large corporation systems across the globe.

Some possible solutions to security concerns are to deploy the following methods to secure the network and system. For Example, Participant 1 has identified the following in Question 4C *"1. Use of latest technology, 2. Do penetration testing before releases, 3. Encryption, 4. Firewalls, 5. Anti-Virus, 6. Anti-Malware"* the principle here is to ensure the infrastructure, network, system and security protocols are up to date.

Another solution identified for minor security issues such as a forgotten password, (Participant 2 Question 5C) users can contact the vendor support team and ask for help. This may also be useful in creating restrictions or user access.

The use of security standards was also identified as a possible solution for ensuring security during implementation. Participant 5 has identified in Question 4C that the use of standards and protocols can support organisations and there is a new protocol coming into effect next year to help support security compliance, GDPR (Commissioner, 2017).

Some examples of security standards;

ISO 9001 Quality Management Systems Certification (2017)

"*ISO 9001 belongs to the ISO 9000 family of standards which is related to quality management systems. It has been created to help organisations ensure that they meet the needs of their customers and other stakeholders while also meeting statutory and regulatory requirements related to the product."*

ISO 27001 Information Security (certificationeurope, 2017)

"By integrating a robust information security management system your organisation can ensure that the quality, safety, service and product reliability of your organisation has been safeguarded to the highest level."

GDPR - General Data Protection Regulation (Commissioner, 2017)

"The GDPR emphasises transparency, security and accountability by data controllers and processors, while at the same time standardising and strengthening the right of European citizens to data privacy."

5.5 Limitations of Research

Limitations of the research to date are few but significant, the first limitation on the research is the limitation to literature. This point refers to the research being supported heavily by literature and not being equally balanced in relation to questionnaire feedback. While

questionnaire did support the research, in future research a wider scope of participants could widen the results returned.

The second limitation to date that will remain throughout the research is that failures are not readily recorded or in detail. While success and positive literature on the use of such systems is available it can be difficult to establish the failures or the detail in the failures that are recorded.

To date, time has also been a factor, in reviewing and generating the common difficulty key terminology a large amount of literature must be reviewed to gather meaningful results. This will take time on an already tight timescale.

Another limitation of the research is the participant engagement with the questionnaire. Unfortunately, of the twenty participants contacted, only five returned completed questionnaires. Furthermore, the questionnaires returned were collected from the researcher's place of employment limiting the feedback to one organisation.

5.6 Conclusion of Research Findings

The questionnaire has also allowed for further review of the difficulties established and has enabled the participants of the questionnaire to identify possible solutions to the common difficulties. Enabling the second and final component of the research question to be answered.

Furthermore, this section presented the comparison of the two methods of research literature and questionnaire, to further establish a combined evaluation of the common difficulties established.

5.7 Conclusion of Discussion

In conclusion of this chapter, a discussion of the literature took place to identify how the literature was reviewed and to identify that the difficulties established in the literature were collated and ranked based on their frequency appearing in the literature. Discussion on the questionnaire being derived from the difficulties established in the literature was presented. Participants feedback on their own experiences that may not have been identified in the literature.

Finally, in this chapter to complete the research question discussion of the five most common difficulties and then possible solutions outlined to support users was complete. Here are the five most common difficulties based on the literature and some points on the solutions identified, see below Table 12 for key points against each common difficulty.

Table 12 Summary of Common Difficulty Solutions

Cost	Ease of Use	Interoperability	Infrastructure	Security
Minimum Viable Product	System Design to support Ease of Use	Standards	Support from Vendor	Secure System/ Network/ Infrastructure
Benefits of System to Outweigh the Cost	Training	Support from Vendor	Cloud System	Support from Vendor
Cloud Systems	Help Material	Recommended Protocols		Standards
				GDPR

Chapter 6 Conclusion and Future Work

6.1 Introduction

In this chapter the research dissertation will be concluded, here the goals and objectives initially set out will be reviewed and concluded. Furthermore, a discussion on each chapter to conclude the dissertation as a whole will be completed. The strengths and limitations of the research will also be discussed along with recommendations for any future work in relation to this topic.

6.2 Strengths and Limitations of the Study

6.2.1 Strengths

One of the strengths of this dissertation is the broad approach to gathering the literature to give as much insight as possible while also ensuring the evaluation of the literature was controlled to provide the most accurate result possible in an area that is sparsely documented. The research carried out at this point supported the early stages of the research and the development of the questionnaire.

Another distinct strength of this research is the feedback provided from the questionnaire participants. The questionnaire was developed based on the most common or accessible topics established from the literature. This meant that the feedback provided was available and relevant to the topics discovered and enabled the ongoing work of the dissertation in the form of providing the solutions to the common difficulties established.

6.2.2 Weaknesses

Searching limitations, such as time, restricted the research. Time was restricting as to ensure the dissertation continued in a timely manner, to complete the research and develop the questionnaire to distribute, and subsequently evaluate. If time allowed, further evaluation of the literature could have taken place. Also, limitations in researching were also experienced as only English papers were accessible to the researcher. This meant only papers of sources available in English could be included in this research.

Another restriction came later in the research following distributing the questionnaire only five participants returned answered questionnaires. Furthermore, although having distributed to several outside organisations, all the participants are employed in the same organisation as the

researcher. This may be in relation to the method of collection of the questionnaire, the questionnaire was emailed as a word document or provided as a paper based questionnaire.

Another limitation stemming from the poor participant response is the inability to conclusively compare the literature review results with question 8 in the questionnaire feedback. With larger number, it may be possible to draw more conclusions.

6.3 Dissemination of Findings

The research set out to establish common difficulties of implementing healthcare IT solutions, this has been completed based on the literature review. The research also set out to devise a set of solutions to these implementation difficulties. This has been completed based on the participant feedback to the questionnaire and support from the literature. See below Table 13 of the dissertation goals and objectives and how these have been executed.

Table 13 Question, Objective, Goal, Execution and Status

	Question	**Objective**	**Goal**	**Execution**	**Status**
1	What is a healthcare IT solution	Establish definition of Healthcare IT solutions	Define healthcare IT solutions	What is a healthcare IT solution	Complete
2	What are the phases of such an IT solution?	Research IT solution development phases	Establish what are 'Implementation' phases	What are the phases of such an IT solution?	Complete
3	What is the term 'Common Difficulty'?	Establish what the term means	Establish if the term is suitable	What is the term 'Common Difficulty'?	Complete
4	Are there any existing case studies of similar system implementation?	Review case studies	Outline some examples of current implantation	Are there any existing case studies of similar system implementation?	Complete
5	What are some common difficulties noted in the literature and recommended solutions?	Complete literature review	From literature establish examples of common difficulties and where possible solutions to these where possible	What are some common difficulties noted in the literature and recommended solutions?	Complete
6	What are the questionnaire participants experience and possible solutions to some common difficulties recommended solutions?	Complete questionnaire	From questionnaire discuss common difficulties and where possible solutions to these where possible	Discuss common difficulties established in questionnaire and recommended solutions?	Complete

7	Implementation of Healthcare IT Solution: What are some common difficulties and some possible solutions?	Establish common difficulties and some solutions	Based on common difficulties established, evaluate some possible solutions	Implementation of Healthcare IT Solution: What are some common difficulties and some possible solutions?	Complete

6.4 Recommendations for Future Research

The research completed could provide a good basis for further research. Further development of the literature searches could be deployed if time allows to further evaluate and outline any possible solutions available in the literature.

Furthermore, using the difficulties established, another approach to the research could be undertaken by generating and circulating the existing or updated questionnaire to a greater audience to attempt to increase the number of participants responding. Also, the researcher could develop the questionnaire to be web based to allow users to easily agree to the terms and complete the questionnaire online.

6.5 Reflections on the Study

In reflecting the study, the initial idea was established based on the researchers' background in healthcare IT wanting to further understand the difficulties both implementers of systems and users of systems experience. In Chapter 1 this was discussed and outlaid the project planning and goals and objectives of the study.

Building on from the study introduction, the state of the art Chapter 2 looked at the way the literature was researched, collated and evaluated. This chapter also discussed the purpose of the research and where the problem fits in to the research.

Based on the research completed previously, Chapter 3 the researcher terminology, gave way to the terms deployed in researching and discussed the structure a systematic process of researching and evaluating the literature.

Chapter 4 then looked at the results that the literature searches completed. This gave way to two sections of results. The first was the literature review results which looked at each of the

difficulties established and discussed what they are and how they are relevant to the study. Secondly, in this chapter a review of the results from the questionnaire was completed, this gave way to discussion on the difficulties established and the possible solutions to these difficulties. This chapter also included a review of a case study included under Appendix 1.

Based on the results established Chapter 5 then evaluated the results from each of the research methods. Furthermore, a review of the combined results was also illustrated using a table. At this point it was possible to look at the top five common difficulties established and pair this with the possible solutions established and discuss each of the top five difficulties with a solution in turn.

Chapter 6 then allowed for the research to conclude each of the research methods deployed and evaluate the results and findings of the research.

6.6 Conclusion

In this chapter, the researcher initially discussed the strengths and weaknesses of this research. Some strengths established include the literature being well evaluated and an example of a limitation is the number of participants in the questionnaire are limited.

At this point the researcher also evaluated the initial goals and objectives matrix and included the work carried out to complete the goal and the status to establish if the goal is complete or incomplete. It can be established that all goals set out initially have now been met based on the ongoing systematic approach to the research.

Recommendations for future work were also established to advise readers of possible future work to be carried out by the researcher to outline how this paper can be used in future research. It was discussed that either a literature based development of the literature or questionnaire based development of this topic and paper could be completed to allow for further discussion on this topic.

The chapter then allowed space for a final review of the research as a whole to give a rounded picture of the work complete and discussion taken place.

Chapter 7 References

2017. *certificationeurope* [Online]. Available: http://certificationeurope.com/iso-9001-quality-management-certification/ [Accessed 12/05/2017 2017].

AGBAKOBA, R., MCGEE-LENNON, M., BOUAMRANE, M.-M., WATSON, N. & MAIR, F. S. 2016. Implementation factors affeting the large-scale deployment of digital health and well-being technologies: A qualitative studt of the initial phases of the 'Living. *Health Informatics journal,* 22**,** 867-877.

ALWAN, M. 2009. What is System Development Life Cycle? airbrake. [Online] Available: https://airbrake.io/blog/sdlc/what-is-system-development-life-cycle [Accessed 09/01/2017]

BAIN, C. 2015. The Implementation of the Electronic Medical Records System in Health Care Facilities. *Procedia Manufacturing,* 3**,** 4629-4634.

BEGLARYAN, M., PETROSYAN, V. & BUNKER, E. 2017. Development of a tripolar model of technology acceptance: hospital-based physician's perspective on EHR. *International journal of Medical informatics,* 102**,** 50-61.

BEN-ASSULI, O., SAGI, D., LESHNO, M., IRONI, A. & ZIV, A. 2015. Improving diagnostic accuracy using EHR in emergency departments: A simulation-based study. *Journal of Biomedical Informatics,* 55**,** 31-40.

BERESNIAK, A., SCHMIDT, A., PROEVE, J., BOLANOS, E., PATEL, N., AMMOUR, N., SUNDGREN, M., ERICSON, M., KARAKOYUN, T., COOREVITS, P., KALRA, D., DE MOOR, G. & DUPONT, D. 2016. Cost-benefit assessment of using electronic health records data for clinical research versus current practices: Contribution of the Electronic Health Records for Clinical Research (EHR4CR) European Project. *Contemporary Clinical Trials,* January 2016**,** 85-91.

BLUMENTHAL, D. 2010. Launching HITECH. *New England Journal of Medicine,* 362**,** 382-385.

BRUEN, B. K., KU, L., BURKE, M. F. & BEEUWKES BUNTIN, M. 2011. More than four in five office based physicians could qualify for federal electronic health record incentives. *Health Affairs,* 30**,** 472-480.

BULLARD, K. L. 2016. Cost Effective Staffing for an EHR Implementation. *Nursing Economics,* 34**,** 72-76.

BUSHELLE-EDGEHILL, J., BROWN, J. L. & DONG, S. 2017. An examination of EHR implementation impacts on patient-flow. *Health Policy and Technology,* 6**,** 114-120.

CERTIFICATIONEUROPE. 2017. *ISO 27001 Information Security* [Online]. Available: http://certificationeurope.com/iso-27001-information-security/ [Accessed 12/05/2017 2017].

CIFUENTES, M., DAVIS, M., FERNALD, D., GUNN, R., DICKINSON, P. & COHEN, D. J. 2015. Electronic Health Record Challenges, Workarounds and Solutions Observed in Practices Integrating Behavioral Health and Primary Care. *The Journal of the American Board of Family Medicine,* 28 Suppliment**,** s63-s72.

CLARKE, A., ADAMSON, J., SHEARD, L., CAIRNS, P., WATT, I. & WRIGHT, J. 2015. Implementing electronic patient record systems (EPRS) into England's acute, mental health and community care trusts: a mixed methods study. *BMC Medical Informatics and Decision Making,* 15**,** 1-8.

COMMISSIONER, O. O. T. D. P. 2017. *General Data Protection Regulation* [Online]. Available: https://www.dataprotection.ie/docs/GDPR/1623.htm [Accessed 12/05/2017 2017].

CRESSWELL, K. M. B., DAVID W SHEIKH, AZIZ 2013. Ten key considerations for the successful implementation and adoption of large-scale health information technology. *J Am Med Inform Assoc* . 20**,** 9-13.

CUCCINIELLO, M., LAPSLEY, I., NASI, G. & PAGLIARI, C. 2015. Understanding key factors affecting electronic medical record implementation: a sociotechnical approach. *BMC Health Services Research,* 15**,** 1-19.

DELL. 2013. *Building Future-ready IT Platforms* [Online]. http://www.dell.com: 2017 Dell. Available: http://www.dell.com/learn/us/en/70/public~solutions~healthcare~en/documents~healthcare-future-ready-it-security-cloud.pdf [Accessed 06/05/2017 2017].

DEVLIN, A., MCGEE-LENNON, M., O'DONNELL, C. A., BOUAMRANE, M.-M., AGBAKOBA, R., O'CONNOR, S., GRIEVE, E., FINCH, T., WYKE, S., WATSON, N., BROWNE, S. & MAIR, F. S. 2016. Delivering digital health and well-being at scale: lessons learned during the implementation of the dallas program in the United Kingdom. *J Am Med Inform Assoc,* 23**,** 48-59.

DJALAI, S., URSPRUNG, N., ROSEMANN, T., SENN, O. & TANDJUNG, R. 2015. Undirected health IT implementation in ambulatory care favors paper-based workarounds and liits health data exchange. *International Journal of Medical Informatics,* 84**,** 920-932.

EC.EUROPA.EU. 2017. Interoperability & standardisation: connecting eHealth services [Online]. Available: https://ec.europa.eu/digital-single-market/en/interoperability-standardisation-connecting-ehealth-services [Accessed 13/05/2017 2017].

EHEALTHIRELAND. 2017. *Open Data for Health* [Online]. Available: http://www.ehealthireland.ie/Strategic-Programmes/Open-Data-for-Health/ [Accessed 13/05/2017 2017].

GAGNON, M. P., NSANGOU, E. R., PAYNE GAGNON, J., GRENIER, S. & SICOTTE, C. 2014. Barrier and facilitators to implementing electronic prescription: a systematic review of user groups perceptions. *J Am Med Inform Assoc.,* 21**,** 535-541.

GILLIES, R. R., ZUCKERMAN, H. S., BURNS, L. R., SHORTELL, S. M., ALEXANDER, J. A., BUDETTI, P. P. & WATERS, T. M. 2001. Physician-system relationships stumbling blocks and promising practices. *Medical Care,* 39**,** 92-106.

GINSBERG, D, 2016. *Successful Preparation and Implementation of an Electronic Health Records System* [Online]. www.cmanet.org: Available: https://www.cmanet.org/files/pdf/ehr/best-practices-7.pdf [Accessed 06/05/2017 2017].

HAMID, F. & CLINE, T. W. 2013. Providers' acceptance factors and their perceived barriers to electronic health record (EHR) adoption. *Online Journal of Nursing Informatics* 17**,** 1-11.

HANDEL, D. A. & HACKMAN, J. L. 2010. Implementing Electronic Health Records in the Emergency Department. *The Journal of Emergency Medicine,* 38**,** 257-263.

HEART, T., BEN-ASSULI, O. & SHABTAI, I. 2016. A review of PHR, EMR and EHR integration: A more personalized healthcare and public health policy. Health Policy and Technology, August 2016, 20-25.

HEEKS, R. 2006. Health information systems: Failure, success and improvisation. *International Journal of Medical Informatics,* 75**,** 125-137.

HITINFRASTRUCTURE. 2017. *Comparing Healthcare SaaS, PaaS, IaaS Cloud Technology* [Online]. Available: http://hitinfrastructure.com/news/comparing-healthcare-saas-paas-iaas-cloud-technology [Accessed 13/05/2017 2017].

HUSSUNG, T. 2016. What Is the Software Development Life Cycle? *Husson Universities* [Online]. Available: http://online.husson.edu/software-development-cycle/ [Accessed 10/03/2017].

IDEN, J. & EIKEBROKK, T. R. 2013. Implementing IT Service Management: A systemic literature review. *International Journal of Information Management,* 33**,** 512-523.

INOKUCHI, R., SATO, H., NAKAMURA, K., AOKI, Y., SHINOHARA, K., GUNSHIN, M., MATSUBARA, T., KITSUTA, Y., YAHAGI, N. & NAKAJIMA, S. 2014. Motivations and barriers to implementing electronic health records and ED information systems in Japan. *American Journal of Emergency Medicine,* 32**,** 725-730.

KERN, L. M., EDWARDS, A. & KAUSHAL, R. 2015. The Meaningful Use of Electronic Health Records and Health Care quality. *American Journal of Medical Quality,* 30**,** 512-519.

KILSDONK, E., PEUTE, L. W. & JASPERS, M. W. M. 2017. Factors influencing implementation success of guideline-based clinical decision support systems: A systematic review and gaps analysis. *International Journal of Medical Information,* 98**,** 56-64.

KRUSE, C. S., KRISTOF, C., JONES, B., MITCHELL, E. & MARTINEZ, A. 2016. Barriers to Electronic Health Record Adoption: a Systematic Literature Review. *Journal of Medical Systems,* 40**,** 1-7.

KRUSE, C. S., MILESKI, M., ALAYTSEV, V., CAROL, E. & WILLIAMS, A. 2015. Adoption factors associated with electronic health record among long-term care facilities: a systematic review. *BMJ Open,* 5**,** 1-9.

LI, Y.-C., YEN, J.-C., CHIU, W.-T., JIAN, W.-S., SYED-ABDUL, S. & HSU, M.-H. 2015. Building a national electronic medical record exchange system-experiences in taiwan. *Computer Methods and Programs in Biomedicine,* 121**,** 14-20.

LINDZON, J. 2015. *Why One-Size-Fits-All Health Initiatives Don't Work* [Online]. Available: https://www.fastcompany.com/3041383/why-one-size-fits-all-health-initiatives-dont-work [Accessed 13/05/2017 2017].

LUDWICK, D. A. & DOUCETTE, J. 2009. Adopting electronic medical records in primary care: Lessons learned from health information systems implementation experience in seven countries. *International Journal of Medical Informatics,* 78**,** 22-31.

MAKOWSKI, D. 2016. Best practices for implementing, testing and using a cloud-based communication system in a disaster situation. *Journal of Business Continuity & Emergency Planning,* 9**,** 338-345.

MCLEOD, A. J. J., CLARK, J. G., WARREN, J. & DIETRICH, G. B. 2008. The Impact of Information Systems on End User Performance: Examining the Effects of Cognitive Style Using Learning Curves in an Electronic Medical Record Implementation. *Communications of the Association for Information Systems,* 22**,** 165-184.

MEIGS, S. L. & SOLOMON, M. 2016. Electronic Health Record Use a Bitter Pill for Many Physicians. *Perspectives in Health Information Management,* 13, 1-34.

MELIN, U. & AXELSSON, K. 2014. Implementing healthcare information systems – Mirroring a wide spectrum of images of an IT project. *Health Policy and Technology,* 3**,** 26-35.

OAK, M. R. 2007. A review on barriers to implementing health informatics in developing countries. *Journal of Health Informatics in Developing Countries,* 1**,** 19-22.

POON, E. G., BLUMENTHAL, D., JAGGI, T., HONOUR, M. M., BATES, D. W. & KAUSHAI, R. 2004. Overcoming barriers t adoption and implementing computerized physician order entry systems in U.S. hospitals. *Health Affairs,* 23**,** 184-190.

PRESS, O. U. 2017a. compatability. *oxford dictionaries.*

PRESS, O. U. 2017b. interoperability. *oxford dictionaries.*

PROJECT, T. N. H. 2017. *Supporting Healthcare in Ireland* [Online]. Available: http://www.healthlink.ie/ [Accessed 13/05/2017 2017].

PYPER, C., AMERY, J., WATSON, M. & CROOK, C. 2004. Patients' experiences when accessing their on-line electronic patient records in primary care. *British Journal of General Practice,* 54**,** 38-43.

QIAO, Y., ASAN, O. & MONTAGUE, E. 2015. Factors associated with patient trust in electronic health records used in primary care. *Health Policy and Technology,* 4**,** 357-363.

RATHERT, C., MITTLER, J. N., BANERJEE, S. & MCDANIEL, J. 2016. Review article: Patient-centered communication in the era of electronic health records: What does the evidence say? *Patient Education and Counseling,* Feb**,** 1-15.

RESPONSE, S. S. 2017. *What you need to know about the WannaCry Ransomware* [Online]. Available: https://www.symantec.com/connect/blogs/what-you-need-know-about-wannacry-ransomware [Accessed 20/05/2017 2017].

REZAEIBAGHA, F., WIN, K. T. & SUSILO, W. 2015. A systematic literature review on security and privacy of electronic health record systems: technical perspectives. *Health Information Management Journal,* 44**,** 23-38.

ROSS, J., STEVENSON, F., LAU, R. & MURRAY, E. 2016. Factors that influence the implementation of e-health: a systematic review of systemic reviews (an update). *Implementation Science,* 11**,** 1-12.

ROUSE, M. 2015. *HL7 (Health Level Seven International)* [Online]. Available: http://searchhealthit.techtarget.com/definition/Health-Level-7-International-HL7 [Accessed 13/05/2017 2017].

ROUSE, M. 2016. *systems development life cycle (SDLC)* [Online]. Available: http://searchsoftwarequality.techtarget.com/definition/systems-development-life-cycle [Accessed 14/11/2016 2016].

SLIGO, J., GAULD, R., ROBERTS, V. & VILLA, L. 2017. A literature review for large-scale health information system project planning, implementation and evaluation. *International journal of medical informatics,* 97, 86-97.

TALL, J. M., HURD, M. & GIFFORD, T. 2015. Minimal impact of an electronic medical records system. *American Journal of Emergency Medicine,* 33**,** 663-666.

TECHOPEDIA. 2017. *Minimum Viable Product (MVP)* [Online]. Available: https://www.techopedia.com/definition/27809/minimum-viable-product-mvp [Accessed 20/05/2017 2017].

VAN PANHUIS, W. G., PAUL, P., EMERSON, C., GREFENSTETTE, J., WILDER, R., HERBST, A. J., HEYMANN, D. & BURKE, D. S. 2014. A systematic review of barriers to data sharing in public health. *BMC Public Health,* 14**,** 1-9.

WANG, T. & BIEDERMANN, S. 2012. Adoption and Utilization of Electronic Health record systems by Long-Term care facilities in Texas. *Perspectives in Health Information Management,* 9**,** 1-14.

Chapter 8 Appendices

Appendix 1 – Case Study Example

This case study was chosen as it has evaluated some real-life implementation and discussed direct results, difficulties and solutions. This is in comparison to most of the other literature which is written in a literature review format. The case study has also been included as part of the literature review for establishing the common difficulties.

Case Study - Introduction

The case study selected (Cifuentes et al., 2015) has monitored and examined eleven medical practices and their use of EHR systems. In doing so the case study has established several difficulties to the implementation of such systems and compared how the practices have progressed and monitored, not only their difficulties established, but how the difficulties were overcome to establish a possible solution to resolve the difficulties in the future.

The case study examined eleven medical practices; eight of which were primary care clinics and three of which were mental health centres. All centres focused on implementing integrated care. Of the eleven practices eight practices used a single EHR and three used multiple EHR systems to capture different data sets. It has been outlined within the case study that EHR systems can support care providers, however, they can cause several difficulties throughout the life cycle of the EHR. It is understood that integrated care is a multidisciplinary team based effort and EHR systems can support sharing information and supporting clinical use.

The case study has examined the practices over a three-year period between 2012 and 2014, each of the eleven practices participated in initiative funded by the Colorado Health Foundation. For participating in the Advancing Care Together (ACT) initiate the practices each received $150,000 over the three-year period to offset the cost of participation. It is understood that this funding was not used to purchase an EHR system, each participant must be implementing the system on their own behalf.

Case Study - Methods

Case Study - Data Collection

Data was collected over the three-year period, including data such as administrative documentation, practice documentation and monitoring of clinical practice via online journals

and on-site observations. The site visits allowed the case study researchers to evaluate in detail the clinical day to day functions, including the use of the EHR systems. During the site visits, it allowed time for interviews with both clinical and administrative EHR users to learn about their implementation experience.

Case Study - Data Management

Site visit notes were prepared soon after each visit; interviews were voice recorded and transcribed. Any practice information collected was done via a paper based survey. Any data collected was anonymised. Atlas.ti and SAS systems were used to further examine the data collected.

Case Study - Analysis

A team from multiple disciplines gathered and reviewed the data collectively in multiple cycles. The team examined the text of the data collected and then tagged the important themes that were identified. The iterative process allowed the researchers to identify the barriers and subsequently identify the possible solutions to these barriers within the same data.

Case Study - Results

Following examination of the data, the researchers have identified three distinct difficulties from the eleven practices examined.

Case Study - Documentation and Tracking

Documentation shared among users varied due to the nature in which each user used the system. It was identified when new staff come on board in some practices the methods used in documenting patient data varied to existing methods. This meant that data was not tracked and recorded in the same way or possibly not available or possible to record in the EHR. This made it difficult for the practices to extract the relevant data they require and further made managing care more difficult.

Case Study - Communication

The practices in this case study require the ability to support integrated care, a team approach, which means that communication is key. It has been established following use of the EHR systems that communication is supported to a limited extent. Standardised templates to support communication are not available to support sharing of care plans or reporting for

example. Some EHR systems did support task tracking to allow the user to identify when items are scheduled and subsequently completed.

Case Study - Interoperability

System interoperability was established as an issue in relation to EHR systems sharing data with other EHR systems, meaning that patient information documented was not readily available to be shared appropriately. Furthermore, it has been noted in the case study that EHR system interoperability with other systems or hardware, for example linking to a tablet device to fill a report for a patient, subsequently limited the way in which users could support and document information for patients available on the EHR system.

Case Study - Workarounds

Within the research carried out, several workarounds have been noted to support EHR system users in the future to resolve or get around issues identified as barriers.

Case Study - Double documentation and Duplicate Data Entry

It has been noted that in some cases, the practices that use multiple EHR's or multiple systems were required to record data in multiple places which was causing the data to be recorded multiple times even though it was only generated once.

To resolve this, some of the practices implemented using a tablet device with a form regenerated that could be completed and, when saved, could then be sent to two systems at the same time to record that data as required but reduced the data input requirement overall. In some cases, the forms were designed to set certain fields to one system and other fields to another system so that only relevant data is recorded in the right place and ensures cleanliness of data recoded.

Although in some cases the data was recorded in a form template and then later entered into the EHR system, simplifying the recording and reducing time and data entry with the patient. Another nice feature in using the digital forms is they can then be designed to generate reports and used to summarise the data collected.

Case Study - Scanning and Transporting Documents

In some cases, where practices used multiple EHR's or multiple systems, the different systems are not interoperable. An example of this is a practice which required medication lists from a primary care system to be available from a mental health system.

To resolve this, the medication lists were printed daily and made available to the staff. At the end of each day the medication lists were scanned into the primary care system to track this routine. While the required information was available it does require additional time and resources to complete this task.

Case Study - Reliance on Patient or Clinician recall for clinical information

When information is not accessible on the system for any reason, it is understood the clinician must establish the required information. It is understood that to resolve this the clinician would need to recall the information or ask the patient to recall the information required. In some cases, the clinician may be required to re-record the information to ensure accurate data is documented at the time of care.

Case Study - Use of Freestanding Tracking Systems

In many of the practices examined, freestanding tracking was implemented. An example of this was one case where an excel spreadsheet was used to record information in relation to patients or their care. This is required because the EHR systems do not allow users to record or report on the data required. This resulted in data not being available in EHR systems or difficult to find and furthermore they require substantial resources to manage.

Case Study - Emerging Solutions

In this section the case study identifies possible solutions to EHR barriers in the future.

Case Study - Customised EHR Templates

The data entry available on EHR's relies substantially on free text fields. This could be further supported with form templates that will support data coding, or shared language to support the data recorded to be readily available to be shared and interoperable with other systems. Furthermore, coded data can then be used to generate reports and may support some of the excel sheets that practices use.

Case Study - EHR Upgrades

In upgrading the EHR system more functionality and improved form templates are available to users. Thus, improving the clinical care and resolving issues such as documentation issues and interoperability.

Case Study - Unified EHR

Throughout the case study barriers have been identified as part of practices using multiple EHR's or multiple systems. It is understood that unifying the systems in use to ensure that all data is recorded on one system instead of multiple systems. This will reduce the requirement of multiple data entry and interoperability.

Case Study - Review

In review of the case study, the detailed and iterative process of establishing the issues allows the reader to be assured that the barriers identified are valid, also the variety of practices identified further support the understanding that the barriers identified are common difficulties established from the research.

The approach of establishing the barriers and then surmising workarounds and future resolutions worked well in the case study as it gave a rounded picture of the implementation and how users may use a similar system.

Case Study - Limitations of Case Study

The case study has three limitations; the first being the few participating practices. In including a greater number of practices with a variety of patient demographics other issues within EHR or similar systems may have been highlighted.

The second limitation is the practices' lack of resources to implement such a system and following implementation their lack of resources in relation to further improvements.

The third limitation is the study is unable to establish in using an EHR or similar system what are the cost benefits and is there any difference in clinical outcomes or return on investment.

Case Study - Relevance to Dissertation

This case study is relevant to this research as it further supports some of the common difficulties established in the literature. Furthermore, the process of establishing a difficulty and identifying the possible solutions is like the construct of the research.

The difficulties identified were relevant to EHR systems or similar systems. Such systems are relevant to the dissertation as the term EHR was included as part of the initial research terms. The items identified were also established in the literature during the dissertation.

Case Study - Conclusion

In conclusion to the case study the barriers identified; documentation and tracking, communication and interoperability are supported by iterative process of a multidisciplinary team review. These items have also been established as part of this dissertation along with further difficulties established in the literature. The case study identifies not only current workarounds to resolve the issues identified within the case study but also discusses possible future solutions that will resolve the issue in the future. It is believed this case study does further support the research in this dissertation and established good understanding of emerging technologies to improve EHR use and similar system use.

Appendix 2 - Literature Notes Captured

	A	B	C
1			
2	*Source ID*		**1**
3	*Items Noted*		Holistic look at EHR adoption
4			intuitive system is a benefit
5			Cost an important factor
6			Not as simple as off the shelf purchase and install

Appendix 3 - Web Sources Notes Captured

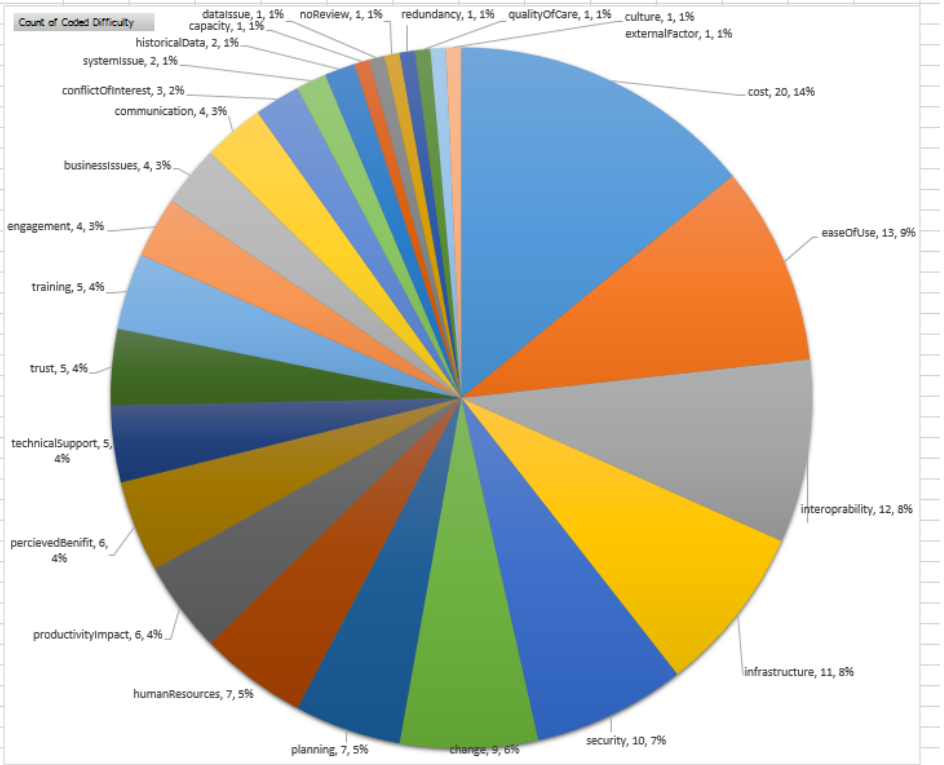
	A	B	C
1			
2	*Source ID*		**43**
3	*Items Noted*		emr
4			open source
5			demo
6			http://www.open-emr.org/wiki/index.php/OpenEMR_Version_4.1.2_Demo

Appendix 4 - Notes Captured Coding

	A	B	C	D	E	F
1						
2		**Source**	**Item Noted**	**Coded Difficulty**		
3		1	Holistic look at EHR adoption	-		
4		1	intuitive system is a benefit	-		
5		1	Cost an important factor	cost		
6		1	Not as simple as off the shelf purchase and install	easeOfUse		
7		2	More success stories	-		
8		2	success	-		
9		2	myth in implementing is	-		
10		5	population inflation	training		
11		3	cloud based system	-		
12		4	implementation steps	-		
13		5	barriers to implementation	-		
14		5	cost	cost		
15		5	affect on ability to provide care	-		
16		5	conflicts of interst	conflictOfInterest		
17		37	Medical errors	-		
18		5	culture	infrastructure		
19		5	human resources	humanResources		
20		5	it support and infrastructure	-		
21		5	it support and infrastructure	infrastructure		
22		6	initial succes does not mean continued success	-		
23		6	late failure or system drop off	-		

Appendix 5 - Count of Coded Notes

Row Labels	Count of Coded Difficulty
cost	20
easeOfUse	13
interoprability	12
infrastructure	11
security	10
change	9
planning	7
humanResources	7
productivityImpact	6
percievedBenifit	6
technicalSupport	5
trust	5
training	5
engagement	4
businessIssues	4
communication	4
conflictOfInterest	3
systemIssue	2
historicalData	2
capacity	1
dataIssue	1
noReview	1
redundancy	1
qualityOfCare	1
externalFactor	1
culture	1
Grand Total	142



Appendix 6 - Questionnaire Results Anonymised

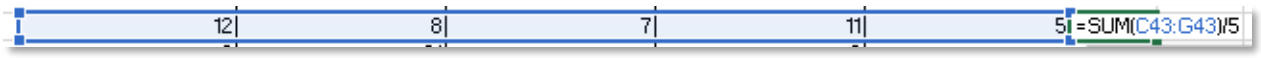
No.	Question	Participant 1 Responses	Participant 2 Responses	Participant 3 Responses	Participant 4 Responses	Participant 5 responses
1	From the literature to date, the researcher has found 'Ease of Use' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Ease of Use' when implementing?					
1.a	Have you experienced difficulties in relation to ease of use?	Yes	Yes	No	Yes	
1.b	Please provide details of the difficulty below	Due to the complexity of	New features sometime are hard to understand.		The IT system was easy to use however some minc	
1.c	How did you try to resolve the difficulty?	cases by applying different techniques. Some of which are as follows. 1. We try to keep the system processes aligned to the actual processes as much as possible. 2. We provide the users with tooltips and process workflows for easy navigation and understanding. 3. We provide the users with help material, video tutorials etc. to help them in using the system easily. 4. We divide the system into different sections so that if a person has to work only in a specific area then he doesn't feels overcrowded by other features of the system.	Talk to support team to resolve the issue and ask t		Training resolved most of these issues.	

Appendix 7 - Questionnaire Question 8 Results

8	From your experience, what are some common difficulties you experienced during the implementation phase of a health IT project? Please rank (1 being most difficult and continue to rank difficulties per importance) as they apply to your experience							
	Question	rticipant 1 Respons	ticipant 2 Respon	ticipant 3 Respon	ticipant 4 Respon	ticipant 5 respon	Average	Rank
	Difficulty							
	Cost	1	9			6	3.2	21
	Ease of Use	11	15		10	3	7.8	13
	Interoperability	12	8	7	11	5	8.6	11
	Security	2	21		9		6.4	17
	Planning	6	7		5	4	4.4	19
	Change	7	6		4		3.4	20
	Infrastructure	13	4	6	19	2	8.8	9
	Human Resources	3	2		2		1.4	24
	Technical Support	10	17		12		7.8	13
	Perceived Benefit	21	19		8		9.6	6
	Productivity Impact	22	18		14		10.8	5
	Trust in System	9	16		13		7.6	15
	Communication	14	5		7		5.2	18
	Conflict of Interest	15	14	1	14		8.8	9
	Training	24	13	2	6		9	8
	Business/Organizational Issues	5	1	3	3	1	2.6	23
	Historical Data	4	12		18		6.8	16
	System Capacity	23	20		17		12	4
	Redundancy	20	10		16		9.2	7
	Data Issue	16	11		15		8.4	12
	Organizational Culture	8	3	4	1		3.2	21
	System Issue	17	22	8	20		13.4	2
	Clinical Issue	18	24		21		12.6	3
	External Factor	19	23	9	22		14.6	1
	Other - Fear of Change					1	0.2	25
	Other - Interdepartmental Issues					1	0.2	25
	Other - Decision Support		1				0.2	25
	Other - Business Intelligence		1				0.2	25
	Other (please outline in box provided below)		Business Intelligence Decision Support			Interdepartmental issues between deeloper/infrastructure team/security team this can lead to finger pointing on delays in project rollouts also a big issue is fear of change from clients who are used to working in a		

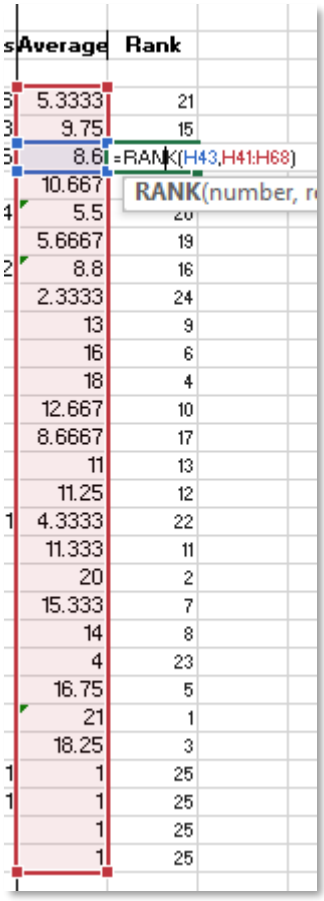
Appendix 8 - Example Average Formula Deployed for Questionnaire Results

```
=SUM(C43:G43)/5
```



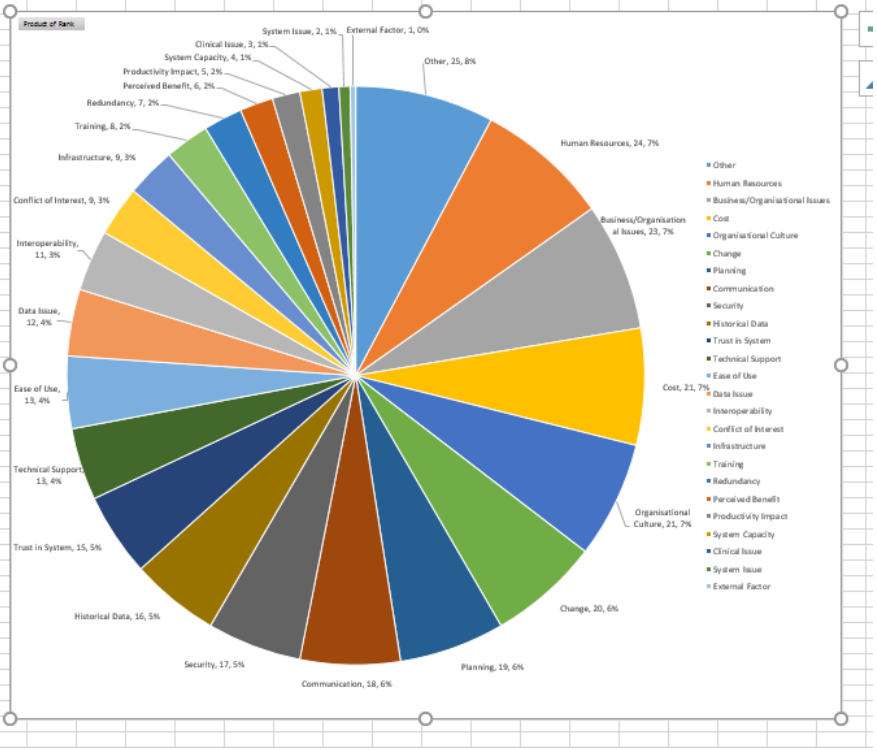
Appendix 9 - Example Rank Formula Deployed

```
=RANK(H41,H41:H68)
```

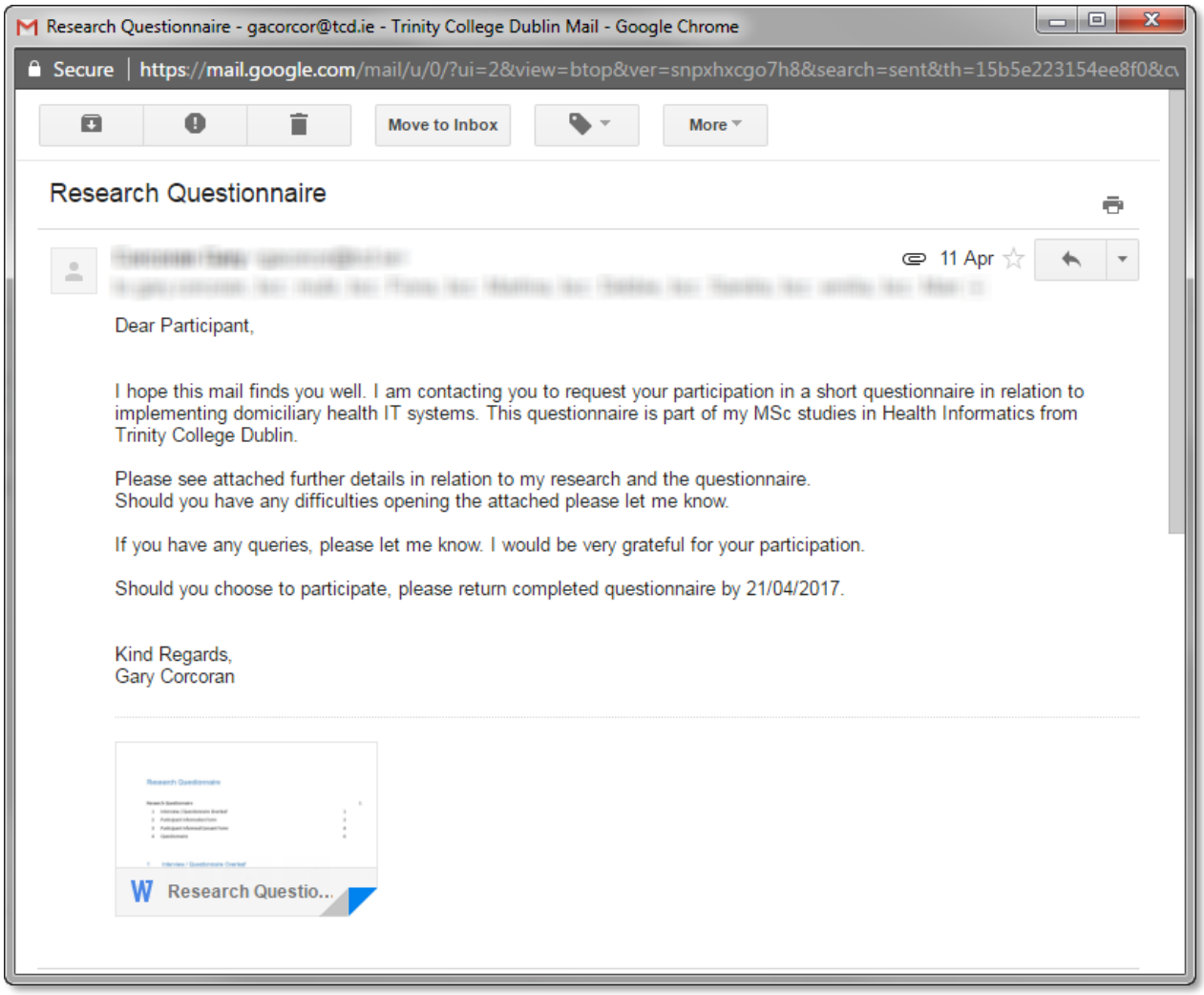

Average
Rank
5.3333
21
9.75
15
8.6
=RANK(H43,H41:H68)
RANK(number,
10.667
5.5
5.6667
19
8.8
16
2.3333
24
13
9
16
6
18
4
12.667
10
8.6667
17
11
13
11.25
12
4.3333
22
11.333
11
20
2
15.333
7
14
8
4
23
16.75
5
21
1
18.25
3
1
25
1
25
1
25
1
25

Appendix 10 - Questionnaire Question 8 Ranking

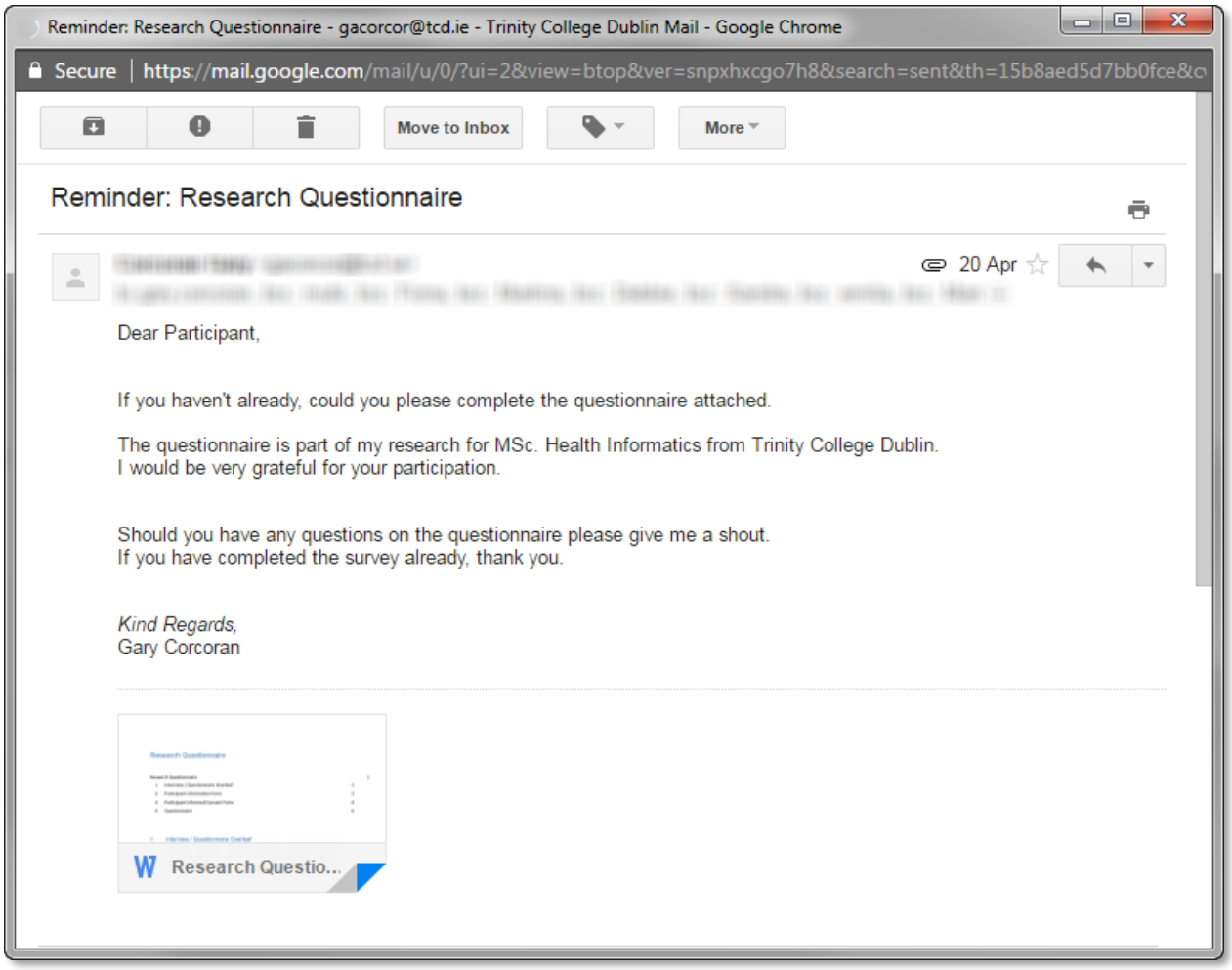
Row Labels	Product of Rank
Other	25
Human Resources	24
Business/Organisational Issues	23
Cost	21
Organisational Culture	21
Change	20
Planning	19
Communication	18
Security	17
Historical Data	16
Trust in System	15
Technical Support	13
Ease of Use	13
Data Issue	12
Interoperability	11
Conflict of Interest	9
Infrastructure	9
Training	8
Redundancy	7
Perceived Benefit	6
Productivity Impact	5
System Capacity	4
Clinical Issue	3
System Issue	2
External Factor	1
Grand Total	**1.23737E+25**



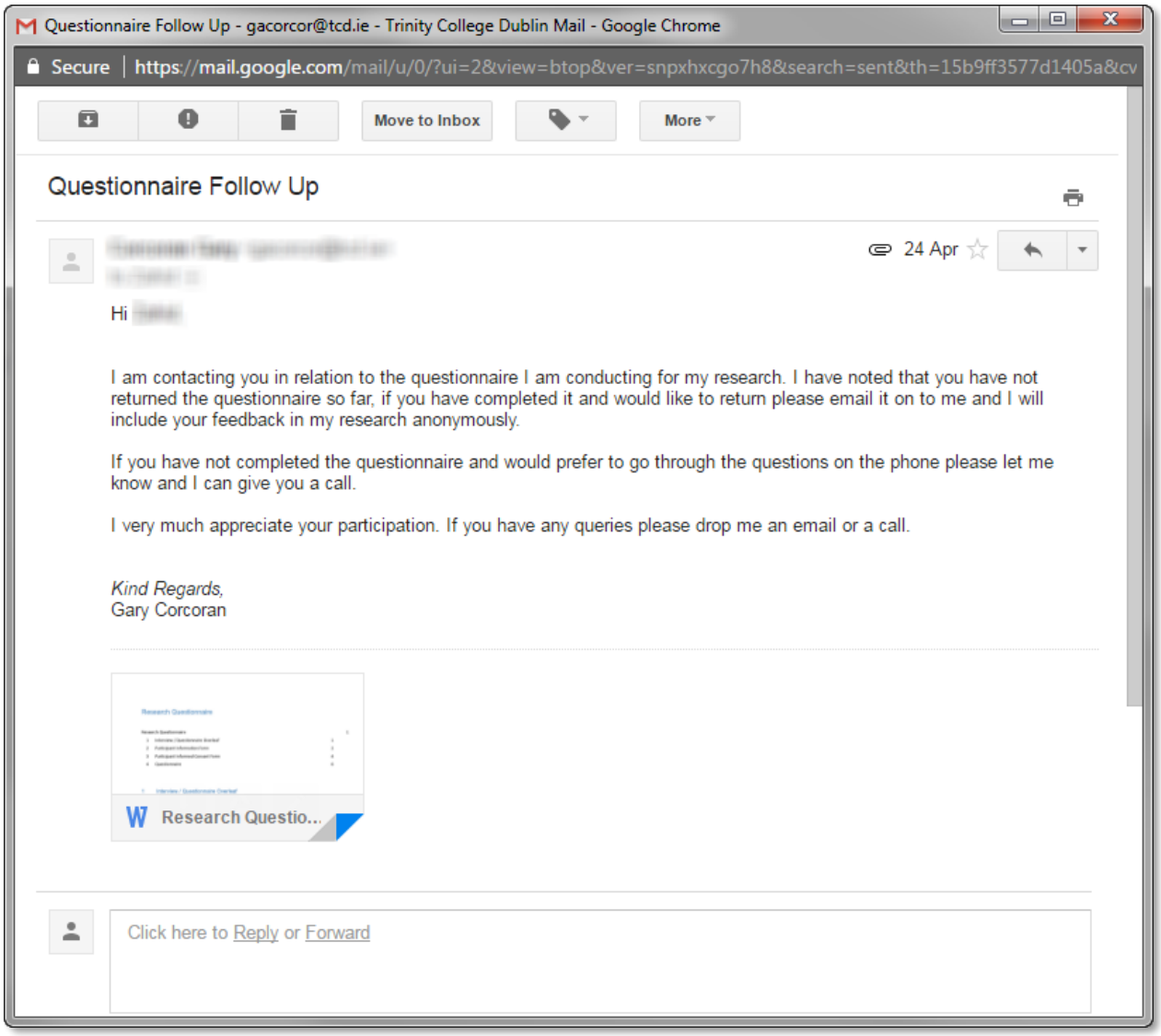
Appendix 11 - Initial Email Sent to Participants



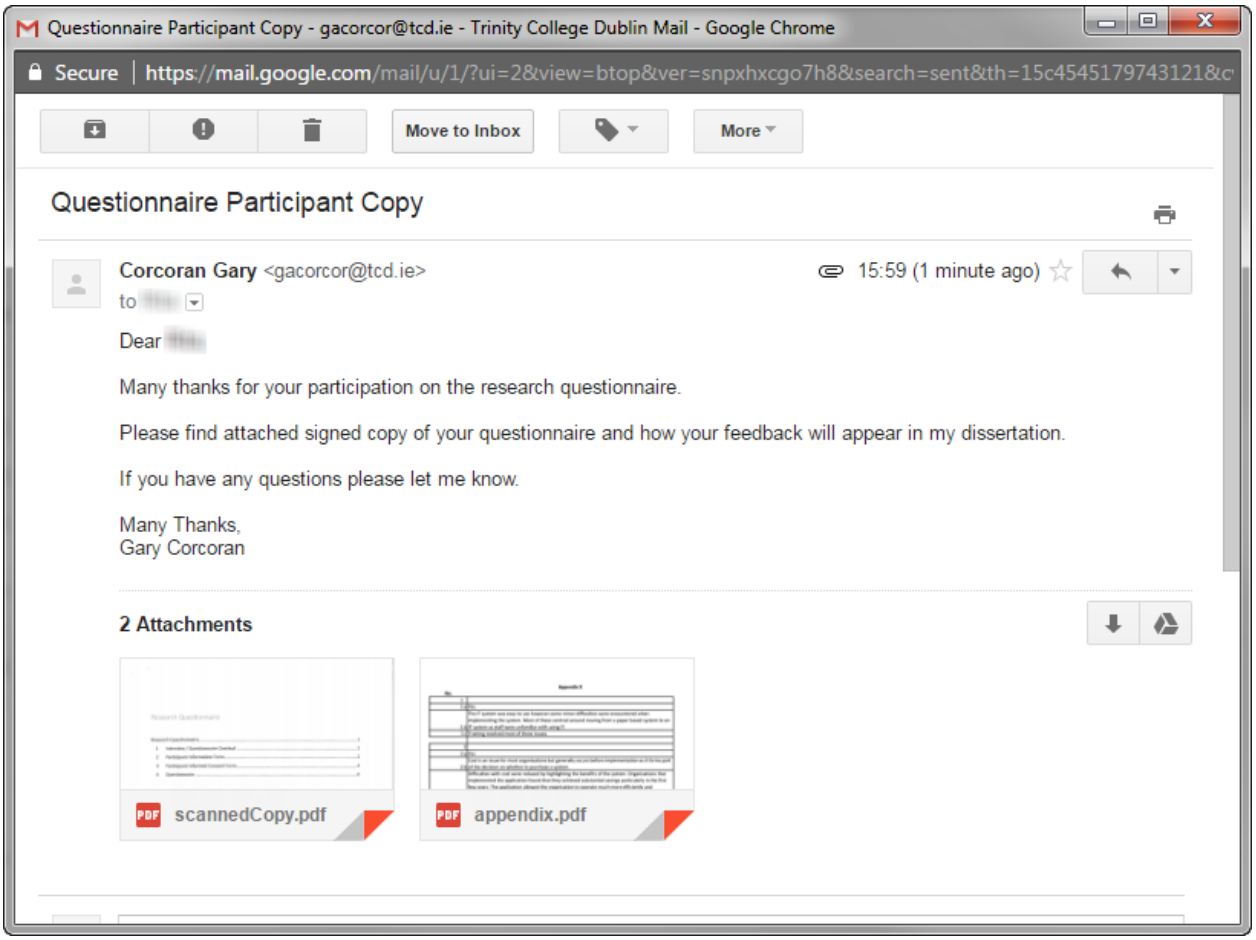
Appendix 12 - Reminder Email Sent to Participants



Appendix 13 - Questionnaire Follow Up Email



Appendix 14 - Questionnaire Conclusion Email



Appendix 15 - Questionnaire Ethical Approval Consent

GaryCorcoran_EthicalApproval

Status | View | Assign Supervisor

Submitted by gacorcor on Mon, 03/06/2017 - 09:07

Project overview

Name of Applicant:
Gary Corcoran
Academic Supervisor / Lead Researcher:
Gaye Stephens
Research Project Type:
Element of Taught Postgraduate Course
Project Duration:
Friday, September 23, 2016 to Thursday, June 22, 2017

Funder

Funder:
N/A

File Attachment

REC Application Form:

Filename	Date Uploaded	Size
GaryCorcoranEthicalApproval.pdf	2017-03-06 09:07:38	1.1 MB
GaryCorcoranEthicalApprovalAmmended.pdf	2017-03-26 09:13:24	1.11 MB

Admin fields

Academic Supervisor / Lead Researcher (username):
gstephen
Application Number:
20170307
Final Comments:

This project is now approved

Status:
Approved

Appendix 16 - Questionnaire Valentia Technologies Consent

Research Questionnaire

1 Interview / Questionnaire Overleaf

Project Title:

Implementation of Domiciliary Healthcare IT Solution: What are some common difficulties and some possible solutions?

Name of Lead Researcher (student in case of project work):

Mr. Gary Corcoran

Name of Supervisor:

Gaye Stephens.

TCD E-mail:

gacorcor@tcd.ie *or* gary@valentiatech.com

Telephone No.:

085 7580046

Course Name and Code (if applicable):

MSc Health Informatics

Estimated start date of survey/research:

03/04/2017

TRINITY COLLEGE DUBLIN

Project Participant Information

LEAD RESEARCHER:
Mr. Gary Corcoran

Project Information:

The study is to review the common difficulties or barriers that are found when implementing a domiciliary health IT system or a similar system.

There are three key points in the project, the first being to understand the systems that are available in the arena of domiciliary health. Domiciliary health is becoming more and more main stream in the Irish healthcare market to further support individuals at home. This research aims to establish the systems that are available and what are some issues during implementation may be.

The second key point is to evaluate similar systems and establish some of the common difficulties experienced during implementation of these systems. The rationale behind this search is to be able to give greater detail as system failures are often unreported.

The third and final key point is to establish some possible solutions for the common difficulties noted in the literature and established via interview or questionnaire. It is believed by developing the list of common difficulties, the solutions for the difficulties identified can be established through a combination of literature review and feedback via questionnaire or interview.

The list of common difficulties will then be reviewed and further researched how they can be avoided or supported during implementation. It is believed that the greater understanding of such difficulties and development of possible solutions will support project managers and system implementers in the future.

Please note any data collected in relation to this study will form part of an MSc in Health Informatics dissertation. Any data collected will be stored on the researchers Trinity College Google account. Following the submission and completion of the dissertation the researcher will delete any data stored.

Researcher Information:
The project has been undertaken by the researcher to develop the understanding of such systems and the difficulties during the implementation phase and furthermore, allow the student to complete dissertation in relation to MSc Health Informatics from Trinity College Dublin.

Please also note the researcher is a current employee of Valentia Technologies Ltd., and the researcher may be known to you. Contact information for participation was available to the researcher to send you (the participant) this study through normal work tasks. Approval to contact participants has been granted by Valentia Technologies Ltd.

Participant Information:
Participation is not required and should the you (the participant) choose to opt to join in the study please complete the questionnaire or confirm that you would like to participate in an interview. It is important to note that participation is optional and each question should you choose to participate is also optional, feel free to omit a response to any question; however, the researcher would be grateful if all questions are responded to.

Please Note: Participants must be over 18 years of age to participate in this study.

It is requested that any participants do not name any third party in an open text field. Any such replies will be anonymised. Furthermore, as this is a voluntary study, you have the right not to participate, withdraw and to omit individual responses without penalty, at any time.

Please Note: It is estimated the study will take between 10-25 minutes to complete. During interview, audio recording will be in place to allow the researcher to review and generate transcripts. It is important to note, no audio or video recordings will be made available to anyone other than the research/research team, nor will any such recordings be replayed in any public forum or presentation of the research. If participating in interview, following participation in interview the student will collate the transcripts, confirm they are correct and anonymised before including in the main document

Following completion of the questionnaire please return a copy to the student via email or printed copy. Contact information is available on the overleaf. If participating in questionnaire, following return of the questionnaire the student will review and anonymise any third-party information and send you (the participant) a copy of your questionnaire as it will appear in the project

Please Note: In the extremely unlikely event that illicit activity is reported I will be obliged to report it to appropriate authorities

3 Valentia Technologies Consent Form

TRINITY COLLEGE DUBLIN

INFORMED CONSENT FORM

LEAD RESEARCHER:

Mr. Gary Corcoran

BACKGROUND OF RESEARCH:

This study is to review the common difficulties or barriers that are found when implementing a domiciliary health IT system or a similar system.

There are three key points in the project, the first being to understand the systems that are available in the arena of domiciliary health. Domiciliary health is becoming more and more mainstream in the Irish healthcare market to further support individuals at home. This research aims to establish the systems that are available and what some issues during implementation may be.

The second key point is to evaluate similar systems and establish some of the common difficulties experienced during implementation of these systems. The rationale behind this search is to be able to give greater detail as system failures are often unreported.

The third and final key point is to establish some possible solutions for the common difficulties noted in the literature and established via interview or questionnaire. It is believed by developing the list of common difficulties, the solutions for the difficulties identified can be established through a combination of literature review and feedback via questionnaire or interview.

The list of common difficulties will then be reviewed and further researched how they can be avoided or supported during implementation.

PROCEDURES OF THIS STUDY:

This study will request that participants review the consent information and project/participant information. Following this, they may opt to complete the questionnaire attached and subsequently return the completed questionnaire.

Following this, the researcher will review and anonymise any third party information if required and return a copy of the questionnaire as it will appear in the project.

PUBLICATION:

The researcher may publish this research at a later date.

DECLARATION:

- VT (Valentia Technologies Ltd.) have read, or had read to them, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- VT understand that if Participants make illicit activities known, these will be reported to appropriate authorities by the Student
- VT agrees to allow the researcher to contact clients that he would normally have contact with for standard work tasks.
- VT confirms the researcher can use the provided Valentia contact email as a support email for contact with clients, gary@valentiatech.com. Initial contact will be made via student email address, gacorcor@tcd.ie.
- VT have received a copy of this agreement.

~~PARTICIPANT'S~~ NAME: VALENTIA TECHNOLOGIES

PARTICIPANT'S SIGNATURE: Ann Costlie
General Counsel.

Date: 10/4/17

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

RESEARCHERSCONTACTDETAILS:

Email:

gacorcor@tcd.ie or gary@valentiatech.com

Telephone No.:

085 7580046

RESEARCHER SIGNATURE: GARY G

Date: 31/03/2017

Appendix 17 - Sample Questionnaire

Research Questionnaire

1 Interview / Questionnaire Overleaf

Project Title:

Implementation of Domiciliary Healthcare IT Solution: What are some common difficulties and some possible solutions?

Name of Lead Researcher (student in case of project work):

Mr. Gary Corcoran

Name of Supervisor:

Gaye Stephens.

TCD E-mail:

gacorcor@tcd.ie *or* gary@valentiatech.com

Telephone No.:

085 7580046

Course Name and Code (if applicable):

MSc Health Informatics

Estimated start date of survey/research:

03/04/2017

2 Participant Information Form

TRINITY COLLEGE DUBLIN

Project Participant Information

LEAD RESEARCHER:

Mr. Gary Corcoran

Project Information:

The study is to review the common difficulties or barriers that are found when implementing a domiciliary health IT system or a similar system.

There are three key points in the project, the first being to understand the systems that are available in the arena of domiciliary health. Domiciliary health is becoming more and more main stream in the Irish healthcare market to further support individuals at home. This research aims to establish the systems that are available and what are some issues during implementation may be.

The second key point is to evaluate similar systems and establish some of the common difficulties experienced during implementation of these systems. The rationale behind this search is to be able to give greater detail as system failures are often unreported.

The third and final key point is to establish some possible solutions for the common difficulties noted in the literature and established via interview or questionnaire. It is believed by developing the list of common difficulties, the solutions for the difficulties identified can be established through a combination of literature review and feedback via questionnaire or interview.

The list of common difficulties will then be reviewed and further researched how they can be avoided or supported during implementation. It is believed that the greater understanding of such difficulties and development of possible solutions will support project managers and system implementers in the future.

Please note any data collected in relation to this study will form part of an MSc in Health Informatics dissertation. Any data collected will be stored on the researchers Trinity College Google account. Following the submission and completion of the dissertation the researcher will delete any data stored.

Researcher Information:

The project has been undertaken by the researcher to develop the understanding of such systems and the difficulties during the implementation phase and furthermore, allow the student to complete dissertation in relation to MSc Health Informatics from Trinity College Dublin.

Please also note the researcher is a current employee of Valentia Technologies Ltd., and the researcher may be known to you. Contact information for participation was available to the researcher to send you (the participant) this study through normal work tasks. Approval to contact participants has been granted by Valentia Technologies Ltd.

Participant Information:

Participation is not required and should the you (the participant) choose to opt to join in the study please complete the questionnaire or confirm that you would like to participate in an interview. It is important to note that participation is optional and each question should you choose to participate is also optional, feel free to omit a response to any question; however, the researcher would be grateful if all questions are responded to.

Please Note: Participants must be over 18 years of age to participate in this study.

It is requested that any participants do not name any third party in an open text field. Any such replies will be anonymised. Furthermore, as this is a voluntary study, you have the right not to participate, withdraw and to omit individual responses without penalty, at any time.

Please Note: It is estimated the study will take between 10-25 minutes to complete. During interview, audio recording will be in place to allow the researcher to review and generate transcripts. It is important to note, no audio or video recordings will be made available to anyone other than the research/research team, nor will any such recordings be replayed in any public forum or presentation of the research. If participating in interview, following participation in interview the student will collate the transcripts, confirm they are correct and anonymised before including in the main document

Following completion of the questionnaire please return a copy to the student via email or printed copy. Contact information is available on the overleaf. If participating in questionnaire, following return of the questionnaire the student will review and anonymise any third-party information and send you (the participant) a copy of your questionnaire as it will appear in the project

Please Note: In the extremely unlikely event that illicit activity is reported I will be obliged to report it to appropriate authorities

3 Participant Informed Consent Form

TRINITY COLLEGE DUBLIN

INFORMED CONSENT FORM

LEAD RESEARCHER:

Mr. Gary Corcoran

BACKGROUND OF RESEARCH:

This study is to review the common difficulties or barriers that are found when implementing a domiciliary health IT system or a similar system.

There are three key points in the project, the first being to understand the systems that are available in the arena of domiciliary health. Domiciliary health is becoming more and more mainstream in the Irish healthcare market to further support individuals at home. This research aims to establish the systems that are available and what some issues during implementation may be.

The second key point is to evaluate similar systems and establish some of the common difficulties experienced during implementation of these systems. The rationale behind this search is to be able to give greater detail as system failures are often unreported.

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The list of common difficulties will then be reviewed and further researched how they can be avoided or supported during implementation.

Please note any data collected in relation to this study will form part of an MSc in Health Informatics dissertation.

PROCEDURES OF THIS STUDY:

This study will request that participants review the consent information and project/participant information. Following this, they may opt to complete the questionnaire attached and subsequently return the completed questionnaire.

Following this, the researcher will review and anonymise any third-party information if required and return a copy of the questionnaire as it will appear in the project.

PUBLICATION:

The researcher may publish this work at a later date.

DECLARATION:

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- I agree that my data is used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.
- I understand that if I make illicit activities known, these will be reported to appropriate authorities.
- I understand that I may stop electronic recordings at any time, and that I may at any time, even subsequent to my participation have such recordings destroyed (except in situations such as above).
- I understand that, subject to the constraints above, no recordings will be replayed in any public forum or made available to any audience other than the current researchers/research team.
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.
- I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.
- I understand that my participation is fully anonymous and that no personal details about me will be recorded.
- I understand that I am completing this study on my own behalf and not of any organisation I was or am currently associated with.
- I have received a copy of this agreement.

PARTICIPANT'S NAME: _____

PARTICIPANT'S SIGNATURE: _____

Date: _____

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and have fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

RESEARCHERS CONTACT DETAILS:

Email:

gacorcor@tcd.ie *or* gary@valentiatech.com

Telephone No.:

085 7580046

INVESTIGATOR'S SIGNATURE: _____

Date: _____

4 Questionnaire

1. From the literature to date, the researcher has found 'Ease of Use' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Ease of Use' when implementing?

   a) Have you experienced difficulties in relation to ease of use? Yes ☐ No ☐

   b) Please provide details of the difficulty below

   ☐

   c) How did you try to resolve the difficulty?

   ☐

2. From the literature to date, the researcher has found 'System Cost' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'System Cost when implementing?

   a) Have you experienced difficulties in relation to System Cost? Yes ☐ No ☐

   b) Please provide details of the difficulty below

   ☐

   c) How did you try to resolve the difficulty?

   ☐

3. From the literature to date, the researcher has found 'System Interoperability' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'System Interoperability' when implementing?

   a) Have you experienced difficulties in relation to System Interoperability? ☐ Yes ☐ No

b) Please provide details of the difficulty below

c) How did you try to resolve the difficulty?

4. From the literature to date, the researcher has found 'Security' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Security' when implementing?

a) Have you experienced difficulties in relation to Security? Yes ☐ No ☐

b) Please provide details of the difficulty below

c) How did you try to resolve the difficulty?

5. From the literature to date, the researcher has found 'IT Infrastructure to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'IT Infrastructure' when implementing?

a) Have you experienced difficulties in relation to IT Infrastructure? Yes ☐ No ☐

b) Please provide details of the difficulty below

c) How did you try to resolve the difficulty?

6. From the literature to date, the researcher has found 'Change Management' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Change Management' when implementing?

a) Have you experienced difficulties in relation to change management? ☐ Yes ☐ No

b) Please provide details of the difficulty below

c) How did you try to resolve the difficulty?

7. From the literature to date, the researcher has found 'Technical Support' to be one of the most common difficulties. Please discuss your experience of any difficulties in relation to 'Technical Support' when implementing?

a) Have you experienced difficulties in relation to Technical Support? ☐ ☐o

b) Please provide details of the difficulty below

c) How did you try to resolve the difficulty?

8. From your experience, what are some common difficulties you experienced during the implementation phase of a health IT project?

Please rank (1 being most difficult and continue to rank difficulties per importance) as they apply to your experience

Difficulty	Rank
Cost	
Ease of Use	
Interoperability	
Security	
Planning	
Change	
Infrastructure	
Human Resources	
Technical Support	
Perceived Benefit	
Productivity Impact	
Trust in System	
Communication	
Conflict of Interest	
Training	
Business/Organisational Issues	
Historical Data	
System Capacity	
Redundancy	
Data Issue	
Organisational Culture	

System Issue	
Clinical Issue	
External Factor	
Other (please outline in box provided below)	

Other Difficulties Experienced

Appendix 18 - Participant 1 Results

Appendix X

No.	
1	
1.a	Yes
1.b	Due to the complexity of the processes involved, it becomes very difficult to keep the system at a level where an end user, who is no-technical and has limited understanding of the computer systems, can easily use the system.
1.c	We try to handle such cases by applying different techniques. Some of which are as follows. 1. We try to keep the system processes aligned to the actual processes as much as possible. 2. We provide the users with tooltips and process workflows for easy navigation and understanding. 3. We provide the users with help material, video tutorials etc. to help them in using the system easily. 4. We divide the system into different sections so that if a person has to work only in a specific area then he doesn't feels overcrowded by other features of the system.
2	
2.a	Yes
2.b	Majority of the times the domiciliary organizations are run by NGO's who are working on non-profit basis. This means that they have very limited budget to get a sophisticated system implemented.
2.c	We try to break the system into multiple iterations so that the organization doesn't have to bear the full cost of a system at once. We start with giving them the "Minimum viable Solution" so that they can run the core parts of their system. Further enhancements are then provided based on the budget of organization.
3	
3.a	No
3.b	This issue arises mostly with the old systems which were built on some old technology or with the solution providers who tend to hold data rather than sharing it.
3.c	In cases where we do face this problem, we always try to follow standards. This helps in getting the implementation correct and future proof.
4	
4.a	Yes
4.b	Technology is evolving all the time and things are becoming secure. But, this also means that hackers have got new technology to exploit the loop holes.
4.c	There are multiple measures that we take to cater for the security threat. 1. Use of latest technology 2. Do penetration testing before releases 3. Encryption 4. Firewalls 5. Anti-Virus 6. Anti-Malware
5	
5.a	No

5.b	This used to be an issue in the past. But going forward, it is no longer an issue.
5.c	

6	
6.a	Yes
6.b	Processes do change in the organization and the system needs to be upgraded to reflect that. This means that change will be made in the system to complete that process in the software system. This process looks simple but is very complicated because of the following reasons. 1. Requirements of change are not fully understood 2. They are not properly documented and communicated 3. All stakeholders are not taken on board 4. Change is not broken down into smaller components and by the time it is available things have changed again
6.c	We embrace changes when they arise. We do the following to ensure that no or minimal rework is required. 1. Ensure that all stakeholders get a finalized document and sign it off. 2. We prioritize the changes so that the important changes are delivered first and we have control over the schedule of delivery, scope and budget.

7	
7.a	Yes
7.b	The users of the system are mostly those people who have got little or no technical background. Mostly, they have got little experience of technology stuff like Computers, smart phones etc. This means that even if they get a software generated message that they didn't expected then they will panic.
7.c	We resolve this by providing the end user with multiple levels of support. Some of them they can use themselves and if that doesn't work then they can always have a helpdesk to answer their questions. 1. User Manuals 2. Video tutorials 3. Troubleshooting Document 4. Level 1 Support provided by on site super users 5. Level 2 Support provided by Vendor.

8	**Participant 1 Responses**
Cost	1
Ease of Use	11
Interoperability	12
Security	2
Planning	6
Change	7
Infrastructure	13
Human Resources	3
Technical Support	10
Perceived Benefit	21

Productivity Impact	22
Trust in System	9
Communication	14
Conflict of Interest	15
Training	24
Business/Organisational Issues	5
Historical Data	4
System Capacity	23
Redundancy	20
Data Issue	16
Organisational Culture	8
System Issue	17
Clinical Issue	18
External Factor	19
Other (please outline in box provided below)	

Appendix 19 - Participant 2 Results

Appendix X

No.	
1	
1.a	Yes
1.b	New features sometime are hard to understand.
1.c	Talk to support team to resolve the issue and ask them for help.
2	
2.a	No
2.b	Cost has not been an issue
2.c	negotiate with sales team on price
3	
3.a	Yes
3.b	Some time had issues with legacy system approach of connecting for data access.
3.c	Talk to support team to find best way normally we find out many way as system is open source commnication protocol
4	
4.a	No
4.b	Havent experienced issue with system in terms of security
4.c	sometime get issues with password help desk resolve the issue
5	
5.a	Yes
5.b	Got a lot of issues while setting up enviorment. E.g. internet, firewall, pc, monitor
5.c	Talk to vendor on suggestion and help. They have always been very helpful.
6	
6.a	Yes
6.b	With new version get a lot of issues internally with respect to changes made in system
6.c	Vendor provide release notes, help material, videos etc.
7	
7.a	Yes
7.b	Some Time its hard to explain the issue
7.c	Try to post everything on the helpdesk with screen shots
8	
	Participant 2 Responses
Cost	9
Ease of Use	15
Interoperability	8
Security	21
Planning	7
Change	6
Infrastructure	4
Human Resources	2
Technical Support	17

Perceived Benefit	19
Productivity Impact	18
Trust in System	16
Communication	5
Conflict of Interest	14
Training	13
Business/Organisational Issues	1
Historical Data	12
System Capacity	20
Redundancy	10
Data Issue	11
Organisational Culture	3
System Issue	22
Clinical Issue	24
External Factor	23
Other (please outline in box provided below)	Business Intelligence Decision Support

Appendix 20 - Participant 3 Results

Appendix X

No.	
1	
1.a	No
1.b	
1.c	
2	
2.a	No
2.b	
2.c	
3	
3.a	No
3.b	
3.c	
4	
4.a	No
4.b	
4.c	
5	
5.a	No
5.b	
5.c	
6	
6.a	Yes
6.b	You cannot just log in and use the system. Need training before use.
6.c	Lot of traning use user manual.
7	
7.a	No
7.b	
7.c	
8	
	Participant 3 Responses
Cost	
Ease of Use	
Interoperability	
Security	7
Planning	
Change	
Infrastructure	
Human Resources	6
Technical Support	
Perceived Benefit	

Productivity Impact	
Trust in System	
Communication	
Conflict of Interest	
Training	1
Business/Organisational Issues	2
Historical Data	3
System Capacity	
Redundancy	
Data Issue	
Organisational Culture	
System Issue	4
Clinical Issue	8
External Factor	
	9
Other (please outline in box provided below)	

Appendix 21 - Participant 4 Results

Appendix X

No.	
1	
1.a	Yes
1.b	The IT system was easy to use however some minor difficulties were encountered when implementing the system. Most of these centred around moving from a paper based system to an IT system as staff were unfamiliar with using IT.
1.c	Training resolved most of these issues.
2	
2.a	Yes
2.b	Cost is an issue for most organisations but generally occurs before implementation as it forms part of the decision on whether to purchase a system.
2.c	Difficulties with cost were reduced by highlighting the benefits of the system. Organisations that implemented the application found that they achieved substantial savings particularly in the first few years. The application allowed the organisation to operate much more efficiently and effectively. It improved organisational compliance, increased transparency and eased reporting requirements.
3	
3.a	No
3.b	No difficulties experienced.
3.c	The system can integrate with most third party systems.
4	
4.a	No
4.b	
4.c	No difficulties experienced. It is a fully secure, role based system. There is a full audit trail of all activity on the system.
5	
5.a	No
5.b	
5.c	An internet connection was required as it is a cloud based system. It can run on most PCs.
6	
6.a	No
6.b	Resistance to change from existing practices and methods.
6.c	To assist with change management, it was important to provide adequate training and support. It was important to have a train the trainer approach to have an 'expert' on site at all times. Finding product champions within the organisation was important. it was also important to highlight the benefits of the system to all stakeholders including employees (management, administrators and front-line staff), service users and the organisation. By highlighting the benefits a greater level of 'buy in' was achieved and this assisted with change management.
7	
7.a	No
7.b	

7.c	Support is provided by a help desk (call and email), online help manual and tutorials.
8	
	Participant 4 Responses
Cost	
Ease of Use	
Interoperability	10
Security	11
Planning	9
Change	5
Infrastructure	4
Human Resources	19
Technical Support	2
Perceived Benefit	12
Productivity Impact	8
Trust in System	14
Communication	13
Conflict of Interest	7
Training	14
Business/Organisational Issues	6
Historical Data	3
System Capacity	18
Redundancy	17
Data Issue	16
Organisational Culture	15
System Issue	1
Clinical Issue	20
External Factor	21
	22
Other (please outline in box provided below)	

Appendix 22 - Participant 5 Results

Appendix X

No.	
1	
1.a	
1.b	
1.c	
2	
2.a	Yes
2.b	Cost of hardware for healthcare roll outs can often be prohibitive. As well as back end infrastructure there is also costs incurred with mobile technologies which can require replacing every few years.
2.c	Cloud services are providing more adaptable role out options for sutomers. This means infrastructutre can be upgraded as required with out incurring lare costs. Also the increase in mobile devices has given more options when making decisions
3	
3.a	Yes
3.b	This is an area which is always difficult to overcome when installing new system. This can be due to the technical difficulties involved and also issues between different vendors
3.c	these issues are becom easier to resolve with experience and also using the systems unsing the recommended protocols
4	
4.a	Yes
4.b	Security is becoming an ever increasing issue in healthcare and patient records. Todays infrastructure models require access from everywhere on all devices.
4.c	It's important to follow standards and recommended operating procedures for this such as ISO 27001 and 9001. Also the GDPR coming into effect next year will assist companies in security complience
5	
5.a	Yes
5.b	Yes infreatructure requirement can change quickly depending on success of projects and new hardward requirements can cause friction between software companies and their clients
5.c	Prevalence of Cloud computing platforms such as AWS and Azure can assist here and allow infrastructure to grow in relation to system requirements
6	
6.a	Yes
6.b	Yes from a personal view point I have worked on rollouts where this can affect project rollouts. For example a new firewall policy which has been forgotten and is required but the company policy is that it requires two weeks notice
6.c	This needs to be done through close collaboration with client. We are provided with the clients change management procedures befre rollout so it is up to us to follow and make sure it doesn't become an issue
7	

7.a	Yes
7.b	Been on the technical support team the issues I would experience are communications issues when explaining issues. This can take a lot of time to discover what the real issues is
7.c	Have someone from the client as the designated contact
8	
	Participant 5 responses
Cost	
Ease of Use	6
Interoperability	3
Security	5
Planning	
Change	4
Infrastructure	
Human Resources	2
Technical Support	
Perceived Benefit	
Productivity Impact	
Trust in System	
Communication	
Conflict of Interest	
Training	
Business/Organisational Issues	
Historical Data	1
System Capacity	
Redundancy	
Data Issue	
Organisational Culture	
System Issue	
Clinical Issue	
External Factor	
Other (please outline in box provided below)	
	Interdepartmental issues between deeloper/infrastructure team/security team this can lead to finger pointing on delays in project rollouts also a big issue is fear of change from clients who are used to working in a particular way.

Appendix 23 - Project Gannt Chart

ID	Task Name	Start	Finish
1	Develop Research Question	23/09/2016	07/10/2016
2	Develop Research Proposal	14/10/2016	12/11/2016
3	Research Proposal Due	25/11/2016	25/11/2016
4	Literature Review	25/11/2016	03/01/2017
5	Literature Review Draft Due	20/01/2017	20/01/2017
6	Submit Ethical Approval	24/02/2017	24/02/2017
7	Literature Review	20/01/2017	11/03/2017
8	Documentation	20/01/2017	30/04/2017
9	Questionnaire	20/03/2017	30/04/2017
10	Soft Bound Copy Due	04/05/2017	04/05/2017
11	Revise and Amend Documentation	04/05/2017	07/06/2017
12	Final Dissertation Due	22/06/2017	22/06/2017

Oct 2016
25/9
2/10
9/10
16/10
23/10
30/10
Nov 2016
6/11
13/11
20/11
27/11
Dec 2016
4/12
11/12
18/12
25/12
Jan 2017
1/1
8/1
15/1
22/1
29/1
Feb 2017
5/2
12/2
19/2
26/2
Mar 2017
5/3
12/3
19/3
26/3
Apr 2017
2/4
9/4
16/4
23/4
30/4
May 2017
7/5
14/5
21/5
28/5
Jun 2017
4/6
11/6
18/6

Appendix 24 - Project Google Drive Backup