A CONCEPTUAL FORESIGHT MODEL TO INVESTIGATE THE ADOPTION OF RADIO FREQUENCY IDENTIFICATION TECHNOLOGY IN THE ENGLISH NATIONAL HEALTH SERVICE.

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Dedication

For Sanam, my guiding light.

For my Mother, her love has no bounds. For my Father, who taught me to treat triumph and disaster just the same.

For my Brother, who inspires me to keep on going. For my Sister, who balances east and west with such grace.

For my Uncles, allowing me to stand on the shoulders of giants. For my Aunties whose time, love and attention I can never repay.

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Selected Outputs

This section lists the selected research outputs achieved through work conducted in preparation and in support of this thesis. The publications are presented in descending time order.

- Automatic Identification and Data Capture Technology Focused Scenario Thinking in the English National Health Service. *Proceedings of the 4th European Commission's Future Technology Analysis Conference (FTA 2014)*, Brussels, Belgium.
- Combining Scenario Planning And Technology Roadmapping. *Proceedings of the British Academy of Management Conference (BAM 2014)* Belfast, Ireland.
- A Conceptual Method Combining Scenario Planning and Technology Roadmapping. *Proceedings of the XXV International Society of Professional Innovation Management Conference (ISPIM 2014)* Dublin, Ireland.
- Foresight Technology Adoption, Combining Scenario Planning and Technology Roadmapping*. Proceedings of the OR55 (Operational Research 55 2013) Annual Conference,* Exeter UK.
- Scenarios and health supply management: Using Scenario Planning to investigate and facilitate system level change in healthcare supply management. *Proceedings of the 22nd Annual International Purchasing and Supply, Education and Research Association Conference (IPSERA 2013)* (pp. 1115-1129) Nice, France.
- RFID in English Healthcare. *Proceedings of the Japanese Association for the Promotion of Science Summer Programme (JSPS SF 2012).* Tokyo, Japan.
- Scenario Planning for Healthcare Management: Aligning Guidance from Practice to Research. *Proceedings of the Qualitative Health Research Conference (QHR 2012)* Montreal, Canada.
- RFID in English Healthcare Supply Chains. *The Modern Information Technology in the Innovation Processes of the Industrial Enterprises (MITIP 2011),* Trondheim, Norway.

Thesis Summary

A Conceptual Foresight Model to Investigate the Adoption of Radio Frequency Identification Technology in the English National Health Service.

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Radio Frequency Identification Technology (RFID) adoption in healthcare settings has the potential to reduce errors, improve patient safety, streamline operational processes and enable the sharing of information throughout supply chains. RFID adoption in the English NHS is limited to isolated pilot studies. Firstly, this study investigates the drivers and inhibitors to RFID adoption in the English NHS from the perspective of the GS1 Healthcare User Group (HUG) tasked with coordinating adoption across private and public sectors. Secondly a conceptual model has been developed and deployed, combining two of foresight's most popular methods; scenario planning and technology roadmapping. The model addresses the weaknesses of each foresight technique as well as capitalizing on their individual, inherent strengths.

Semi structured interviews, scenario planning workshops and a technology roadmapping exercise were conducted with the members of the HUG over an 18-month period. An action research mode of enquiry was utilized with a thematic analysis approach for the identification and discussion of the drivers and inhibitors of RFID adoption. The results of the conceptual model are analysed in comparison to other similar models.

There are implications for managers responsible for RFID adoption in both the NHS and its commercial partners, and for foresight practitioners. Managers can leverage the insights gained from identifying the drivers and inhibitors to RFID adoption by making efforts to influence the removal of inhibitors and supporting the continuation of the drivers. The academic contribution of this aspect of the thesis is in the field of RFID adoption in healthcare settings. Drivers and inhibitors to RFID adoption in the English NHS are compared to those found in other settings.

The implication for technology foresight practitioners is a proof of concept of a model combining scenario planning and technology roadmapping using a novel process. The academic contribution to the field of technology foresight is the conceptual development of foresight model that combines two popular techniques and then a deployment of the conceptual foresight model in a healthcare setting exploring the future of RFID technology.

Key Words: Technology Adoption, Healthcare, Foresight, RFID

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Chapter 1: Introduction

1. Introduction

This Chapter introduces the subject of this thesis, sets out the background context of the study, establishes why the topics covered are worthy of research, details the key contributions to knowledge and presents a short summary of each following Chapter.

This study brings together two areas of academic inquiry. The first is Radio Frequency Identification Technology (RFID) adoption in the English National Health Service (NHS). RFID technology has proven potential in healthcare settings in the areas of patient safety, reduction of errors, process efficiency, inventory management, tracking of mobile devices and information sharing throughout supply chains (Lee and Shim, 2007; Macario et al., 2006; Sheng et al., 2008; Tu et al., 2009; Tzeng et al., 2008; Varshney, 2007).

However, RFID adoption in the NHS is limited to isolated pilot projects, not funded centrally and faces the added complexities of needing collaboration and co-ordination efforts across organisational boundaries and across boundaries between the publicly funded health sector and the commercial sector. Isolated pilot projects, although providing an indication of the case for RFID adoption, do not take full advantage of the technical, operational, and clinical capabilities of RFID technology. There are drivers and inhibitors to RFID adoption in the English NHS, which this thesis aims to identify. Currently, RFID is an emerging technology in the NHS as shown in Chapter 2. Those who hold interest in RFID adoption at the system level in the English NHS could look to foresight techniques to provide insight into the future of this emerging technology.

The second area of academic inquiry is concerned with the combination of two popular foresight techniques: scenario planning and technology roadmapping. Foresight techniques provide the capability of systematically exploring the future of science, technology, economy and policy with the goal of identifying key areas of research and development which may produce the greatest benefits to society.

Scenario planning provides a future-focused methodology, which allows for the systematic use of insights from experts across a field, and helps explore the joint impact of various uncertainties (Tapinos, 2012). Scenario planning has three main schools of approach (Amer et al., 2012). This thesis is concerned with the 'intuitive logics' method of scenario planning.

Contemporary roadmapping was first utilized by Motorola in the 1970's to facilitate effective alignment between technology and product development. Since the 1970s, it has been exploited at national, sector and company levels. It is applicable to a wide range of issues including capability planning, programme planning and knowledge asset planning (Phaal and Muller, 2009). Kostoff and Scaller (2001) describe the main benefit of roadmapping as the provision of information to help make better technology-investment decisions.

The informants of this research study are the members of UK GS1 Healthcare User Group (Global Standard HUG). The GS1 HUG is a unique group of individuals with expertise in the field of Automatic Identification and Data Capture Technologies (AIDC). RFID technologies are a form of AIDC technology with the other forms encompassed in general as barcoding. The UK GS1 Healthcare User Group's remit is to drive the adoption of RFID technologies in the NHS at the system level. The HUG's members are interested in the future of RFID adoption in the NHS at the System level. The GS1 HUG was established in 2009 by the DoH to drive the adoption of RFID technologies by co-ordinated effort. The primary function of the HUG is to ensure RFID technologies are adopted in operational areas of the NHS where the benefits of adoption have been proven. The key aim is to ensure the supporting systems adopted share data standards to enable information sharing between the individual RFID systems and NHS monitoring/performance management bodies.

2. Key Contributions to Knowledge

This section sets out the key contributions to knowledge made by this thesis. The academic fields in which the contributions are made are identified and implications for practice are indicated by giving brief overviews of the outcomes of this study. The first academic contribution of this thesis is in the field of RFID adoption in healthcare settings and in particular the English NHS. This study explored the drivers and inhibitors of RFID adoption in the English NHS. Drivers and inhibitors to RFID adoption in the English NHS are compared to those found in other settings. The nature of the NHS and how it is funded has implications for RFID adoption not present in private/insurance healthcare systems as the setting is very complex as are the influencing factors (Robert et al., 2009).

The main drivers of RFID adoption identified are: successful pilot studies, the need to constantly improve the NHS, the changing nature of care required and technical improvements in RFID technology. The main inhibitors identified are: communication, a lack of central investment, legislation, standards and regulation and a reactive culture. There are implications for managers responsible for RFID adoption in both the NHS and its commercial partners and foresight practitioners. Managers can leverage the insights gained from identifying the drivers and inhibitors to RFID adoption by making efforts to influence the removal of inhibitors and supporting the continuation of the drivers. Identifying the drivers and inhibitors of RFID adoption in the English NHS provided a snapshot of the current situation. As RFID is an emerging technology in the English NHS, foresight techniques applied to this setting could deliver useful insights for practitioners interested in the future of RFID adoption at the system level.

The academic contribution of the conceptual foresight model developed and deployed in this study contributes to the field of technology foresight by providing an empirical proof of concept, deployed in a healthcare setting. The outputs of the conceptual foresight model are a proof of concept of a novel technology foresight model whereby three scenarios of 2030 are produced with corresponding implications for RFID adoption and a technology roadmap inclusive of flex points leading to one of the scenarios. The three scenarios of 2030 combined with a technology roadmap allow users of the scenarios and roadmap to both develop internal short and medium term activities as well as understand the longer-term macro environment.

The outputs of the conceptual model can help managers plan short and medium term activities in the areas of internal business strategies, products/services, technologies and resources (through the technology roadmap) and gain long term understanding of the macro environment RFID adoption faces (through the scenarios). The implication for technology foresight practitioners is a proof of concept of a model combining scenario planning and technology roadmapping using a novel process.

3. Thesis Structure

Chapter 2 presents the literature review structured as four sections. The first section sets the scene by introducing RFID and its current level of adoption in the English NHS. The second section reviews studies that identify the drivers of and inhibitors to RFID adoption in healthcare settings in general. The third section presents the current state of technology foresight and reviews two of foresight's most popular techniques; scenario planning and technology roadmapping. The final section concludes the literature review with a problem statement and details the research questions of this thesis. The research questions of this thesis are:

Drivers of RFID adoption in healthcare settings have been identified by other studies from around the world. This study aims to identify the drivers in the English Healthcare System.

- What are the drivers of RFID technology adoption in the English NHS?

Inhibitors of RFID adoption in healthcare settings have been identified by other studies from around the world. This study aims to identify the drivers in the English Healthcare System.

- What are the inhibitors of RFID technology adoption in the English NHS?

However, the GS1 Healthcare User Group and other interested parties in RFID adoption at the system level would benefit from insight of what the NHS may be like in 10-20 years and what implications the future English NHS would have for RFID technology. By deploying the techniques of technology foresight, the GS1 HUG can gain insights into the potential micro and macro developments effecting the English NHS and RFID adoption.

- What are the plausible futures of RFID adoption in the English NHS of 2030?

Chapter 3 presents a conceptual method that blends scenario planning for the development of alternative plausible future states at the macro level and then employs a technology roadmapping framework for the development of strategies for specific technologies. Conceptual and empirical examples of existing attempts at combining the two approaches are reviewed. A new, novel combination is presented and justified based on alleviating the inherent weaknesses of each technique whilst ensuring their strengths remain intact.

The purpose of Chapter 4 is to present the research design, discuss the researcher's philosophical position in relation to other philosophical approaches, select a mode of enquiry, illustrate the data collection methods selected, appraise the available data analysis methods and detail how those methods were deployed in order to meet the research questions set out in Chapter 2.Ontologically the subjective tradition is taken where subjects interact with the setting, which structures and constrain said setting. Epistemologically, the goal is to understanding the subject's aims, perceptions, perspectives and assumptions. Therefore, the world view of this researcher and how this present research will be conducted is that of the 'Interpretivist'; interacting with the setting and the participants where reality is socially constructed, subjective and can be perceived differently by different people. The informants of this research are the UK GS1 Healthcare User Group (HUG). This is a unique group responsible for driving the adoption of RFID technologies in the NHS at the system level. This research setting, due to the emerging nature of RFID adoption in the NHS, presented the conditions to deploy a technology foresight activity with practical implications for the English NHS, attain an academic contribution in the areas of (a) drivers/inhibitors of RFID adoption in healthcare from the perspective of those responsible for its adoption and (b) technology foresight. The strategy of inquiry used for this present research is Action

Research. This is an area that requires change and through 'empowering practitioners' and by adopting an action research approach, this study produces practical implications for RFID adoption across the English NHS. Three main methods of data collection were used: semi structured interviews, field notes and foresight workshops.

Chapter 5 presents the data and subsequent analysis from the interviews, workshops in the scenario planning process and the technology roadmapping exercise. The first section introduces the Chapter and gives an outline of data collected and the analysis conducted. The second section presents the drivers of and inhibitors of RFID technology adoption. The third section presents the application of the conceptual model developed in Chapter 3 combining a scenario planning exercise and a technology roadmapping exercise. The final section presents a conclusion to this chapter and sets the scene for the Discussion Chapter to follow.

Chapter 6 discusses the findings presented in Chapter 5. The chapter is organised into a discussion with each section relating to the research questions posed by this thesis. Research questions 1 & 2 aimed to identify the drivers and inhibitors of RFID in the English NHS. The third research question aimed to ascertain plausible futures of RFID adoption In the English NHS of 2030. This research question required a new technology foresight model to be developed, a discussion of which is presented in this chapter. In accordance with the Action Research strategy of enquiry, a discussion on reflexivity and the processes involved is also presented. The final section of this chapter discusses the limitations of this study.

Chapter 7 concludes this thesis. Chapter 7 links the findings and discussion of this thesis to the problem statement and research questions. Empirical findings are presented as Section 2. Section 3 details the implications for research. The implications for practice are set out in Section 4. Section 5 details the limitations of this study and Section 6 presents recommendations for future research.

Chapter 2: Literature Review

1. Introduction

Chapter 2 presents the literature review structured as four sections. Section two sets the scene by introducing the general challenges facing IT/IS adoption in the English NHS. Section 3 introduces RFID and its current level of adoption in the English NHS. The third section reviews studies that identify the drivers of and inhibitors to RFID adoption in healthcare settings in general. The fourth section presents the current state of technology foresight and reviews two of foresight's most popular techniques; scenario planning and technology roadmapping. The final section concludes the literature review with a problem statement and details the research questions of this thesis.

2. IT/IS adoption in the English NHS

The challenges facing technology adoption in the NHS at not only local levels but national levels, are substantial. Fitzgerald et al. (2002) conclude, based on their empirical studies in the NHS, "in healthcare, the adopters use more nebulous criteria for judging the efficacy of an innovation than the profit-orientated criteria used in a commercial setting. So high levels of ambiguity are created, partly, by the 'fuzzy' nature of the evidence and also by the complexity of the range of other factors which are taken into account and by the existence of multiple stakeholders" (Fitzgerald et al., 2002 p.1445). The complexity of the setting and the wide range of influencing factors to technology adoption in the NHS presents a difficult arena (Robert et al., 2009). Robert et al. (2009) synthesised four main challenges for healthcare organisations when adopting technology as:

- How to improve an organisation's decision-making processes and systems with regard to the adoption of technological innovations.

This is a broad challenge involving bringing clinicians and managers together to consider technical innovations in order to engage all relevant stakeholders. One such avenue in achieving this is to establish Healthcare Technology Adoption (HTA) committees whom sole task is drive the adoption of technological innovations. These committees then, should consider technological, organisational and social concerns together. For example, not only the impact on patient care but to seek substantial engagement and regular feedback on improvements from the specific groups of staff the technological innovations effect. These committees would be also responsible for seeking good practice guidance from bodies such as the National Institute of Clinical Excellence (NICE) and the National Technology Adoption Centre (NTAC).

- How to increase an organisation's absorptive capacity for new knowledge about technological innovations.

This challenge specifically addresses the training, recruitment and development of staff in healthcare organisations. Skills such as the capacity to 'horizon-scan', comfort with working within a 'questioning culture' and capture new ideas should be sought after and developed. Developing training for nurturing adoption champions and leaders is also seen as crucial. The organization may need to create new or extended roles that cross traditional boundaries.

Mechanisms developed to establish/strengthen internal exchange of both tacit and explicit knowledge. Staff should then be encouraged and supported to attend specialist workshops and conferences and visit other sites where a relevant technological innovation is being considered or has already been implemented. Although somewhat difficult in patient care environments, small-scale innovation experiments should also be encouraged to develop and test various prototype solutions.

- How to ensure a receptive organisational context for technological innovations.

This challenge concerns the strength of the relationships between stakeholders. This can heavily influence the outcome of the innovation process. Key to establishing these relationships the responsibility of senior management to articulate clear goals and priorities for the organisation with a 'roomy' and adaptive strategic plans. In turn, this would aid the strengthening of relations and communication at middle management levels.

- How to improve organisational readiness for a specific technological innovation.

This challenge is focused around preparation for adoption of a specific technological innovation. This challenge is perhaps the most complex to tackle of the challenges set out by Robert et al. (2009) due to the considerable difficulty of the sub-challenges involved. First is to identify the decision system(s) most critical to the adoption and assimilation of the specific innovation. Second is to overlay the stakeholder relationships and governance to the process of care. Third is to consider the relative distribution of expertise within the organization and identify significant gaps in organizational knowledge. Fourth is to ensure that there is a, evidence based business case for the innovation, reflective of the effect to the various organisational levels, stakeholders and patient care processes involved. Sixth is to dry-run and test systems as adoption often depends upon successful assimilation of the technology with existing systems and processes. Seventh is to hold 'go live' events as a symbol of the importance being attached to the innovation by the organization.

To give further insight into the complexity of the setting, the example of how the NHS manages its supply chains and how they have been through considerable change in recent years can be presented. Zheng et al. (2007) proposed that the English healthcare sector comprises organisations that influence supply policy and practice such as professional bodies, trade associations and the NHS Purchasing and Supply Agency (NHS PASA) as well as being a vast supply network of healthcare products, service suppliers and NHS Trusts". Aspects of the NHS PASA related specifically to supply chain management have since been amalgamated into a service called the NHS Supply Chain. The NHS supply chain was formed from the NHS Logistics Authority and parts of the NHS PASA in 2006. It is operated by DHL on behalf of the NHS Business Services Authority (NHS Supply Chain, 2008). The NHS Supply Chain has the task of delivering £1bn of savings through making efficiencies in

NHS supply chains by 2016. This type of large scale change and the complex organisational structures and cross public/private sector boundaries created as a result would present challenges for any type of technology adoption, let alone RFID, which in itself is evolving rapidly.

Any effort to adopt technology on a wider scale than local, isolated settings also face scepticism due to previous controversial large scale IT projects. Due to the problems with "technology, contracts, timescales, organisational change and user acceptance that have continually dogged (for example) the NHS National Programme for IT (NPfIT)" (Pagliari et al., 2009), it is unlikely that a large scale, government led IT project will be popular (Pagliari et al., 2009). RFID in English Healthcare

The two main Automatic Identification (Auto-ID) technologies are Barcoding and RFID. Barcoding has a number of disadvantages when compared to RFID. In summary, barcoding involves a manual process that requires human intervention, where one barcode can only be read at a time, it requires a clear line of sight, it has no writing capability, the barcode labels are easily damaged and are comparatively unsophisticated in the aspect of security. RFID however, has the capability to: be automated, requiring almost no human capital once the system is up and running, read multiple tags at once, not require a clear line of sight, read and write, remain intact in various environments and be relatively secure.

The author recognises however, RFID technology is not without its drawbacks. Previous studies have identified the main drawbacks as (i) technical issues such as interference, reliability, and a lack of a common standard (ii) costs including hardware, software, training, infrastructure and interoperability can be huge and (iii) privacy concerns due to the sensitive nature of the personal data which could be held on patient centred applications of RFID(Ting et al., 2011a; Yao et al., 2010). The case for RFID will be explored in subsequent Sections in this Chapter but with the recognition that RFID in healthcare is certainly not a 'silver bullet' application to dissipate all of the challenges faced by healthcare and its supply chains.

The aim of the following sections is to provide a background to RFID adoption within the English healthcare system. This section begins with a synthesis of the literature concerning the value of RFID in supply chains. Building upon the value of RFID in supply chains, a collation of the main issues associated with technology adoption in the English healthcare system are then synthesised. A collection of examples of RFID usage in hospitals sets out the current level of adoption and an outline of the recent structural changes in NHS supply chains is presented as the last section.

RFID is an increasingly popular technology in a wide range of industries. As a technology, it has been in use since the Second World War, however, research in the area and development of the technology has gathered pace in the last decade (Lahtela, 2009). RFID is defined by Tajima (2007) as "an automatic identification (Auto-ID) technology, which gathers data on items without human intervention or data entry". In its most basic form, RFID has three components: tags, readers and middleware. A tag or a transponder consists of a microchip that stores identification data to which it is attached and an antenna to transmit this data via radio waves (Wamba, 2007). A reader or interrogator sends out a radio signal and prompts a tag to broadcast the data contained on its chip (Tajima, 2007). The reader then converts the radio waves returned from the tag into digital data and forwards them to a computer system (Tajima (2007).

Strategic advantages can be gained from the implementation of RFID in hospitals and their supply chains. Improvements in the healthcare supply chain can lead to a better service for customers, increasing the quality of care for patients and minimizing the underutilization of equipment (Ju et al., 2008; Kumar et al., 2009). However, to fully leverage the benefits of RFID technology; inter-organisational communication, cooperation and shared information management systems are crucial (Ju et al., 2008; Kumar et al., 2009).

Review articles conducted on the impact of RFID implementation in supply chains (Chao et al., 2007; Ngai et al., 2008; Sarac et al., 2010; Visich et al., 2009) conclude RFID technology presents the potential for huge gains through reengineering supply chains but this is dependent on the level of adoption. These articles were chosen for their broad coverage of the literature in the area and their differing approaches. This enabled a thorough understanding of the strategic value of RFID in supply chains. Although taking slightly different stances and approaches to assessing the literature around RFID implementation in supply chains, these articles reviewed a large body of ever increasing literature in the area.

Along with individual conclusions and recommendations, a number of findings were consistent throughout the articles reviewed. They argue the benefits of RFID adoption can only be realised if there is co-operation and collaboration. If all actors collaborate, share costs, develop shared information management systems and co-ordinate adoption efforts, potential benefits can be achieved. This is due to not only having to implement a new technology project but also having to deal with the wider issues of organisational change and re-engineering during the process of adoption. The review articles also consider the reasons why organisations may not want to adopt RFID. The common issues were the lack of shared standards, the cost compared to other similar technologies and performance of the technology in certain environments. Further insights from the three articles are now discussed.

Visich et al. (2009) utilise a model suggested by Mooney et al. (1996) for assessing the impact of IT on business value, to identify the major effects from the implementation of RFID in the supply chain. Using the Mooney et al. (1996) model, Visich et al. (2009) identify automation effects on operations processes and informational effects on managerial processes as the major effects of RFID implementation. Visich et al. (2009) build on the Mooney et al. (1996) model by proposing a three-stage model. The first stage or impact by RFID in supply chains is its use to “automate certain processes such as inventory count, product locating, and goods shipping and receiving” (Visich et al., 2009 p.1305). Visich et al. (2009) propose the second stage or impact is the result of the automation of processes, the availability of rich information for managerial processes and further implementation of RFID throughout the supply chain, allowing for greater analysis and development of managerial processes such as inventory management, forecasting and inventory replenishment. However Visich et al., (2009) found limited empirical evidence in this study to support the second order impact of RFID on supply chains since RFID is still at an early stage of implementation in many organisations. The third stage or impact is described as "transformational, driven by process innovation and supply chain redesign to achieve competitive advantage" (Visich et al., 2009). Supply chain redesign will "revolutionise supply chain dynamics" (Visich et al., 2009) by allowing dissemination of large amounts of accurate, real time data. These enhancements should lead to "higher levels of customer satisfaction, sales and profits, and sustainable competitive advantage" (Visich et al., 2009). However, none of the examples (both academic and practitioner) from the Visich et al. (2009) review article are supported by a detailed cost/benefit analysis and the majority are indeed from pilot studies as "few firms have implemented end-to-end RFID applications in their internal operations or in their extended supply chain" (Visich et al., 2009).

Serac et al. (2010) also acknowledge the benefit of RFID in the supply chain to informational effects on managerial processes with improvements in information accuracy facilitation of management through real time information. Building upon Visich et al. (2009), Serac et al. (2010) state the automation effects on operations processes are also advantages of RFID in the supply chain. Serac et al. (2010) are in agreement with Visich et al. (2009) in stating "an important factor is the re-engineering of the supply chain. The most gain can be leveraged by reorganizing the supply chains" (Serac et al. 2010). The Serac et al. (2010) article provides further comment on the lack of examples of RFID implementation beyond pilot projects with "most companies still prefer to use isolated pilot projects but analysis shows the true effectiveness of RFID in the supply chains is when all actors collaborate and cost share" (Serac et al. 2010). Both Serac et al. (2010) and Visich et al. (2009) build on a previous review article conducted by Chia-Chen et al. (2007). Chia-Chen et al. (2007) concluded on the use of RFID in industry with "an increasing number and a widening variety of enterprises are employing RFID to improve the efficiency of their operations" (Chia-Chen et al., 2007). The Chia-Chen et al. (2007) article specifically highlights healthcare facilities as an area of increased adoption and diffusion of RFID technology and state the main benefit gained would be the ability of RFID technology to "solve operational problems" (Chia-Chen et al., 2007).

Ngai et al. (2007) also conducted a review of the literature on RFID research between 1995-2005. Their main recommendations to practitioners involved the consideration of the "importance of initially focusing on the technical issues of a new technology rather than issues related to realizing business value or impact on inter-organisational relationships" (Ngai et al., 2007). The Ngai et al. (2007) article stood apart from the other review articles with the recommendation to concentrate on the technical issues first rather than inter organisational relationships. At the time of publication of the article, some of the technical issues mentioned are starting to be addressed, especially the issue of the lack of shared data standards. ISO (International Standards Organisation) have increased the development of data standards for RFID over the last decade (RFID Journal, 2010).

The strategic value of RFID in the supply chain is being acknowledged as a catalyst in improving organisational processes, developing shared information management systems and increasing collaboration. However, there are still concerns around data standards, the performance of the technology in certain environments and the cost of the technology. These concerns are slowly being addressed, which in turn will allow for a greater number of examples of widespread adoption to further strengthen the case for RFID implementation in the supply chains of organisations.

Healthcare is a promising sector for RFID applications. Healthcare organisations using RFID technologies can improve the patients' care, optimize the workflows, reduce the operating costs, help avoiding severe mistakes and reduce costly thefts (Fuhrer and Guinard, 2006). With proven benefits of lowering costs, improving the quality of care, and making patient care more reliable and consistent by properly managing and tracking information and material flows, increasing attention is being afforded by academics and practitioners to this technology and its applications in healthcare (Sarac et al., 2010).

With increasing examples of the application of RFID in healthcare settings from around the world (Chao et al., 2007), the NHS is also beginning to adopt RFID in isolated pilot projects as discussed later in this Chapter. The NHS has grown to become the world's largest publically funded health service. The NHS was born out of a long-held ideal that "good healthcare should be available to all" (The NHS, 2009), regardless of wealth. NHS organisations and their suppliers, manufacturers and distributors can be regarded as a complex adaptive system in which patterns of behaviour, in this case the adoption of RFID and other RFID technologies, are emergent.

Recognising the potential benefits of RFID technology, the Department of Health (DoH) are offering guidance and support for NHS organisations who wish to adopt RFID technologies and by doing so are providing the driving force behind RFID adoption in the NHS. The NHS have reported on the evidence of real improvements to patient safety with "reducing medication errors, reducing the risk of wrong-site surgery and the effective track and trace of surgical instruments, equipment and other devices" (Thuemmler and Buchanan, 2010 p.5) being achievable through the use of RFID technologies.

One such example of a pilot study of RFID technology in the NHS is that of Leeds Teaching Hospital NHS Trust. The Trust carried out RFID pilot to track and trace its orthopaedic loan kits containing vital hip and knee joints as a "proof of concept" exercise in 2007.

The kits or modules are usually ordered on loan to the Trust on a consignment basis and only the elements that are utilized or not returned to the supplier are invoiced for. At each point in the lifecycle of the kit, a manual check is carried out by both the supplier and the Trust to ensure that all the elements are accountable at all times. At each point, it could take up to 2 hours depending on the complexity of the kit.

Orders are usually made over the phone and are inconsistent with orders made electronically for other stock using the Trust's automated ordering system. Staff tend to work around the system which can result in data inaccuracies. The Trust is also unable to track its loan kits accurately from purchase order to invoice due to the manual process. The ordering, checking and invoicing processes for these kits are very time consuming, labour intensive and often result in lengthy invoice reconciliations due to inaccuracies.

The Trust has identified Radio Frequency Identification (RFID) technology as a potential solution and in conjunction with GS1 UK, Depuy, Sybase and GHX, has carried out a "proof of concept" RFID pilot to simplify the ad-hoc checking, receipting, issuing and final return of kits. During the pilot, each item in the kit was RFID tagged and identified with a unique code allocated by the supplier to enable the accurate track and trace of all the elements in each kit.

The beneficial outcomes of the pilot were that clinical staff were able to check the contents of a kit instantly, without the need for manual counts at each step in the administrative and clinical process. The pilot identified benefits that would be gained in early demand information for hospital staff and suppliers, reduced administration and improved process efficiency.

The turnaround time for suppliers from sale to receipt of payment could potentially only take approximately 10 days compared to the current 2 months. "Our RFID pilot has proven that the technology is scalable and the concept is possible. To be able to fully implement RFID at Leeds and reap the benefits, we would need to drive adoption within the healthcare sector. We need to get the major suppliers and healthcare providers on board to see the benefit of implementing RFID in healthcare" (GS1, 2008).

However, pilot projects of RFID in healthcare, especially in England, are often limited in scale and scope. Therefore the benefits that the literature on the strategic value of RFID could deliver with widespread adoption cannot be achieved. RFID is increasingly being used by the healthcare industry (Zailani et al., 2015), but take up in the English healthcare system is slow.

In summary this section presented how RFID can be beneficial to the NHS but why adoption has been slow due to the complex setting and wide range of influencing factors. The complexity of the setting will be reflected upon in the Discussion Chapter in Section 5.3.1

2.1. **Current level of adoption**

This next section explores the current level adoption of RFID and RFID technologies in the English NHS. There have been limited projects and pilots exploring the use of RFID in isolated situations as summarised in Table 1 below:

Organisation	Use of RFID	Results	Conclusion of Study
Royal Alexandra Hospital, Paisley (Britton, 2007).	Temporary installation of three active readers and tags to portable medical devices. Tags and readers linked through bespoke data network.	Two different suppliers were used. The supplier that designed tags to allow for the casing of the medical devices not to interfere with the signal achieved an overall error rate of 12.3%.	RFID could be used to track medical equipment but as of yet there is no plan for implementation.
Birmingham Heartlands Hospital (RFID Journal, 2007)	Safe Surgery System RFID wristband solution. The RFID wristbands are being issued to surgical patients, printed and encoded using an RFID wristband printer for admitted patients.	10 weeks to implement the hardware and software.	Though no specific plans have yet been identified, Birmingham Heartlands Hospital plans to roll out the Safe Surgery System throughout its facility.
St Andrew Healthcare (RFID Journal, 2010)	RFID based real-time location system (RTLS) to enable staff members to send alerts, and to route them to the appropriate personnel.	Staff members report that they prefer the RFID system to the infrared version, as it provides them with greater security in knowing that responders are on their way, while not sounding alarms that can be heard throughout the building.	Within the next two years, St. Andrew's intends to install the system throughout each of its four campuses, including outdoors on the facility grounds. Once fully in place, the system will comprise around 3,000 Ekahau tags and up to 5,000 Motorola access points.
Leeds Teaching Hospital NHS Trust (GS1, 2008)	The Trust has carried out a successful proof of concept RFID pilot to track and trace its orthopaedic loan kits containing vital hip and knee joints.	Clinical staff were able to check the contents of a kit instantly, without the need for manual counts at each step in the administrative and clinical process. The turnaround time for suppliers from sale to receipt of payment could potentially only take approximately 10 days compared to the current 2 months.	"Our RFID pilot has proven that the technology is scalable and the concept is possible. To be able to fully implement RFID at Leeds and reap the benefits, we would need to drive adoption within the healthcare sector. We need to get the major suppliers and healthcare providers on board to see the benefit of implementing RFID in healthcare" (GS1, 2008).

Mayday Healthcare NHS Trust (GS1, 2008)	RFID technology for its electronic blood-tracking pilot to track blood from ordering through to sampling and transfusion.	This helps ensure the correct blood is administered to patients. The trust has adopted GS1 standards for its passive RFID enabled patient wristbands using unique GS1 codes to help ensure positive patient identification	Further proof of concept pilots are being planned for the tracking of beds and mattresses and high value surgical equipment

Table 1. Current Examples of RFID Implementations in English Hospitals

From Table 1 it is clear that RFID is only being implemented as an intra-organisation technology and is limited to isolated pilot projects. RFID in English healthcare has not yet reached implementation on a supply chain level. The lack of RFID implementation and adoption in the supply chains of the NHS is not surprising given the inherent slow take up of technology in the NHS and the structural changes that NHS supply chains have only recently undergone. Despite a positive reaction to the effectiveness of RFID in the isolated pilot projects presented in Table 1, the decision to adopt technology, for managers in the NHS, is often very difficult. NHS hospitals are fairly immature in terms of the adoption and usage of information systems and technology; struggling to provide adequate foundations for systems integration in terms of data, work and culture (Wainwright and Waring, 2000).

However, guidance to promote and support use of RFID was launched in 2007. “Coding for Success: Simple technology for safer patient care” written in partnership with the NPSA, MHRA, CfH and PASA (Department of Health, 2010) recommends both industry and the NHS adopt auto identification technologies to increase patient safety and improve efficiency. As of yet, there is only guidance and support being provided by the DoH and not a DoH led mandatory national project such at the National Programme for Information Technology (NPfIT). Instead, the policy position is to support implementation at a local level with membership of the GS1 coding/standards system for any NHS Trust wishing to adopt RFID and therefore engagement in the GS1 Healthcare User Group. This review mapped the current state of play for RFID in English healthcare supply chains, adoption to date, learning from pilot projects and prospects for future adoption.

3. Drivers and Inhibitors to RFID Adoption in Healthcare Settings Identified By Previous Studies

This section presents the exiting literature concerning the factors effecting RFID technology adoption in healthcare settings. Yao et al. (2012) conducted a review on the literature on the use of RFID in healthcare/hospitals aiming to identify the common applications, potential benefits, barriers, and critical success factors. The key barriers (inhibitors) Yao et al. (2012) identify are; interference, ineffectiveness, standardization, cost, privacy/legal issues and other barriers including a lack of organisational support and unclear returns on investments. Yao et al. (2012) identified interference and ineffectiveness as barriers when the article was originally accepted by the Journal of Medical Systems in 2011. Since then, there have been technical improvements in RFID technology for healthcare settings where the issue has moved on from 'interference and ineffectiveness' of the technology itself to 'interoperability' (implementation with existing systems) (Carr et al., 2010). Yao et al. (2012) identify the cost of RFID technology as a major barrier to adoption. The costs include hardware/software, training, and infrastructure maintenance. Unclear returns on investments was another barrier identified by Yao et al. (2012). In the context of this present research, unclear returns on investment are diminishing with the ever-increasing number of pilot projects. However, as noted, the isolated pilot projects do not take full advantage of the widespread adoption benefits of shared information systems and data transparency as identified earlier in this chapter.

Lee and Shim (2007) investigated the decision processes involved in the adoption of RFID within organisations in the healthcare industry and proposed a model to identify drivers of adoption. Lee and Shim (2007) tested three categories of factors, technology push; need pull, and presence of champions to determine the likelihood of adopting RFID within organisations. Lee and Shim (2007) also found that the relationships between the three categories and the likelihood of adopting RFID are strengthened or weakened by organisational readiness. Deploying a web-based survey, Lee and Shim (2007) found two technology push factors (perceived benefits and vendor pressure), two need pull factors (performance gap and market uncertainty) and presence of champions (decision makers). These factors, moderated by financial resources, technology knowledge, and organisational size, affect the likelihood of adopting RFID in hospitals. Lee and Shim (2007) employed a survey of 126 executives within the healthcare industry in America. Lee and Shim (2007) presented prerequisites of RFID adoption and not issues concerning implementation, maintenance or scalability. This quantitative approach to identifying factors effecting RFID adoption in healthcare settings led to Lee and Shim (2007) calling researchers to embark on qualitative studies to better understand the wide ranging influences of RFID adoption.

Ting et al. (2011a) presented the critical factors of RFID adoption, not as Lee and Shim (2007) did in 'prerequisites stages' but concentrating on factors during the implementation and maintenance stages of adoption. Ting et al. (2011a) identified three groups of lessons learned as technological, economic and operational. The technological group included determining any hazardous interference and knowing the limitations of RFID. Hazardous interference is also identified by Yao et al. (2012) and is closely linked to another inhibitor identified by their study as the limitations of RFID technology itself. The technological group of factors as identified by Ting et al. (2011a) would be more pertinent for consideration if a one-off site was to implement a specific RFID system. The economic group of factors identified by Ting et al. (2011a) include identifying implementation cost beforehand and formulating a clear Return On Investment (ROI). Again, these factors concern an individual implementation and are difficult to discuss on a system wide consideration of RFID adoption. The operation group identified by Ting et al. (2011a) included setting up a time schedule for the RFID project, conducting risk management and planning for emergency. These factors again would be pertinent for the management of an individual implementation of RFID technologies to consider but do not take into account the wider political, economical, social and technological adoption in a wider scale system such as the English NHS. Ting et al. (2011a) called for future research and development of international standards for the applications of RFID technology in combination with medical technology and extension of RFID technology to the supply chain partners to enhance the patient safety, especially in the area of medicine authentication.

Carr et al. (2010) also intended to identify factors that influence the adoption of RFID in healthcare organisations through testing seven different hypotheses. These hypotheses are tested using structural equation modelling. Carr et al. (2010) identified a number of different relationships effecting the adoption of RFID technology including direct relationships among the factors of risk, resistance to change, supplier support and perceived usefulness. There was also support for several indirect relationships. These include indirect relationships between the factors of perceived resistance to change, risk, suppliers' support and perceived ease of use with the factor of intention to adopt RFID technology in the healthcare organisation. Carr et al. (2010) identify factors effecting adoption of RFID technologies within one healthcare organisation. Carr et al. (2010) call for further research of this nature to identify factors effecting RFID adoption in healthcare in larger settings and in other countries.

Rosenbaum (2014) concludes that privacy of patient data is the most important obstacle in allowing the healthcare industry to take advantage of the numerous benefits RFID technology affords. Safeguarding patient data concerns a number of areas according to Rosenbaum (2014). First, in agreement with Carr et al. (2010) and Yao et al. (2012) interference can be affected by the physical environment which requires more testing in a greater number of healthcare environments. In addition, Rosenbaum (2014) advocates the clarity of value must be established but it is not in the infrastructure but the information analysis available through underlying applications. Rosenbaum (2014) discusses lessons learned from an implementation of RFID technology. Rosenbaum (2014) highlights the development and adoption of an adequate data standard ensuring security allowing for RFID's considerable benefits to be utilized.

Lai et al. (2014) developed a comprehensive model integrating technological, organisational and environmental factors in order to understand hospitals' considerations regarding RFID adoption. In a study encompassing a literature review of Information Systems (IS) adoption in business, a survey with 37 practical experts, a field survey involving 102 hospitals and follow-up interviews with 3 directors of IS departments in 3 hospitals. The key factors effecting RFID adoption in hospitals identified by the study were; cost, ubiquity, compatibility, security and privacy risk, top management support, hospital scale, financial readiness and government policy.

Yazici (2014) collected data from 81 operation directors and concluded that hospital real time information requirements are significantly linked to perceived efficiency and patient satisfaction benefits of RFID. The biggest inhibitor to RFID adoption that Yazici (2014) found was the cost of RFID technologies. The key drivers identified by Yazici (2014) were; more effective communication among staff, increased asset utilization, enhancement of the patient-care process, better participation of the patients in care processes and better visibility on workflows. Yazici (2014) asserts that if hospital needs are understood, user acceptance by staff and patients of RFID technologies is likely.

Rosenbaum (2014) gives lessons learned from a single implementation of RFID technology whereas this present research is concerned with adoption at a system level, identifying a different set of factors outside the realms of individual system implementation. For this reason, the inhibitors identified here do not include specifics of implementation studies such as 'interference' and 'ROI' but wider issues encompassing macro, rather than micro factors.

Ting et al. (2011a) presented the critical factors of RFID adoption, not as Lee and Shim (2007) did so in prerequisites stages, but concentrating on factors during the implementation and maintenance stages of adoption. Ting et al. (2011a) called for future research and development of international standards for the application of RFID technology in combination with medical technology and the extension of RFID technology to the supply chain partners to enhance patient safety, especially in the area of medicine authentication. Rosenbaum (2014) continues the assertion of Ting et al. (2011a) in calling for the development and adoption of an adequate data standard, ensuring security of RFID systems allowing for the considerable benefits of RFID to be utilized. Lee and Shim (2007) called for researchers to embark on qualitative studies to better understand the wide-ranging influences of RFID adoption.

Yao et al. (2012) identified interference and ineffectiveness as a barrier when the article was originally accepted by the Journal of Medical Systems in 2011. Since then, there have been technical improvements in RFID technology for healthcare settings where the issue has moved on from ‘interference and ineffectiveness’ of the technology itself to ‘interoperability’ (implementation with existing systems) (Carr et al., 2010). Carr et al. (2010) identified a number of different relationships effecting the adoption of RFID technology including direct relationships among the factors of risk, resistance to change, supplier support and perceived usefulness. There was also support for several indirect relationships. These included indirect relationships between the factors of perceived resistance to change, risk, suppliers’ support and perceived ease of use with the factor of intention to adopt RFID technology in the healthcare organisation. Carr et al. (2010) identified factors effecting adoption of RFID technologies within one healthcare organisation. Carr et al. (2010) called for further research of this nature to identify factors effecting RFID adoption in healthcare in larger settings and other countries. Yazici (2014) and Lai et al. (2014) contributed to this call. The biggest inhibitor to RFID adoption that Yazici (2014) found was the cost of RFID technologies. The key drivers identified by Yazici (2014) were; more effective communications among staff, increased asset utilization, enhancement of the patient-care process, better participation of the patients in care process and better visibility on workflows. Yazici (2014) asserts that if hospital needs are understood, user acceptance in staff and patients of RFID technologies is likely. Further studies identified the key factors effecting RFID adoption in hospitals are; cost, ubiquity, compatibility, security and privacy risk, top management support, hospital scale, financial readiness and government policy (Lai et al., 2014).

In summary, previous studies exploring the adoption of RFID technology in healthcare settings reveal a wide range of factors. These factors include: cost, resistance to change, risk, suppliers' support, ubiquity, compatibility, security and privacy, risk, top management support, hospital scale, financial readiness, interoperability, adequate data standards, limitations of RFID technology, organisational readiness, presence of champions, technology knowledge, organisational size, unclear returns on investments and government policy (Carr et al., 2010; Lai et al., 2014; Lee and Shim, 2007; Rosenbaum, 2014; Ting et al., 2011a; Yao et al., 2012; Yazici, 2014). As presented in the Introductory Chapter, RFID adoption in English healthcare faces added complexities of needing to collaborate and co-ordinate efforts across organisational boundaries and across boundaries between the publically funded health sector and the commercial sector. The factors identified in previous studies of RFID adoption in healthcare settings and the approaches taken in terms of methodology may not be appropriate for the English NHS due to added complexities. Researchers need to identify ways of conceptualising and investigating this field, which suit the highly complex governance structures, varied organisational strategies and goals, and the inter-organisational supply processes of the English healthcare system.

4. Technology Foresight

The field of technology foresight has its roots in the industrial era and was developed out of the need for long range planning for defence (Linstone, 2011). A popular definition of technology foresight is given by Martin (1995 p.142) as:

> "*Technology foresight is the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and emerging generic technologies likely to yield the greatest economic and social benefits*"

Although born in the US, technology foresight was developed and since utilized in a defence context. Other countries in Asia and Europe used technology foresight to inform development of their science, technology and innovation systems in the form of 'National Foresight Projects' (Linstone, 2011; Miles, 2010). National Foresight Programs rely on expert opinion but often differ in their objectives; simply to stimulate debate, forming networks of innovators or setting priorities for national science and technology policy (Georghiou, 1996). Broadly there are a number challenges to technology foresight: practitioners are urged to increase the quality of their work in order to present instances of "success stories" and further the impact of foresight activities (Costanzo, 2004; Cuhls, 2003; DenHond and Groenewegen, 1996; Rohrbeck and Gemünden, 2011; Salo and Cuhls, 2003). Researchers are being called to further contribute to the methodological and conceptual advances so that a clearer definition can be established of what foresight activities can and cannot deliver (Rohrbeck and Gemünden, 2011; Salo and Cuhls, 2003).

There are a number of challenges that technology foresight faces. These include the lack of agreement in which sets of foresight activities have validity in which circumstances, a lack of clarity in assessing impact of foresight activities, the epistemological differences in the qualitative and quantitative approaches, the selection criteria for identifying appropriate experts is underdeveloped and combinations of activities not well explored (Georghiou and Cassingena Harper, 2013). There are a number of examples of exercises with the aim of categorising, organising and arranging foresight methods (Georghiou, 2008; Magruk, 2011; Porter et al., 2004; Saritas and Aylen, 2010). Saritas and Aylen (2010) organized foresight methods into groups of: understanding, synthesis and models, analysis and selection, transformation and actions. Understanding consists of activities such as; literature reviews, interviews, the identification of trends/drivers and scanning. Synthesis and models includes activities such as gaming, scenario planning, network analysis, and modelling. Analysis and selection incorporates activities such as 'strength weakness opportunities and threat' (SWOT) analysis, delphi and multi-criteria analysis. Transformation includes activities such as backcasting, roadmapping, relevance trees and logic charts. Actions and Transformation includes activities such as research and development planning, priority lists, critical technologies and operational planning. Magruk (2011) developed a classification of technology foresight techniques with 10 classes based on a cluster analysis: consultative, creative, prescriptive, multi-criteria, radar simulation, diagnostic, analytical, survey and strategic. Georghiou (2008 p.72) present a 'Foresight Diamond' where the four tips of the diamond, not intended to be independent, are defined as 'expertise, creativity, evidence and interaction. Examples of 'expertise' methods include; roadmapping, expert panels and interviews presented as qualitative methods. Examples of 'creativity' methods include wildcards, simulation and gaming presented as semi quantitative groups. 'Evidence' methods are also defined as semi-quantitative, including methods such as modelling, scanning, extrapolation and literature reviews. 'Interactive' methods are defined as fully quantitative including voting and polling. According to Georghiou (2008) roadmapping is in the 'expertise' area of the diamond as is scenario planning, and spans the area between 'expertise' and 'creativity'. Porter et al. (2004) present technology foresight as encompassing a broad menu of methods often involving a blend of quantitative and qualitative approaches in order to compensate for the weaknesses in any one approach. Placing the conceptual combination of scenario planning and technology roadmapping into perspective within the broader menu of technology foresight methods available, Porter et al. (2004) describe scenario planning as belonging to "Scenarios" and technology roadmapping as belonging to 'descriptive' and 'matrices' respectively out of 13 'families'.

4.1. **Technology Roadmapping**

Contemporary roadmapping was first utilized by Motorola in the 1970's to facilitate effective alignment between technology and product development. Since, it has been exploited at national, sector and company levels. It is applicable to a wide range of issues including capability planning, programme planning and knowledge asset planning (Phaal, et al, 2010). Technology roadmaps are varied due to a diverse range of application settings including: science/research roadmaps, cross-industry roadmaps, industry roadmaps, technology roadmaps, product roadmaps and product-technology roadmaps (Saritas and Aylen, 2010).

Kostoff and Scaller (2001) describe the main benefit of roadmapping as the provision of information to help make better technology investment decisions. There is a multitude of approaches both in structure and process to technology roadmapping but in general terms, it can be broken down into expert/computer-based approaches (Kostoff and Scaller, 2001; Probert et al., 2003). Adopting the most appropriate features of each approach for a given technology roadmapping exercise is recommended (Kappel, 2001; Kostoff and Scaller, 2001; Petrick and Echols, 2004; Phaal et al., 2004a). The widespread application of roadmapping has led to difficulty in finding a universal or standard definition. There have been efforts to classify roadmaps to this end (Kappel, 2001). Through the attempts of classification, there are a number of differing views of the application and purpose of roadmapping (Albright and Schaller, 1998; Garcia and Bray, 1997; Kappel, 2001; Phaal et al., 2009). Four classes of technology roadmapping were set out by (Albright and Schaller, 1998); science and technology (S&T) roadmaps, industry technology roadmaps, corporate or product-technology roadmaps, and product/portfolio management roadmaps. These span various boundaries including products, projects, organisations, industries and inter-industrial settings. Kappel (2001) classify technology roadmapping based on the purpose of the exercise. This leads to two dimensions to emerge in the classification: purpose and objective (Kappel, 2001). The difference between the (Albright and Schaller, 1998) and the (Kappel, 2001) classifications are in understanding the industry perspective against understanding the requirements of technology development. Garcia and Bray (1997) reached three definitions of roadmaps: the product technology roadmap, emerging technology roadmap and the issue-oriented roadmap. Phaal et al. (2009) assert that the classification of technology roadmaps is firstly dependent on the purpose of the planning activity in question, giving eight categories of such. Where Phaal et al. (2009) differs from (Albright and Schaller, 1998), Garcia and Bray (1997) and (Kappel, 2001) is in the notion of classification of technology roadmaps is secondly dependant on their visual formats. Four visual format classifications are given by Phaal et al. (2009) including: multiple layers (encompassing bars and tables), single layers (encompassing bars. tables and graphs), pictorial (encompassing flow charts) and text formats.

4.1.1. **Philosophical Underpinnings of Technology Roadmapping**

The development of technology roadmapping has its roots in the automotive and telecommunications industry as a corporate technology strategy development tool (Probert and Radnor, 2003). In exploration of the philosophical underpinnings of technology roadmapping, Tapio and Hietanen (2002) provide a delicate typology of seven schools of thought of future studies: comtean positivism, optimistic humanism, pluralistic humanism, polling democracy, critical pragmatism, relativistic pragmatism and democratic anarchism. The guiding system of how the typology was developed is from the perspective of three groups of actors: the professionals, the decision- makers and the public. Technology roadmapping would fall into the school of pluralistic humanism in that the professional forms the roadmap(s) and the decision-maker, evaluates them with the help of the professional. In an alternative framework, three broad future studies dimensions were mapped out by (Stevenson, 2002) as “predictive/empirical”, “cultural/interpretive” and “post structural/critical”. According to these dimensions, technology roadmapping would be underpinned by the “cultural/interpretive” dimension as there is a reliance on the knowledge, credibility, communication skills and commitment of the participants and ability of the facilitator (Walton, 2008).

4.1.2. **The process and underlying architecture of technology roadmaps**

There are various classifications of roadmaps and the differences have been highlighted in the preceding sections. Each classification is valuable in gaining an overview of the historical development, uses, purposes and formats of technology roadmaps. Next, the process of creating the technology roadmap and the underlying architecture are discussed with the aim of identifying a generic/common framework.

Often the process of technology roadmapping is more valuable than the roadmap itself due to the communication and consensus generated within the organisation or stakeholders in the setting (Kappel, 2001; Kostoff and Scaller, 2001; Petrick and Echols, 2004; Phaal et al., 2004a).

A basic model of technology roadmapping as developed by Garcia and Bray (1997) is presented below:

Phase 1. Preliminary activity

- Satisfy essential conditions.
- Provide leadership/sponsorship.
- Define the scope and boundaries for the technology roadmap.

Phase 2. Development of the Technology Roadmap

1. Identify the “product” that will be the focus of the roadmap.
2. Identify the critical system requirements and their targets.
3. Specify the major technology areas.
4. Specify the technology drivers and their targets.
5. Identify technology alternatives and their time lines.
6. Recommend the technology alternatives that should be pursued.
7. Create the technology roadmap report.

Phase 3. Follow-up activity.

Gerdsri et al. (2009) propose a three-phase process. Stage 1 is the Initiation stage aiming to get an organisation ready before beginning to implement technology roadmapping process. Stage 2 is the development stage and aims to develop a desired roadmap by engaging the right people, gathering the necessary information, and conducting a step-by-step analysis through workshops. Stage 3 is the integration stage, which aims to integrate the technology roadmapping process into on-going business planning activities so that a roadmap can be constantly reviewed and updated in a timely manner.

Phaal and Muller (2009) accommodate the flexibility and customizable nature of technology roadmapping by establishing an architectural framework which can be tailored to suit the setting of a given technology roadmapping exercise through Timeframes and Layers. Timeframes (typically the horizontal axis), may include the past, short-, medium- and long-term perspectives, as well as aspirations/vision. Layers and sub-layers (typically the vertical axis), are represented by a systems-based hierarchical taxonomy, organised into three broad layers.

The top layer relates to the trends and drivers that govern the overall goals or purpose associated with the roadmapping activity, including external market and industry trends and drivers (social, technological, environmental, economic, political and infrastructural), and internal business trends and drivers, milestones, objectives and constraints. The middle layer generally relates to the tangible systems that need to be developed to respond to the trends and drivers (top) layer. Frequently this relates directly to the evolution of products (functions, features and performance), but the middle layer can also represent the development of services, infrastructure or other mechanisms for integrating technology, capabilities, knowledge and resources. The bottom layer relates to the resources that need to be marshalled to develop the required products, services and systems, including knowledge-based resources, such as technology, skills and competences and other resources such as finance, partnerships and facilities.

Saritas and Aylen (2010) present three short-comings of technology roadmapping: they are normative, rather than exploratory; they encourage linear and isolated thinking; dissemination is difficult; only experts can understand the output, especially if it is couched in technical terms. Other short-comings of technology roadmapping are established by Phaal and Muller (2009) in that multiple specific forms exist which have to be tailored to the needs of the organisation and can create more questions than answers initially. Petrick and Echols (2004) established, based on the 16 types of technology roadmaps identified by Phaal et al. (2004a) that technology roadmaps have common elements. These common elements were presented as an architectural framework by Phaal and Muller (2009).

The development of technology roadmapping as a foresight activity has resulted in the recommendation of the most appropriate features from the various techniques available to be customized to the setting. Often the process of technology roadmapping is more valuable than the roadmap itself due to the communication and consensus generated within the organisation or stakeholders in the setting. A number of drawbacks to technology roadmapping have been identified: they are normative, rather than exploratory; they encourage linear and isolated thinking; dissemination is difficult; only experts can understand the output; multiple specific forms exist which have to be tailored to the needs of the organisation and can create more questions than answers initially.

4.2. **Scenario planning**

Scenario planning provides a future-focused methodology, which allows for the systematic use of insights from experts across a field, and helps explore the joint impact of various uncertainties (Tapinos, 2012). Scenario planning is not about predicting the future; it is about preparing an organisation for a number of possible futures (Varum and Melo, 2010). Scenario planning provides an opportunity to envision plausible future states and thus helps to generate strategies to reduce risks, to take advantage of opportunities and avoid potential threats (Varum and Melo, 2010). According to Schoemaker (1995) there are several conditions, which dictate the use of scenario planning:

- Uncertainty is high relative to managers' ability to predict or adjust.
- Too many costly surprises have occurred in the past.
- The organisation does not perceive or generate new opportunities
- The industry has experienced significant change or it is about to

- The organisation wants a common language and framework without stifling diversity.

Van der Heijden (2005) established four purposes of scenario work, namely:

- Sense-making: a one-off ‘exploratory question-raising scenario project’
- Developing strategy: a one-off ‘decision-making scenario project’
- Anticipation: an ‘on-going exploratory scenario activity’
- Action-based organisational learning: an ‘on-going decision-making activity’

Scenario planning is a flexible approach to developing strategies and acts as a process for organisational learning (O'Brien, 2004a). Tapinos (2012) claimed that the use of scenarios for planning is an underdeveloped field. The majority of the existing published studies focus on how scenarios are used for strategy development in case study organisations. There is even less theory on how to use scenario planning to foresight technologies which is important for policy development or strategizing for network development guidance, change management initiatives or supply chain re-engineering. The use of scenarios should ensure as many of the long term threats and opportunities facing the organisation are identified and addressed (Van der Heijden, 2005).

There are three overarching schools of developing scenarios all of which have interchangeable sub techniques. Intuitive logics and probabilistic modified trends are from the USA and the UK and La Prospective is the French approach. The intuitive logics methodology was developed at the RAND Corporation in the 1960s and was used extensively by Shell (Bradfield et al., 2005). The intuitive logics methodology is regarded as an approach that can produce flexible and internally consistent scenarios but relies on the knowledge, credibility, communication skills and commitment of the participants and ability of the facilitator (Amer et al., 2012; Keough and Shanahan, 2008; O'Brien, 2004a). Scenarios produced via this school deal with the macro environment and are concerned with addressing uncertainty. The Probabilistic modified trends methodology was also developed by the RAND Corporation incorporating the matrix based techniques of trend impact analysis and cross impact analysis to extrapolate trends. Scenarios produced by the probabilistic trends approach are used to develop an understanding of the near future due to uncertainty and volatility of longer time spans. The La Prospective approach was developed by French Philosopher Gaston Berger, with the view that the future can be deliberately created and modelled (Amer et al., 2012). The French Government Office of Regional Planning and Development played a critical role in the development of the approach in the 1960's and 1970's. This approach has been utilized in France as a public sector tool, is often narrowly focused and is not intended for the purpose of corporate planning (Amer et al., 2012). The intuitive logics approach is the focus of this study. Many of the intuitive logic techniques presented in the literature are contradictory, poorly defined, impractical, not well justified and have not been adequately tested (Wright et al., 2013a).

There are a number of areas of the scenario planning method which require addressing. These areas include: critical theoretical considerations of the method and its rationale, the use of the technique in specific applied areas, empirical studies comparing scenario method variants, combining some variant of scenario method with alternative approaches, novel practical applications of the method, novel elaborations of the method and consideration of future prospects for the technique (Wright et al. (2013b). This study aims to contribute to one of the areas suggested by Wright et al. (2013b): combining some variant of scenario method with alternative approaches.

4.2.1. **Philosophical underpinnings of Scenario Planning.**

Future studies span the scale from objective positivism to subjectivist realism in that the tools, techniques and methods are based in many different philosophical standpoints (O'Brien, 2004a; Schoemaker, 1995; Tapinos, 2012). Three broad future studies dimensions were mapped out by Stevenson (2002) as "predictive/empirical," "cultural/interpretive" and "post structural/critical". Differing assumptions underpin each dimension about the nature of the universe, the nature of the future, the role of the subject and what constitutes truth/reality.

The predictive/empirical dimension defines the universe is deterministic and therefore in the case of scenario planning, there would be a single scenario developed, born from probabilistic forecasting where deviations would be attributed to inadequate modelling (Inayatullah and Dator, 2002). The probabilistic modified trends school of scenario planning was developed by the RAND Corporation incorporating matrix based techniques of trend impact analysis and cross impact analysis to extrapolate trends. Scenarios produced by the probabilistic trends approach are used to develop an understanding of the near future only, due to the uncertainty and volatility associated to longer time spans.

The perspective of the cultural/interpretive dimension accepts that multiple possible future alternative scenarios occur and the most popular scenario processes set out in Chapter 2 take this stance (Walton, 2008). The cultural/interpretive dimension governs the intuitive logics school of scenario planning as it is regarded as an approach that can produce flexible and internally consistent scenarios but relies on the knowledge, credibility, communication skills and commitment of the participants and ability of the facilitator (Walton, 2008). In a seven paradigm typology of future studies, Tapio and Hietanen (2002) denote the intuitive logics scenario planning approach as ‘pluralistic humanism’ where scenarios are created by the facilitator and the decision-maker is supposed to choose one, or several.

The post structural/critical dimension concerns challenging pre-existing mind sets and aims to overturn present power relations (Amer et al., 2012; Keough and Shanahan, 2008; O'Brien, 2004a). Although there are aspects of challenging assumptions in popular scenario planning processes that align with the critical perspective, scenario planning as a whole would not fall into the post structural/critical dimension.

4.2.2. **Popular Scenario Planning Processes**

There are a number of differing approaches to Scenario Planning. This section collates the most popular, presenting them in Table 2 with contextual notes. Common stages are then identified with the purpose of developing an accepted process. Commentary is also presented on variations. There are a number of common stages within the popular processes described in Table 2. Firstly, setting the scene: here defining the issues of concern, developing an understanding of the current situation, setting a time horizon, selecting the appropriate participants and defining the need for the scenario planning process are common aspects of the first stage (Shoemaker ;1995, Wright et al; 2013a, Keough and Shanahan; 2008, Neiner et al; 2004, O'Brien; 2004, Tapinos; 2012). The second stage can be widely described as identifying the key factors or uncertainties either via individual interviews or group discussion. This often includes the identification of driving forces for change (Shoemaker; 1995, Wright et al; 2013a, Keough and Shanahan; 2008, Neiner et al; 2004, O'Brien; 2004, Tapinos; 2012). The third common stage involves ranking of key factors, driving forces or uncertainties by impact/importance (Shoemaker ;1995, Wright et al; 2013a, Keough and Shanahan; 2008, (Neiner et al., 2004), O'Brien; 2004, Tapinos; 2012). The fourth stage encompasses choosing themes and developing scenarios via various techniques depending on the contextual setting of the exercise (Shoemaker; 1995, Wright et al; 2013a, Keough and Shanahan; 2008, Neiner et al; 2004, O'Brien; 2004, Tapinos; 2012).

Step	(Schoemaker, 1993))	(Wright et al., 2013a)	(Keough and Shanahan, 2008)	(Neiner et al., 2004)	(O'Brien, 2004a)	(Tapinos, 2012)	Commonalities between individual steps
1	Identify the issue: Clearly define the issue (the current situation for an organisation or industry) and identify why there is a need for future scenarios to be identified.	Setting the agenda defining the issue of concern and process, and setting the scenario timescale	Decide if scenario planning is the appropriate tool for strategy development but identifying the external and internal factors of organisational culture, leadership and time frame.	Refine the Sense of Purpose: Reaching a strong and clear sense of purpose.	Set the scene. Determining the Planning Horizon	Set the scene. Determining the Planning Horizon	Identifying the need for scenario planning and establish the planning horizon.
2	Identify key factors: the result of conducting interviews with key people within the organisation.	Determining the driving forces — working, first, individually, and then as a group	Team composition.	Understand Driving Forces or Key Patterns/Trends: The two types: predetermined and unpredictable.	Generate uncertain and predetermined factors. .	Generate uncertain and predetermined factors.	Identifying factors/drivers/ uncertainties.
3	Research driving forces: The drivers for change and drivers against change including	Clustering the driving forces — group discussion to develop, test and name the clusters	Scenario building: Here the previous models of conducting scenario planning by (Avin, 2007;	Develop Scenario Plots: Experts to identify driving forces and create a scenario plot matrix. Each	Reduce factors and specify factor ranges.	Reduce factors and specify factor ranges.	Reduce factors/drivers/ uncertainties and begin to develop scenario clusters

	technological advances and policy changes.		Schoemaker, 1995) are recommended depending on the setting.	cell in the scenario plot matrix describes how the driving forces may influence the outcome.			
4	Rank key factors and driving forces by their importance and impact on the organisation.	Defining the cluster outcomes — defining two extreme, but yet highly plausible – outcomes for each of the clusters over the scenario timescale	Decision process: Present scenarios in a format and style to which the decision makers are accustom.	Plot Strategy, Rehearse, and Converse: Developing the process from an academic exercise into a practical application.	Choose themes and develop scenario details.	Choose themes and develop scenario details.	Still some ranking processes exist as well as developing scenario themes and further detailed scenarios
5	Develop scenario logics: The outcome of the ranking exercise places drivers on two axes. The logic of a given scenario will be characterized by its location in the matrix, reshaping and regrouping them so a story can be told.	Impact/uncertainty matrix — determining the key scenario factors, A and B — i.e., those which have both the most impact on the issue of concern and also the highest degree of uncertainty as to their resolution as outcomes.	Increased performance: Here an area of further research is identified with the view to show a clear link between scenario planning and performance.	End	Check consistency of scenarios.	Check consistency of scenarios.	Checking consistency of the scenarios.
6	Develop scenario details. Each key factor and driving force is given attention and manipulated. Plausibility should be constantly checked from this point.	Framing the scenarios — defining the extreme outcomes of the key factors, A1/A2 and B1/B2	End		Present scenarios.	Present scenarios.	Presentation or narration of scenarios
7	Consider implications: Step seven examines the implications of the developed scenarios.	Scoping the scenarios — building the set of broad descriptors for four scenarios			Assess impact of scenarios.	Assess impact of scenarios.	Further development of scenarios or the development of strategies
8	Identify indicators: The final step is to select ‘‘leading indicators’’ that signify actual events may be unfolding according to a developed scenario.	Developing the scenarios — working in sub-groups to develop scenario storylines, including key events, their chronological structure, and the “who and why” of what happens.			Develop and test strategies.	Develop and test strategies.	Further development of scenarios or the development of strategies

Table 2. Comparison of popular scenario planning techniques

After the initial four stages, which have commonalities as expressed in Table 2, there are considerable variations in the processes. Recent contributions to scenario planning processes from Tapinos (2012) & O'Brien (2004a) suggest that after the first four stages, is the correct time to check the internal consistency of the initial frameworks of the scenarios developed. Other approaches suggest checking plausibility at later stages (Schoemaker, 1993 & 1995). In addition, the way in which the scenarios are 'fleshed out' has variations from using matrices, storytelling and alignment with existing methods of management communication. Also, the number of steps involved differs. This is mainly caused by differing activities before or after the development of the scenarios. A major limitation of scenario planning processes and where the most variance occurs, is what to do with the scenarios once they have been produced as the act of developing scenarios does not instantly inform strategy development as adequate information is not provided on how to undertake this aspect of the process (Tapinos, 2012). Scenario planning is mainly practiced for the purpose of a single organisation. There is an example of stakeholders from differing organisations (Cairns et al., 2013) concluding that although the scenario method is valuable in bringing stakeholders together, it is not in itself sufficient in bringing about consensus-driven collaborative change.

The review of popular scenario planning processes concludes with the common stages of the method identified for the proposed combination. Commonalities between the scenario planning processes were identified mainly occurring in the first four steps. Step one could be broadly defined as setting the scene where defining the issues of concern, developing an understanding of the current situation, setting a time horizon, selecting the appropriate participants and defining the need for the scenario planning process were common aspects. The second stage can be widely described as identifying the key factors or uncertainties either via individual interviews or group discussion, including the identification of driving forces for change. The third stage involves the commonalities of ranking of key factors, driving forces or uncertainties by impact/importance. The fourth stage encompassed choosing themes and developing scenarios via various techniques depending on the contextual setting of the exercise. Checking the plausibility of the scenarios was also revealed as a stage containing variation. In addition, the way in which the scenarios are ‘fleshed out’ contain variations from using matrices, storytelling and alignment with existing methods of management communication. The number of steps involved also differs, which is caused by differing activities before or after the development of the scenarios.

4.2.3. Scenario Planning in the NHS

There have been a number of scenario planning exercises conducted in the NHS or conducted in consideration of the NHS previous to this present research, as presented in the following sections. The types of scenario planning exercises that have been conducted in the in NHS can be classified as intuitive logics exercises (Astley, 2009), probabilistic modified trends (Dawson et al., 2007; Duane et al., 2014; Wanless, 2002) and other exercises which can be described as ‘hybrid’ approaches (Hadridge and Pow, 2008; Ling, 1999; Smith, 1998; Sutherland and Dodd, 2008). The hybrid approaches utilise either one of the schools of intuitive logics or probabilistic modified trends as the main approach with elements of the other integrated within it. There is also an instance of a proposed intuitive logics scenario planning exercise to be combined with other strategic planning tools. This review of scenario planning exercises conducted in the NHS concentrates on the type of approach used to develop the scenarios with a view to inform the empirical activities and conceptual developments in subsequent chapters of this present research.

Wanless (2002) and the Health Trends Review team at HM Treasury delivered a report to the Chancellor of the Exchequer in 2002, to review the long-term trends affecting the Health Service in the UK into 2022. This report used trend extrapolation to devise three scenarios of the future. A differing array of factors were used to develop the scenarios: demographic change, the costs of the five National Service Frameworks (NSFs) for specific diseases and then generalisations made from these, changes in the age-specific use of care and other factors impacting on expenditure, such as reducing waiting times, technological development and productivity. The review asserted that a similar study be conducted again in 5 years due to the uncertainty over the longer term. This report did not divulge in great detail the exact process of how the scenarios were developed. Nonetheless, the scenario method deployed certainly belongs to the probabilistic modified trends school as was the approach taken by Duane et al. (2014).

Duane et al. (2014) present a study demonstrating the possibility of simulating the carbon footprint for various reconfigurations of a health service (dentistry, in this case) using a sophisticated, ‘bottom up’ approach. The study discusses the limitations of using models for scenario development in that the extrapolated trends are based on the underlying data fed to the model in the first instance. The scenario planning approach of this study was from the ‘probabilistic modified trends’ school, producing five scenarios ranging from ‘current trend continuation’ to ‘ideal configuration’ in the context of reducing carbon footprint of an NHS dentistry service. Duane et al. (2014) consider a number of factors when designing the model they use based on the factor’s current permutations. The study does not take into consideration uncertainties over a longer period of time therefore the configurations given to reduce the carbon footprint would be useful for redesigning services now, but shed little light on service design of the future.

Smith (1998) and Ling (1999) detail a study called “imagining futures for the NHS” conducted by The NHS Confederation, Institute of Health Service Management, and the International Hospital Federation of a scenario planning exercise presented at ‘Celebrating the NHS: 50 years on’. The outputs of this exercise were four main drivers and two scenarios. The scenarios were created using an intuitive logics/trend analysis hybrid process. The first stage of building the scenarios involved the gathering of data on the main trends in social, political, economic, and technological (PEST) change (Ling, 1999). The Department of Health’s other sources were used to obtain the data to extract PEST trends. A step was also taken to look at how other scenario planning exercises from around the world used and presented trend data. The stages so far concluded the ‘trend analysis’ aspect of this exercise. The following steps represent the intuitive logics aspects of the exercise. A workshop with policy analysts was conducted to look for the key issues and the key drivers of change. In particular, the aim was to separate out what was important and relatively certain, from what was important but very uncertain. Further information is not given on what steps were taken in reaching the final ‘fleshed out’ scenarios. In particular, it must be noted that if the internal consistency of the scenarios was checked and included as part of the process, it was not commented upon by Ling (1999) or Smith (1998). The first driver was the development of new technologies and larger amounts of information. The second driver was new power structures in politics, business, and communities. Large scale, producer led organisations (like the NHS) are giving way to smaller, faster moving organisations led by customer needs. The growing importance of our relationship to the living environment was the third driver. Population growth is concentrated where resources are most scarce, and increasing migration may be inevitable. The fourth driver was social and cultural change: the ties which bind us in families, schools, and the workplace (the backbone of community life) will be replaced with new, possibly more fragile, relationships. Two scenarios were developed by the exercise. The first, “Find my way” is a world of individuals. People have immediate access to global information. Partnerships and networks spring up in business, politics, and peoples' lives but are short lived. There is great concern about global issues but no sustained, long-term campaigns. “Trust their guidance” is a world where people get access to information through sources trusted by the public and where well-regulated institutions provide stability. Individualism is less prominent, and national political parties are strong. In both scenarios, Ling (1999) and Smith (1998) report it will be important for the NHS to secure the trust and collaboration of the communities it serves. It will have to do more than deliver a high quality service: it will have to become embedded in communities that will themselves be changing fast.

Astley (2009) presented a scenario planning exercise called “Beyond Estates Strategy? Beyond Master Planning? Open Planning for Future Healthcare Environments”. This paper explored open planning for future healthcare estates, beyond the traditional hospital site. Astley (2009) propose the scenario planning concept be used as a strategic planning technique to facilitate an approach that is better aligned to a healthcare organisation's future business plans. The paper firstly discusses hospital estate management as requiring more flexible and future proof strategies, based on the rate of change in the healthcare environment, especially in advances in care and associated technologies. A key conclusion of the paper is a proposition that scenario planning should be used alongside other, existing planning formats and that scenario planning can be used for strategic, tactical and unplanned aspects of strategy development. Strategic aspects are a planned and integrated large-scale change that could either be a whole system change or phased approach to sub systems change that is also integrated into a whole scale plan. Tactical aspects could be a sub system change that responds to a small-scale need for change or the availability of limited resources to make such a change. Unplanned or opportunistic aspects represent a short term change that addresses an unforeseen need or a quick response to an opportunity to deliver an innovative solution. This paper is suggestive of an integrated intuitive logics model of scenario planning to be combined with other strategic planning tools so that the hospital estates of the future are better equipped to deal with the increasing rate of change in healthcare.

Sutherland and Dodd (2008) present an assessment of NHS Lanarkshire's leadership development programme's impact on clinical practice. A phenomenological approach was employed to gain rich insight into experiences, attitudes, values, thought processes, emotions and assumptions of staff participating in the study. A breakdown of the process used is simplified below:

- A questionnaire disseminated at the pre-participation stage of the new comers to the development programme
- A focus group of 15 experienced subjects, all having completed the programme within the last 18 months. The focus groups were split into 3 groups each lasting 1 hour each. Tape recordings allowed for thematic analysis.
- Member validation of the findings of the focus group thematic analysis.

Scenario Planning was not part of the methodology but an aspect of the subject of assessment of the study. Scenario planning was part of the leadership development programme. However, the commentary specifically on how scenario planning was valuable to the participants, as leaders in the NHS gave relevant insights. Scenario Planning was directly acclaimed for allowing the testing of leadership skills and better preparing participants to directly effect change.

Dawson et al. (2007) detail a Nuffield Trust report, part of the Health Policy Futures series, exploring the development of three possible scenarios of the English health and care system in 2022. Each scenario is associated with a different type of engagement with health and care and is shaped by different sets of policies. The three scenarios are:

- The engaged consumer in a health system shaped by transactions between paid and unpaid participants.
- The engaged worker in a health system shaped by leading engagement with those who provide care, including informal and self-carers, as well as paid employees.
- The engaged citizen in a health system, which minimises the causes of illness and maximises wellbeing through fully engaging citizens and their communities.

The trends in this report are based on an analysis of literature and trend data relevant to the future of care. Engagement with an expert reference group and wider professional networks supplemented the process. Ten background papers on key themes were prepared for this study and a number of subgroups of participants organised. One subgroup considered the trends most relevant to producing a desirable future; the other directed its attention to the trends which would produce an undesirable future. Consideration was also given to policy levers which would contribute to desirable and undesirable outcomes. There was considerable overlap between the two groups, both in a slightly jaded sense of the present, and their views on those trends, which would be most relevant to the future of care. Both groups demonstrated a strong tendency to envisage a future in terms of reaction to the negative aspects of the present rather than a vision of the future. Within this context, a composite scenario was drafted and circulated to the group for comment, inviting them to consider the points in the argument where there could be divergence. Comments were elicited through email, as well as through six supplementary interviews with members of the expert group who had been unable to attend the meeting. These three scenarios, along with the implications of each for the workforce and the policy measures designed to achieve them, were put before the reconvened expert group for their comments. This feedback was used to generate a further composite “vision” of a fully-engaged society to seek, where realistically possible, to embody the positive and address the negative aspects of each form of engagement.

Hadridge and Pow (2008) present a paper entitled ‘What the NHS needs to improve: four behaviours to sort out the health system’. The Mont Fleur Scenarios (developed in South Africa by a team who had experience in developing scenarios at Shell International) the authors believe resonate and provide a useful lens to understand the current situation in the NHS system. A system that the authors believe is destined to repeat its mistakes, is suffering a continuation of low morale and faces political instability unless leaders at all levels pay attention to aspects absent from the NHS; confidence, curiosity, connectedness and compassion. The scenarios used in this article are not originally developed for this study but synergies are made with scenarios developed in a different setting. This process is an example of how the scenarios, once produced can be used to develop strategies.

Scenario planning exercises in the NHS have been conducted for planning and informing policy at the system or macro levels (Dawson et al., 2007; Smith, 1998; Wanless, 2002). Other scenario planning exercises in the NHS are from the perspective of a singular NHS Trust (Astley, 2009; Sutherland and Dodd, 2008). None of the existing scenario planning exercises has been conducted with a focus on technology. The examples of scenario planning exercises in the NHS given here do not simultaneously explore the macro long-term environment and insight into the activities required in the short term (micro) at Trust level.

RFID technology and its adoption in the NHS requires consideration of the macro long term environment and the planning activities required in the short term (micro) Trust level. The foresight techniques of scenario planning and technology roadmapping as stand-alone activities do not meet the requirement of consideration of the macro long term environment and insight into the activities required in the short term (micro) at Trust level.

5. Conclusion, Problem Statement and Research Questions

This literature review comprised three sections. The first section sets the scene of an introduction to RFID and the current level of adoption in the English NHS. This section presented a synthesis of the literature on RFID in English Healthcare, the strategic value of RFID in supply chains, a collation of the main issues associated with technology adoption in the English healthcare system and a collection of examples of RFID usage in hospitals in England and an outline of the structural changes in NHS supply chains.

Evidence indicates that RFID is an important technology for improving supply chain performance. The literature on the strategic value of RFID in supply chains urges the potential full benefits of RFID adoption would only be realised if all actors collaborate, cost share, develop shared information management systems and co-operate in the redesign of supply processes. The literature on the usage of RFID in the English healthcare system is limited to isolated, intra-organisational, pilot projects. The National Programme for IT is a demonstration of the difficulty of implementing large scale IT projects in the NHS (Hendy et al., 2005) Centralised development programmes are now neither popular nor affordable (Albrassi et al, 2009) . Also, the shift in policy position from national mandatory IT projects to centrally supported local voluntary IT projects in the NHS may increase the success of isolated projects but does not align with the evidence of how to leverage the full benefits of RFID.

It is difficult to see then, how isolated pilot projects will result in leveraging the full benefits of RFID. Local, isolated initiatives cannot be expected to provide the momentum, since costs and benefits are often not evenly distributed between members (Albrassi et al., 2009). However, the reported pilot projects have improved processes and reduced operational costs, provided opportunities for learning at a local level and so, albeit on a small scale, play their part in recognising the value of RFID. Some immediate benefits of RFID adoption are being seen at a local level and its adoption has been acknowledged, actively encouraged and supported by central government and its commercial partners. Adoption at local level however, no matter how successful, will miss the opportunity of realising the full benefits of RFID and in particular RFID technology.

RFID adoption in English healthcare faces added complexities of needing to collaborate and co-ordinate efforts across organisational boundaries and across boundaries between the publically funded health sector and the commercial sector. Researchers need to identify ways of conceptualising and investigating this field, which suit the highly complex governance structures, varied organisational strategies and goals, and the inter-organisational supply processes of the English healthcare system. Suppliers, hospital managers and those with a sector perspective, such as trade associations and the DoH need to find alternative ways of promoting RFID adoption.

The second section reviewed previous studies in the area of RFID adoption in healthcare settings. Previous studies exploring the adoption of RFID technology in healthcare settings reveal a wide range of factors: cost, resistance to change, risk, suppliers' support, ubiquity, compatibility, security and privacy, risk, top management support, hospital scale, financial readiness, interoperability, adequate data standards, limitations of RFID technology, organisational readiness, presence of champions, technology knowledge, organisational size, unclear returns on investments and government policy (Carr et al., 2010; Lai et al., 2014; Lee and Shim, 2007; Rosenbaum, 2014; Ting et al., 2011a; Yao et al., 2012; Yazici, 2014). As presented in the previous section, RFID adoption in English healthcare faces added complexities of needing to collaborate and co-ordinate efforts across organisational boundaries and across boundaries between the publically funded health sector and the commercial sector. The factors identified in previous studies of RFID adoption in healthcare settings and the approaches taken in terms of methodology may not be appropriate for the English NHS due to the added complexities.

The third section of the literature review presented a review of technology foresight and then a review of two of the most widely used foresight techniques; scenario planning and technology roadmapping. Technology foresight is a collection of disciplines designed to inform planning for technology developments at both the macro and micro level. However the techniques available are not without their drawbacks. A review of popular scenario planning processes concludes with the common stages of the method identified for the proposed combination. Commonalities between the scenario planning processes were identified mainly occurring in the first four steps. Step one could be broadly defined as setting the scene where defining the issues of concern, developing an understanding of the current situation, setting a time horizon, selecting the appropriate participants and defining the need for the scenario planning process were common aspects. The second stage can be widely described as identifying the key factors or uncertainties either via individual interviews or group discussion, including the identification of driving forces for change. The third stage involves the commonalities of ranking of key factors, driving forces or uncertainties by impact/importance. The fourth stage encompassed choosing themes and developing scenarios via various techniques depending on the contextual setting of the exercise. After the initial four stages there are considerable variations in the processes. Checking the plausibility of the scenarios was also revealed as a stage containing variation. In addition, the way in which the scenarios are ‘fleshed out’ contain variations from using matrices, storytelling and alignment with existing methods of management communication. The number of steps involved also differs, which is caused by differing activities before or after the development of the scenarios. A major limitation of scenario planning processes is what to do with the scenarios once they have been produced, as the act of developing scenarios does not instantly inform strategy development.

The development of technology roadmapping as a foresight activity has resulted in the recommendation of most appropriate features from the various techniques available to be customized to the setting. Often the process of technology roadmapping is more valuable than the roadmap itself due to the communication and consensus generated within the organisation or stakeholders in the setting. A number of drawbacks to technology roadmapping have been identified: they are normative, rather than exploratory; they encourage linear and isolated thinking; dissemination is difficult; only experts can understand the output; multiple specific forms exist which have to be tailored to the needs of the organisation and can create more questions than answers initially.

5.1. **Problem Statement**

RFID adoption in the English NHS is limited to isolated pilot projects. Local, isolated initiatives cannot be expected to provide the momentum for widespread adoption. However, the reported pilot projects have improved processes, reduced operational costs and provided opportunities for learning at a local level and so, albeit on a small scale, play their part in recognising the value of RFID. Some immediate benefits of RFID adoption are being seen at a local level and its adoption has been acknowledged, actively encouraged and supported by central government and its commercial partners. Adoption at local level however, no matter how successful, will miss the opportunity of realising the full benefits of widespread RFID technology adoption.

An investigation into the drivers and inhibitors of RFID adoption in the present moment would be an English addition to the existing literature on RFID adoption in healthcare settings from around the world. The unique contribution this would make is due to the nationalised system in England facing added complexities of needing to collaborate and co-ordinate efforts across organisational boundaries and across boundaries between the publically funded health sector and commercial sectors. This study firstly aims to investigate the drivers and inhibitors of RFID technologies in the English NHS in the present moment.

However, the GS1 Healthcare User Group and other interested parties would benefit from insight over a longer period of time of what the NHS may be like in 10-20 years and what implications the future English NHS would have on RFID technology.

Technology foresight methods can help identify future states of a given industry or potential pathways of evolution of a particular technology. This present research aims to secondly utilise the techniques of technology foresight to provide insight over a longer period of time (10-20 years) to those responsible for RFID technology adoption in the English NHS. In parallel, the academic community concerned with the field of foresight would be presented with widely requested empirical examples of foresight exercises.

Deployment of scenario planning and technology roadmapping in the research setting of this study can provide members of the HUG and wider relevant practice based audiences the benefit of foresight exercises in the relatively early stages of RFID adoption in the English NHS. Firstly, however, the inherent weaknesses of each respective foresight technique as stand-alone practices must be addressed. Secondly previous attempts to combine scenario planning and technology roadmapping largely relying on a overall roadmapping framework with only aspects of scenario planning activities integrated to explore uncertainties. Therefore a new, novel technology foresight model must first be developed. The new model aims to achieve in the combination of scenario planning and technology roadmapping, to alleviate the weaknesses of each respective technique but to keep the strengths, intact. The next section sets out the research questions of this study that have emerged from the preceding introduction chapter, literature review and problem statement.

5.2. **Research Questions**

Drivers of RFID adoption in healthcare settings have been identified by other studies from around the world. This study aims to identify the drivers in the English Healthcare System.

1. What are the drivers of RFID technology adoption in the English NHS?

Inhibitors of RFID adoption in healthcare settings have been identified by other studies from around the world. This study aims to identify the drivers in the English Healthcare System.

2. What are the inhibitors of RFID technology adoption in the English NHS?

By deploying the techniques of technology foresight, the GS1 HUG can gain insights into the potential micro and macro developments effecting the English NHS and RFID adoption.

3. What are the plausible futures of RFID adoption In the English NHS of 2030.

Chapter 3: A Method Combining Scenario Planning With Technology Roadmapping

1. Introduction

This Chapter presents the development of a new, novel conceptual model for technology foresight. The new model blends scenario planning for the development of alternative plausible future states at the macro level and then employs technology roadmapping for the development of strategies for specific technologies. Wright et al. (2013b) set a premise for this chapter with a prediction, but also a call for combinations of futures methods to become increasingly evidence-based. Popper (2008) proposed 11 factors of influence in the selection of foresight methods. The four factors with the most influence on the selection of methods are:

- Their ‘nature’ (qualitative, semi qualitative, quantitative)
- The ‘methods mix’ (selecting methods which compliment each other).
- Thirdly how the codified outputs are to be used.
- What type of exploration – internal/external, short term/long term.

A number of methods were considered for combination including expert panels, key technologies, delphi and options thinking. Scenario planning and Technology roadmapping were selected as they compliment each other in terms of bringing the internal/external and short term/long term aspects of foresight together into one model.

Conceptual and empirical examples of existing attempts at combining scenario planning and technology roadmapping are reviewed. A new, novel combination is presented and justified based on alleviating the inherent weaknesses of each technique whilst ensuring their strengths remain intact.

A number of studies have included scenario planning as a closely related technology strategy development tool to technology roadmapping (Drew, 2006; Lee et al., 2007; Phaal et al., 2004b; Tran and Daim, 2008; Yoon et al., 2008) and even suggested blending the two

(Lizaso and Reger, 2004b; Saritas and Aylen, 2010; Strauss and Radnor, 2004). Combining the tools requires careful consideration, as they are distinct from each other in thinking, scope, and the level within the organisation at which they are utilized (Strauss and Radnor, 2004). Technology roadmapping often assumes a straight line projection or single scenario and can become less useful in the face of change that is volatile, systematic and sudden (Strauss and Radnor, 2004) especially over longer periods of time. Wright et al. (2013b) in a contribution to the development of the scenario method, demonstrate the power of combining methods over a singular focus. There are calls for roadmapping processes to accommodate the uncertainties associated with future forecasts and aspirations (Phaal and Muller, 2009). Where appropriate to communicate these in the roadmap itself. Sensitivity analysis, scenario planning and options thinking are relevant in satisfying the call (Phaal and Muller, 2009).

2. Scenario Driven Technology Roadmapping: A Conceptual Model

This section sets out the development of the new model and the approach taken to devise it. Due to the inherent, advised customization of technology roadmapping, combination with scenario planning, in the few examples available, they are highly context-dependant and give little commentary to how the approaches can be combined other than at conceptual level (Strauss and Radnor; 2004, Phaal et al; 2005, Lee and Park; 2005; Phaal and Muller; 2009, Gindy et al; 2008, Lucheng and Xiuqin; 2010, Ricard and Borch; 2012, Lizaso and Reger; 2004). A key limitation of technology roadmapping is that the output is linear and does not allow for uncertainty in the external environment, especially over longer time periods. This can be mitigated by combining technology roadmapping with scenario planning activities. Where empirical examples exist, there is little commentary on which scenario planning school or approach is used (Passey et al; 2006, Kajikawa et al; 2011). More so, none of the combinations fully employ the whole scenario planning process, rather, certain aspects are adapted to suit the setting as presented in Table 3. For example, only generating uncertainties, an early step in the scenario planning process overall, are as far as even the conceptual combinations go in their use of scenario planning. A number of further observations can be made. Existing combinations try to amalgamate aspects of scenario planning into a technology roadmapping framework. This alleviates some of the limitations of technology roadmapping not being able to cater for the longer time periods in uncertain and volatile environments, which fail to fully utilize the strengths of scenario planning. Existing combinations of scenario planning and technology roadmapping are not fully benefitting from the strengths of scenario planning.

Author, Year	Scope/Focus	Type and Stages of SP used	Stages of technology roadmapping	Nature of combination	Empirical/ Conceptual
(Strauss and Radnor, 2004)	An iterative process building on a number of inputs	Intuitive Logic. Identify Drivers (Stage 1) as a separate stage. The remaining aspects of SP to be conducted as 1 distinct step within a 15 step process.	a technology roadmapping process, with focus on iteration and re-evaluating the roadmaps and scenarios as they become closer to reality	15 step iterative process integrating the Scenario Planning Process as steps into a largely technology roadmapping based process.	Conceptual
(Pagani, 2009)	Combining technology roadmapping and SP for 3G mobile TV	Cross Impact Analysis.	None	SP is used to overcome the limitation on technology roadmapping in assuming a straight line projection	Conjectural framework with roadmappin g as base from which to explore the external environment further with SP.
(Phaal et al., 2005)	Exploring abstract technology roadmapping	SP used to explore the long term aspects of a given roadmap	SP as an add in to a largely technology roadmapping based process.	Integrating other future orientated techniques to technology roadmapping	Conceptual
(Lee and Park, 2005)	Customization of roadmaps to reflect purpose/setting	SP described as closely related to technology roadmapping	-	Should be used a concurrent activity	Conceptual
(Passey et al., 2006)	Combining Roadmapping with Product Concept Visioning & Scenario Building	Scenario Planning to help avoid a singular, inflexible vision.	SP as an add in to a largely technology roadmapping based process.	Drivers and market place imperative identified via a combination of a roadmap and SP	Based on case studies.
(Phaal and Muller, 2009)	Presenting an architectural framework for technology road mapping	Scenario planning used in the 'divergence' phase; the second phase out of four.	Four phases in an iterative process with SP used in the second phase.	The divergence phase is specifically for further exploration	Conceptual
(Abe et al., 2009)	Integrating technology roadmapping with Business Modelling for Engineering and Research in Japan	1st stage of SP used to gain an understanding of the uncertainties in a given field	A combination of technology roadmapping and other business modelling techniques	1st stage of SP used to gain an understanding of the uncertainties in a given field	Empirical
(Gindy et al., 2008)	Aligning R&D at the industry level with business needs	SP to be used to explore "extreme futures" as an "adjunct" process	Technology roadmapping to be used as a customized process.	SP to be used in addition not combined.	Conceptual
(Lucheng and Xiuqin, 2010)	Conceptual development of a framework to develop strategy for the R&D Industry in China	SP to be used as step 3 in a 5 step process based on a technology roadmapping method	Technology roadmapping process overall with SP as a distinct step	Attempt to use both technology roadmapping and SP to mitigate drawbacks	Conceptual
(Kajikawa et al., 2011)	Using Risk analysis and SP for technology roadmapping in the Japanese Energy Sector	SP used to identify uncertainties for multiple technology roadmapping to be developed	Technology roadmapping process with the addition of RA and SP to develop scenarios	Multiple Scenario developed, each with RA deployed for developing technology roadmapping for each scenario	Empirical
(Ricard and Borch, 2012)	A guide to developing strategy.	SP used to used to develop a common vision or before technology roadmapping is employed	Technology roadmapping conducted after the SP process.	An attempt to conduct SP and technology roadmapping in a workshop setting.	Potential guide/conceptual
(Lizaso and	A combination of technology	A 6 step process with SP used in the 2nd, 3rd,	Technology roadmapping based	A 6 step process with SP used in the 2nd, 3rd,	Conceptual

Reger, 2004b)	roadmapping and SP	and 4th steps with the planning horizon as a 5th step	prep as step 1, and production of the actual roadmap as the final step	and 4th steps.	
(Saritas and Aylen, 2010)	Clean Production	Before, during, after	Framework	Scenarios and technology roadmapping	Empirical

Table 3. Review of existing Technology Roadmapping and Scenario Planning.

In a new, novel combination a number of considerations need to be made:

- Developing a combined process is challenging due to the inherent, advised customization of each approach and the 'methodological chaos' (Bradfield et al., 2005) associated with each.
- Each approach is still developing in terms of process and relevance to developing strategy.
- The context in which the approaches are to be used drives the development of existing combined approaches (Abe et al., 2009; Gindy et al., 2008; Kajikawa et al., 2011; Lizaso and Reger, 2004a, b; Lucheng and Xiuqin, 2010; Pagani, 2009; Passey et al., 2006; Phaal and Muller, 2009; Saritas and Aylen, 2010; Strauss and Radnor, 2004). Therefore the combined process developed is only useful for the setting for which it was developed.
- Technology roadmapping is limited due to the long-term uncertainties that it cannot account for which is the main driver for the combination with scenario planning (Farrukh et al., 2003)
- Scenario planning is limited; as after the scenarios have been developed, there is not an established set of guidance of how to turn the scenarios into strategies, or to work back from the scenarios using the intuitive logics school (Tapinos, 2012; Wright et al., 2013a).

A new approach has been developed to improve the practice of technology foresight and tackle both the limitations of each of the two techniques, but capitalizes on their individual strengths. The new approach instead of trying to implement aspects of scenario planning into largely technology roadmapping frameworks, as is the case in the examples in Table 3. This aims to develop one technology roadmap for the scenarios that have been developed but with 'flex points' (Strauss and Radnor, 2004) to indicate developments over time which may lead to one of the scenarios created. Flex points allow for adjustments to be made to fit a range of different scenarios (Strauss and Radnor, 2004). This allows for a flexible roadmap that would help indicate which of the three scenarios is developing over time.

Having the scenarios developed before the technology roadmapping activities alleviates the limitation of technology roadmapping. Current approaches to developing roadmaps become less useful in the longer term due to not being flexible or wide ranging enough to account for uncertainty and volatility in the external environment. In order to address the limitations of scenario planning, namely the lack of guidance and evidence of what to do with the scenarios once they have been developed, a combination with technology roadmapping gives a pathway from the scenarios from the present. Based on the accepted steps in popular scenario planning processes, the strategy development steps as described by Tapinos (2012) are replaced with the technology roadmapping exercise. Tapinos (2012) proposed that developing strategies, although presented as defined stages in many of the popular scenario planning processes, should be separate to the scenario development stages. This notion paves the way for how developing scenarios in the macro environment should be used in other ways than to develop strategies and if they can be utilized to inform and support micro level planning or another foresight activity. The conceptual model presented in this thesis utilizes Tapinos's (2012) notion in that it takes the developed scenarios, and instead of going down the route of using them to develop strategies (which is one of the weaknesses of scenario planning practice in that the process and the accompanying guidance to develop strategies is not well developed as a field), the scenarios are used to better inform another foresight activity. The first layer of technology roadmapping is to establish an understanding of the external, macro environment in which the organisation operates by assessing the trends, drivers and uncertainties of importance to the organisation. By conducting a scenario planning exercise before the technology roadmapping exercise, the first layer can already be populated in the technology roadmapping framework, which only saves the organisation time and reduces repeated efforts.

Furthermore the new approach incorporates what is a full scenario planning exercise, which in turn does allow consideration of uncertainty and volatility over longer periods of time. What is produced then, is a long-term technology roadmap for three plausible futures. The participatory group indicating key events or developments that could lead to one of the developed scenarios indicates flex points. Here, the case is made for scenario development informing technology roadmapping. The common elements of technology roadmapping, arranged into a an architectural framework by Phaal and Muller (2009) are presented in Figure 1. Figure 1 also presents how the development of scenarios informs the technology roadmapping framework. The nature of scenario development informing technology roadmapping is three-fold. Firstly as presented in Figure 1, scenario development would inform the “Past” column as preparing the organisation for scenario development requires various activities in the “Setting the Scene” phase. This would eliminate the need for an organisation to redo much of the preparatory work for a technology roadmapping exercise. Second, is the population of the first layer of the architectural framework presented by Phaal and Muller (2009). This first layer identifies external environment trends/drivers/uncertainties and indeed deploys PEST (L) analysis to do so. This activity is a direct outcome of the second common stage of scenario planning and again, would negate the need for an organisation to allocate resources and time into this part of the technology roadmapping process.

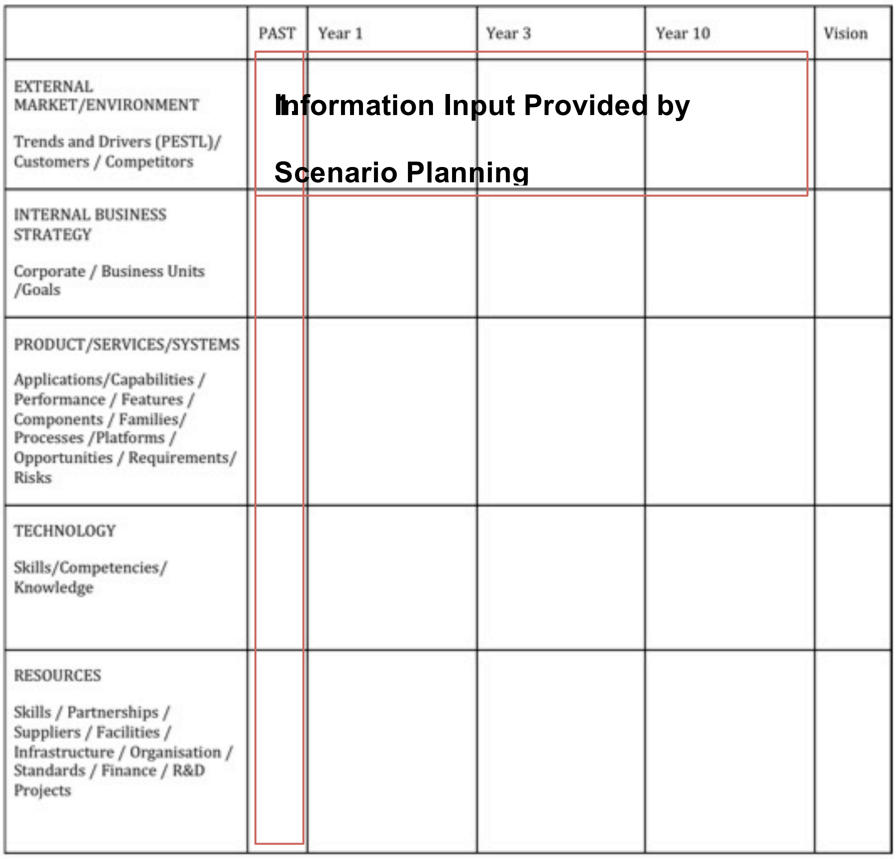


Figure 1. The common elements of technology roadmapping and how scenario planning can inform the process

This conceptual model proposed here not only combines two foresight approaches but also in doing so mitigates the limitations of each and integrates both normative and exploratory foresight activities. The new conceptual model can therefore be used in the following settings:

- Settings where collaboration across organisational boundaries is required, for example supply chain redesigning, policy development networks or industries where technology foresight requires engagement from multiple stakeholders
- Organisations which require the understanding of the macro environment but also desire to develop foresight specific to a given technology
- Settings where emerging technologies have clear benefits but widespread adoption faces challenges from the external environment due to long-term uncertainty.

The new approach is presented below:

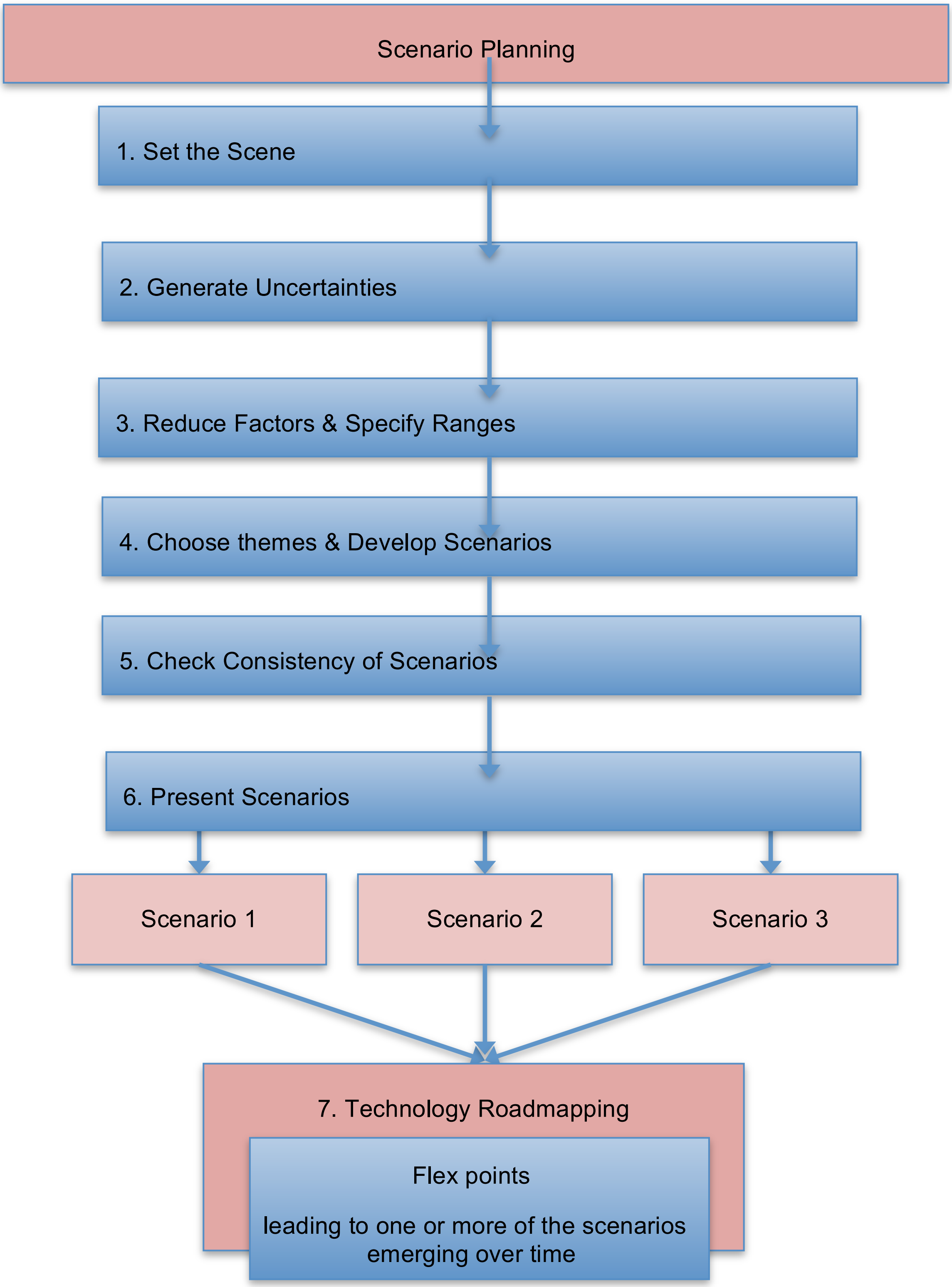


Figure 2. A conceptual model of Scenario Planning and Technology Roadmapping.

There are a number of expected outcomes from deployment of the model:

- A foresight technique allowing stakeholders to collaborate across organisational boundaries.
- Three plausible future scenarios providing context, based on the most uncertain and important factors identified by an expert group in a technologically based setting.
- The ability to then take the scenarios produced forward to inform a technology road map which includes the key aspects of technology roadmaps: external market, internal strategies, systems, technologies and resources.
- The model then gives visibility through ‘flex points’ (Strauss and Radnor, 2004) to one of the scenarios depending on events that occur over the timeline of 15 years.

3. Conclusion

This Chapter presented a conceptual method that blends scenario planning for the development of alternative plausible future states at the macro level and then employs technology roadmapping for the development of strategies for specific technologies with the view to improve the practice of technology foresight. Conceptual and empirical examples of existing attempts at combining the two approaches were reviewed. Reviewing these examples revealed the combinations were highly customized to the setting, therefore allowing little potential crossover or application to other settings. These examples of previous combinations also revealed that mainly, the incorporation of scenario planning was to take the step where uncertainties/factors/drivers were identified and add them to a technology roadmapping exercise. This activity directly attempts to mitigate one of the drawbacks of technology roadmapping in that the inclusion of future uncertainties enable the roadmap developers to use a longer timescale than what a roadmapping exercise on its own would normally allow. This is due to technology roadmapping having a relatively shorter time horizon than scenario planning. However, the whole scenario planning process is only used in one (Saritas and Aylen, 2010) example where it is combined with technology roadmapping, therefore not fully utilizing the capabilities of the technique.

Reviewing the two techniques and discussing existing attempted combinations has led to an original contribution to the ever-increasing foresight techniques literature, by the development of a conceptual model which addresses the limitations of both scenario planning and technology roadmapping. The conceptual method as discussed is to be deployed for organisations, which require the understanding of long-term macro environments but also desire to develop foresight specific to a given technology or settings where emerging technologies have clear benefits, but widespread adoption faces challenges from the external environment.

Chapter 4: Methodology

1. Introduction

The purpose of this chapter is to present the research design, discuss the research's philosophical position in relation to other philosophical approaches, illustrate the data collection methods selected, appraise the available data analysis methods and detail how those methods were deployed in order to meet the research questions set out in Chapter 2.

Section 1 presents the guiding framework used to develop the methodology in the form of five questions (Denzin and Lincoln, 2005 p.25) that, for the purposes of this present research, have been expanded to six questions. The original five questions are: How will the design connect to the paradigm or perspective?, How will these materials allow the researcher to speak to the problems of praxis and change? Who or what will be studied?, What strategies of inquiry will be used?, What methods or research tools will be used for collecting and analysing empirical materials? This last question outlining the research tools used for collecting and analysing empirical materials have been split into two separate questions for the purposes of clarity of presentation and discussion. Through the process of answering each question, the research design is defined and where relevant, appraised. Section 2 presents the aspects of reflexivity to be used in this present research. Section 3 presents the conclusion to the Chapter.

2. Research Design

In order to develop a research design appropriate for the research questions, a guiding framework was first sought out. Denzin and Lincoln (2005 p.25) present five questions for designing research strategies and acted as a guiding structure for the research design. The five questions are as follows:

- How will the design connect to the paradigm or perspective?

- How will these materials allow the researcher to speak to the problems of praxis and change?
- Who or what will be studied?
- What strategies of inquiry will be used?
- What methods or research tools will be used for collecting and analysing empirical materials?

These five questions are used as a guiding framework to present the research design. However, a slight alteration to this structure has been adopted for this study due to the final question containing both methods for data collection and analysis techniques. For a clearer presentation and discussion of techniques, this question has been split into two separate questions. The resulting framework of the research design for this study is presented by using the six questions as section headings.

It is relevant at this stage to revisit the research questions set out in Chapter 2, which were as follows:

Drivers of RFID adoption in healthcare settings have been identified by other studies from around the world. This study aims to identify the drivers in the English Healthcare System.

1. What are the drivers of RFID technology adoption in the English NHS?

Inhibitors of RFID adoption in healthcare settings have been identified by other studies from around the world. This study aims to identify the drivers in the English Healthcare System.

2. What are the inhibitors of RFID technology adoption in the English NHS?

By deploying the techniques of technology foresight, the GS1 HUG can gain insights into the potential micro and macro developments effecting the English NHS and RFID adoption.

3. What are the plausible futures of RFID adoption In the English NHS of 2030?

2.1. **Connecting the research design to the paradigm or perspective**

A paradigm is seen to be comprised of four concepts that go some way to encompassing the researcher's beliefs and outlook in terms of; axiology, ontology, epistemology and methods (Denzin and Lincoln, 2000; Saunders et al., 2011). The four concepts of this present research are: a value bound subjective axiology, a social constructivist ontology, inductive epistemology with aspects of deduction and deploying a multi-methods approach have been utilised for this present research.

The following sections set out to provide deeper exploration and justification of how the research design will connect to the perspective of the researcher.

2.1.1. **Research Philosophical Traditions**

In order to clearly state the ontological and epistemological perspective of this researcher, an understanding of philosophical research traditions is first required. This section outlines the two major research philosophical traditions and finally states the ontological and epistemological perspective from which this research project has been conducted.

Developing an understanding of the philosophical position guides the researcher to understand the taken-for-granted assumptions we all have about how the world works. Only through a understating of the philosophical positions chosen, can we defend them in relation to alternatives we could have adopted and examine the assumptions to evaluate their appropriateness (Saunders et al., 2011).

The two major research philosophical traditions; subjectivism and objectivism, each have respective sets of assumptions relating to ontological and epistemological stances. The first set of assumptions concerns ontology. Ontology is what we believe to be social reality, upon which a theory is based (Grix, 2001). The ontological assumptions in the objective philosophical tradition are based in 'realism' or 'platonic realism' where the stance is to deny that we can have any certain knowledge of the world and accept that all theories about the world are grounded in a certain perspective with the understanding that all knowledge is partial, incomplete and limited (Saunders et al., 2011). The ontological assumption in the subjective philosophical tradition is the rule of nominalism where we drop the assumption that any formulated insight can only have reference to individual concrete objects (Kolakowski, 1993).

The second set of assumptions, concerning epistemology, is the study of the nature of knowledge (Holden and Lynch, 2004). The epistemological stance of the objective philosophical tradition is that of positivism. Positivism's perspective is that reality is stable, can be observed and described from an objective viewpoint without interfering with the phenomena being observed (Levin, 1988). In this type of research, phenomena should be isolated and observations should be repeatable where a single variable is manipulated as to identify regularities and irregularities. The epistemological stance in the subjective philosophical tradition is that of interpretivism. Interpretivism is concerned with conducting research amongst people, not objects, by entering the social world of our research subjects and understanding their world from their point of view (Saunders et al., 2011). Interpretivists accept that they cannot avoid affecting the phenomena they research.

A summary of the differences between subjective and objective research philosophical traditions, adapted from (Hathaway, 1995; Holden and Lynch, 2004; Saunders et al., 2011), is presented in Table 4.

	Objective Tradition	Subjective Tradition
Can include or is described as	Quantitative, varieties of positivism	Interpretive, naturalistic relativist, phenomenological
Underlying assumptions or view of reality (Ontology)	Subjects and objects exist separate from the perception of them	Subjects interact with a setting that structures and constrains that setting.
Approach to knowledge (Epistemology)	Objective reports of measured dimensions of the phenomenon	Understanding subject's aims, perceptions, perspective's and assumptions.
Aim of investigation/inquiry	To identify the presence or absence of predicted changes.	Document understanding from participant's perspective. To articulate emergent themes. Formative evaluation i.e. programme improvement
Researchers role	Observational without interaction with the setting	Actor i.e. interacting with the setting and participants

Table 4. Subjective and Objective research philosophical traditions.

In the terms used by the adapted summaries presented in Table 4 (Hathaway, 1995; Holden and Lynch, 2004; Saunders et al., 2011), the ontological and epistemological positions from which this research was conducted are as follows:

- Ontological: Subjective tradition where subjects interact with the setting, which structures and constrains, said setting.
- Epistemological: The goal is to understanding the subject's aims, perceptions, perspectives and assumptions.

The world-view of this researcher is that of the interpretivist; interacting with the setting and the participants where reality is socially constructed, subjective and can be perceived differently by different people.

2.1.2. **Interpretive Paradigms**

Denzin and Lincoln (2000) present four interpretive paradigms of qualitative research: positivist/post positivist, constructivist-interpretive, critical, and feminist-post structural. Burrell and Morgan (1982) offered four-fold categorisation of social science paradigms representing the major belief systems of management and business researchers. They show how the four paradigms (radical humanist, radical structuralist, interpretive and functionalist) can be arranged as a matrix, corresponding to two conceptual dimensions: subject to objectivist and radical change to regulation.

The present research is largely conducted within the constructivist-interpretive paradigm with some influences from the viewpoints of design and execution coming from the critical paradigm. It is not unusual to have influences from multiple paradigms as this is consistent with the nature of qualitative research (Denzin and Lincoln, 2000). A researcher from the critical interpretive paradigm uses their work as a form of social or organisational criticism (Kincheloe and McLaren, 2000). The interpretivist/constructivist paradigm grew out of German philosophers' study, for example the philosophy of Edmund Husserl's phenomenology, of interpretive understanding called hermeneutics (Mertens, 2005 p.12).

The interpretivist/constructivist researcher’s goal is to rely upon the "participants' views of the situation being studied" (Creswell, 2013 p.8), allowing the participants to construct the meaning of a situation and recognise the impact on the research setting of their own background, viewpoints and experiences. The model devised to investigate this present research setting will involve workshops that rely on the participants constructing the meaning of a situation, as this is a key aspect of scenario planning/technology roadmapping techniques in general.

Kincheloe and McLaren (2000) present six assumptions which inform the critical aspect of the present research:

- all thought is mediated by power relations that are socially and historically constituted. The assertions and assumptions of the participants in this study are influenced by power relations within the group and their own individual experiences.
- facts can never be isolated from the domain of values or removed from some form of ideological inscription.
- the relationship between concept and object, and between signifier and signified is never stable or fixed and is mediated by social relations and genre norms;
- language is central to the formation of subjectivity;
- certain groups are privileged over others and this is generally accepted by all as natural, necessary, or inevitable;
- mainstream research practices are generally, although most often unwittingly, implicated in the reproduction of organisational life that result in the above points remaining hidden from consciousness.

The assumptions of the critical interpretive paradigm as set out by Kincheloe and McLaren (2000) are pertinent in this present research as conducting scenario planning and technology roadmapping workshops require input from participants in a group setting. It is not just the process of going through the activities of the workshops that are responsible for the data outputs as power relationships, ideological/political standpoints, group dynamics and team roles all have a part to play in shaping the data outputs of these workshop-based activities. As this study is conducted within the constructivist-interpretive paradigm, considerations from the design and execution of a critical paradigm have also been acknowledged and implemented. There are overlapping assumptions between the constructivist-interpretive paradigm and the critical paradigm such as both paradigms acknowledgement of research as not value free. The added value of considering the design and execution of the critical paradigm in this study are that the goal of the critical paradigm is to actively challenge interpretations and values of the actors in the research setting.

2.2. **Materials allowing the researcher to speak to the problems of praxis and change**

This present research explores the future of RFID technology adoption in the English Healthcare System. Currently, RFID adoption faces a number of challenges in the form of inhibitors and is being pushed by a number of drivers identified in the literature review. A core group of stakeholders and those responsible for the widespread adoption of RFID technologies are members of the HUG. The problems of praxis in this particular setting are a lack of understanding/confidence of the future landscape and therefore stunted planning capabilities of groups such as the HUG. Deploying a scenario planning exercise with a technology roadmap in this setting could aid the members of the HUG to better understand future landscapes of the English healthcare system with the aim of better informing future planning.

The setting of RFID technology adoption in the English healthcare system is constantly evolving due to the emerging nature of the technology. This present research is a longitudinal study, and in order to deploy the multi-method approach, a time period of 18 months was required. During this time the researcher's and the participant's understanding of the issues involved evolved in an iterative cycle. The selection of action research as the overall strategy of enquiry with a focus on scenario planning suited this setting due to this co-evolution of understanding required of an uncertain future.

2.3. Subjects of this study

The organisation that is the focus of this study is the UK GS1 Healthcare User Group (HUG). This is a unique group responsible for driving the adoption of RFID technologies in the NHS. The individuals comprising the HUG are selected to join the group due to their individual substantial expertise in AIDC technology within the healthcare industry.

The GS1 HUG was established in 2009 to drive the adoption of RFID technologies by co-ordinated effort ensuring, RFID technologies were adopted in areas of the NHS where the benefits were proven. More so, RFID and its underlying systems shared standards enabling information sharing between the individual systems and NHS monitoring/performance/management bodies.

Gaining access to the GS1 HUG involved a process of negotiation, gaining an understanding of the challenges that English Healthcare faces from their perspective and which technology foresight methods would be appropriate, not only to the HUG but the wider English NHS. The co-chair was approached via an email requesting a meeting to discuss this project in late 2011. At that time, this research project was based around exploring the drivers and inhibitors to RFID adoption in the English NHS. After the initial meeting, during which the invitation was extended to attend the (then held six times per year) HUG meetings and be introduced to the group, the co-chair provided various documents to explain the background of the HUG. By attending a number of HUG meetings and speaking to individual members over the next 6 months, it was clear that there was uncertainty about the future, which in term stunted the planning efforts of the various parties involved.

Scenario planning and technology roadmapping was decided upon with the Chair of the HUG after a review of technology foresight (presented in Chapter 2 Section 5), the two most dominant approaches were scenario planning and technology roadmapping. After developing an in-depth understanding in the two approaches, it was realised that they had limitations that would be need to be addressed resulting in the development of the new model.

Initially, there were some procedural questions about what was involved in the process and how much input each member would need to give. However, overall the participants welcomed the idea of a systematic set of workshops to explore the future of RFID in the English NHS. By deploying the techniques of technology foresight, the GS1 HUG can gain insights into the potential micro and macro developments effecting the English NHS and RFID adoption.

It is at this stage where facilitation skills were developed in preparation for the scenario planning and technology roadmapping workshops, as explained in Section 2.5.3.3 of this Chapter.

The HUG is comprised of twelve members two of which are facilitators. Seven of this group were interviewed. All seven participated in the subsequent Scenario Planning Workshops and four in the Technology Roadmapping Workshops. Table 5 presents the participants of the study and their position in their organisations.

Interviewee	Organisation	Post
1	DoH	Work stream lead
2	RFID Technology Suppliers	Engagement Lead
3	Equipment suppliers to the NHS	Engagement Lead
4	Technology Standards Groups	NHS Engagement Leads
5	NHS Supply Chain	Supply Experts
6	Technology provider where RFID is Widespread in their supply chains	Supply technology managers
7	DoH	Work stream lead 2

Table 5. Study Participants

This HUG, comprising of members of the NHS, technology providers, standards agencies, pharmaceutical companies and other suppliers to the NHS, presented a unique opportunity to explore the drivers and inhibitors of RFID technology adoption in the NHS.

Furthermore, the HUG has a future focused perspective of RFID, given the technologies emergent nature in the English NHS. The conceptual technology foresight model developed in Chapter 3 requires a group of participants concerned with the future of a technology in a given setting who aim to take into account the long-term macro environment and gain an indication of short term planning activities. The HUG is lesser concerned with, although takes measures to champion, individual isolated pilot projects but rather the future, system-wide perspective of RFID adoption. This perspective of concern aligns well with the intended use of the conceptual technology foresight model developed in Chapter 3.

Based upon the exploration of the emerging drivers and inhibitors, the conceptual foresight model, as shown in Chapter 3, would implicate practical benefit to the HUG in terms of systematically creating images of the future and planning accordingly and provide an opportunity for academic contribution to the field of foresight. The areas of academic contribution are furthering the identification of drivers and inhibitors of technology adoption in healthcare, technology foresight activities in healthcare and combining technology foresight methods for robust foresight.

However, the using the GS1 HUG as the participant set for this study could have a number of drawbacks. Firstly, the number of participants would be limited in terms of numbers. Secondly, not including the perspective of a wider range of stakeholders to give this thesis input from those who are interested in, responsible for or affected by RFID adoption in the English NHS. Including non-technical stakeholders or those with a limited understanding of RFID would have required extra steps to ensure participants understood the technology in question. Using the GS1 HUG exclusively should manifest in building trust and rapport with the participants, which is highly valuable during the suggested scenario planning and technology roadmapping workshops. Trust and rapport will be achieved by regular and in depth contact and communication with participants.

2.4. **Strategy of inquiry**

The strategy of inquiry used for this present research is Action Research. Action research has also been known as Participatory Action Research (PAR), Community Based Study, Co-Operative Enquiry, Action Science and Action learning (Richardson, 2000b). Lewin (1946) advocates action research's strength lies in generating solutions to practical problems and empowering practitioners, by getting them to engage with the research setting and the subsequent development or implementation activities. The desired outcome of conducting action research is to bring about change in specific contexts, as Parkin (2009) describes it. An action researcher is looking to create meanings using rich descriptions and narratives (Meyer, 2000). The action researcher develops expertise through looking at situations closely and analysing them, recognizing possible bias and interpreting data, rather than looking to generalise findings based on a study of large numbers of cases (Koshy, 2005).

As explored further in this chapter, this study aims to look at the situation that the participants of the HUG are in and analyse this setting through semi-structured interviews and the deployment of the conceptual foresight model. This setting and the aims of this study suit an Action Research approach.

Action Research can pose difficulties in the juxtaposition between making a contribution to an on-going problem an organisation faces (such as the problem the HUG faces in the lack of widespread RFID adoption in the English NHS) and meeting the established criteria of acceptable empirical research (Yorks, 2009 p.379). Another difficulty in Action Research is that the audience that ultimately validates the research as credible actionable knowledge. The audience of an Action Research project is usually diverse and can include academic scholars, practitioners, sponsors and other stakeholders. In order to overcome these difficulties, Action Research requires the researcher to develop a thorough understanding of various research design strategies, differing types of scientific contribution, a wide range of the types of useful, valid data to deliver scientific contributions as well as problem solving outcomes (Yorks, 2009 p.380). The setting of this study means that the participants and those who they think will benefit or gain insight from the results of this study will ultimately validate the research as credible actionable knowledge.

There are a number of popular, models of how to conduct Action Research (Koshy, 2005). The main components of action research models involve an iterative process; planning or fact-finding, action and then reflection. Action Research is an approach commonly used in a wide range of healthcare environments (Koshy, 2005). Action research supports practitioners in seeking out ways in which they can provide an enhanced quality of healthcare (Hart and Bond, 1995; Koshy, 2005; Munn-Giddings and Winter, 2013). For this study, acknowledged good practices of Action Research was used to guide engagement with the HUG and help to establish the standards to follow for conducting fieldwork (Reason and Bradbury, 2001 p.109; Stringer, 2013 p.105). For this present research, the guidelines presented by Yorks (2009 p.379) whereby there are six steps separated into two categories as shown below were used:

- Category 1: Initiating and organizing the project.
    - Defining the problem and the research questions: presented in Chapter 2, Sections 7.1 and 7.2.
    - Defining roles and relationships amongst those actively engaged in the Action Research process: presented in Chapter 4, Section 2.3.
    - Deciding how the problem will be studied and choosing methods that will provide the data necessary for answering the research questions: presented in Chapter 4, Section 2.4.
- Category 2: Implementing the project
    - Gathering and interpreting the data through an appropriate analysis process: presented in Chapter 4, Section 2.6
    - Identifying appropriate and meaningful actions: Presented in Chapter 3.
    - Deciding on how the findings should be disseminated and used. Presented in Chapter 3.

There are two tracks to how Action Research was used in this research project. Firstly, for Research Questions 1 and 2, the use of the action research guidelines above were limited to the first four steps. For Research Question 3, all 6 steps were used in this present research. The advantages and disadvantages of this ‘two track’ Action Research process is reflected upon in Chapter 6, Section 5.

2.5. **Methods or research tools used for collecting empirical materials**

Numerate social science research methods, both qualitative and quantitative could be deployed by the Action researcher. The selection of which is guided by his/her ‘world view’ and the research questions (Yorks, 2009 p.396). Qualitative methods have been selected for this study.

2.5.1. **Conducting and Evaluating Qualitative Research**

Qualitative research emerged in the early 1900s as largely positivist scientific writings of field experiences by anthropologists (Denzin and Lincoln, 2000; Richardson, 2000a). During the 1920s and 1930s the Chicago School established the importance of qualitative inquiry for the study of human group life (Denzin and Lincoln, 2000). Although Schwandt (2000) asserts that qualitative research was established in the American Academy during the reformist movement in the 1970s. Qualitative management research is an umbrella term for the plethora of non statistical data collection and analysis approaches and techniques and are indeed deemed appropriate when studying collective and individual interpretations in a dynamic process (Johnson et al., 2006; Maitlis, 2005).

Qualitative research conducted within the constructivist/interpretive paradigm is a situated activity that locates the observer in the observed world representing the standpoint that a given activity of inquiry reflects the stand point of the inquirer (Prasad and Prasad, 2002; Silverman, 2011). Qualitative research is seen as negotiated co-creation, produced by both the researcher and the researched through a dialogue which is ongoing (Burr, 2003; Silverman, 2011). This is opposed to quantitative approaches where the emphasis is on measurement and analysis of causal relationships between variables; qualitative researchers concentrate on generating a richer understanding of phenomena (Denzin and Lincoln, 2000).

Janesick (2000) advises qualitative researchers to devise research questions related to the whole system, i.e. a classroom, school, school district, city, country, organisation or hospital. This present research is concerned with RFID adoption at the system level and not adoption in one single hospital setting. The foresight model devised to explore the future of RFID adoption in the English NHS, presented in Chapter 3, and the semi structured interviews discussed further in this Chapter allow for exploration at the system level; the English NHS as a whole. Therefore, the research questions, methods selected and model developed for the setting of the study allow for conducting research at the system level.

Criticisms of qualitative research include claims such as as simply journalism, exploratory and unscientific (Denzin and Lincoln, 2000). Qualitative work focuses on producing historically situated narratives and sociologically contextual descriptions which cannot be evaluated by the same criteria as quantitative research studies but rather aims towards achieving relevance, plausibility and credibility (Denzin and Lincoln, 2000). The qualitative researcher also needs to provide a reasoned interpretive commentary by using appropriate tools for analysis and reflexivity, producing analysis of key findings and prevalent ideas alongside assessing specific cases and exceptions (Janesick, 2000; Kemmis and Mctaggart, 2000).

Reflexivity involves the researchers turning a critical lens upon themselves and has a history spanning at least a century (Kvale and Brinkmann, 2009). Finlay and Gough (2008) describe reflexivity as reflecting upon oneself as an instrument of research as well as understanding the impact of the researcher's influence on the research setting. Reflexivity also involves developing an understanding of how the researcher is influenced by the research setting Lincoln et al. (2011). Multiple forms of reflexivity have been practiced; from introspection to critical realism and then more recently to post modern deconstructionism (Taylor, 2001). Finlay and Gough (2008) go on to summarise the uses of reflexivity when taken as a whole and pronounce it as a valuable tool to help with:

- Examine the impact of the position, perspective and presence of the researcher
- Promote rich insight through examining personal responses and interpersonal dynamics
- Open up unconscious motivations and implicit biases in the researcher's approach
- Empower others by opening up a more radical consciousness
- Evaluate the research process, method and outcomes
- Enable public scrutiny of the integrity of the research through offering a methodological log of research decisions

However, there are criticisms of reflexivity. Finlay and Gough (2008) question the actual ability of the researcher being able to step back and reflect on the researcher's influence and the research's influence upon the researcher due to the researcher being intimately involved in knowledge creation. Conversely, Johnson and Duberley (2003) conclude that the non inclusion of a reflective process, for all the difficulties involved in choosing how to exploit the reflexive potential, our research would be fundamentally incomplete.

Drawing upon Finlay and Gough (2008), there are three distinct but interrelated forms of reflexivity. Firstly the personal form encompassing thoughts and feelings prompted by the interviews/interviewees as a model for researcher data and participant data analysis. Secondly the functional form considers the role of the researcher and the effect this may have on the research process. The third form involves disciplinary discussion of the potential contribution of the research to broader debates about theory and method (Wilkinson, 1988).

There is consensus that the criteria used for evaluating quantitative studies are inappropriate for qualitative research due to the philosophical underpinnings and epistemological characteristics being so far apart (Czarniawska, 2004; Denzin and Lincoln, 2000). It is also agreed, albeit in different terms, that the scientific notion of validity is reframed for qualitative studies. For the purposes of qualitative studies, validity takes the form of various reframing; credibility (Janesick, 2000), increased understanding of particular situations (Mueller et al., 2004), usefulness (Burr, 2003) and authenticity (Lincoln et al., 2011). Analysis in qualitative research is centred on the interpretation and description of phenomena, instead of aiming to identify cause and effect relationships, where rigour is reached not by formalising procedures and techniques but via interpretive, theoretical awareness and sensitivity (Alvesson and Deetz, 2000; Gubrium and Holstein, 2000; Janesick, 2000).

2.5.2. **Methods**

Two methods of data collection were used: semi structured interviews and workshops.

The methods of data collection were chosen as to their relevance to the research, in terms of their appropriateness to the world-view of the researcher and the action research based strategy of enquiry. Table 6 sets out the each research question and the method selected with the aim of obtaining an answer.

Research Question	Method Selected
What are the drivers of RFID technology adoption in the English NHS?	Interviews
What are the inhibitors of RFID technology adoption in the English NHS	Interviews
What are the plausible futures of RFID adoption In the English NHS of 2030	Interviews and Conceptual Foresight Model

Table 6. Research Questions and corresponding data collection methods.

Seven individual semi structured interviews took place, these typically lasted for sixty minutes and were audio recorded and transcribed. The interviews involved gaining data for all three Research Questions as shown in Table 6 above. As shown in Section 2.5.3.8 of this Chapter, the interviews contain questions for the first two steps of the technology foresight model. The final section of the interviews was with regards to developing the planning horizon and generating the uncertainties for the scenario planning phase of the technology foresight model. The workshops were conducted after the interviews and do not relate to Research Questions 1 or 2. For the scenario planning exercise, one workshop with all participants was recorded and transcribed, nine separate workshops with two participants each and a final workshop to gain feedback on the scenarios developed, were conducted. Data collection for nine separate workshops with two participants each and a final workshop was conducted through the techniques used in the scenario planning process and the collection of field notes during and after each workshop. The Technology Roadmapping exercise was the final aspect of the data collection process as shown in Figure 3 below. In addition, observation of three HUG meetings were conducted and supplementary to these, informal conversations and observations were conducted during the time frame of the study.

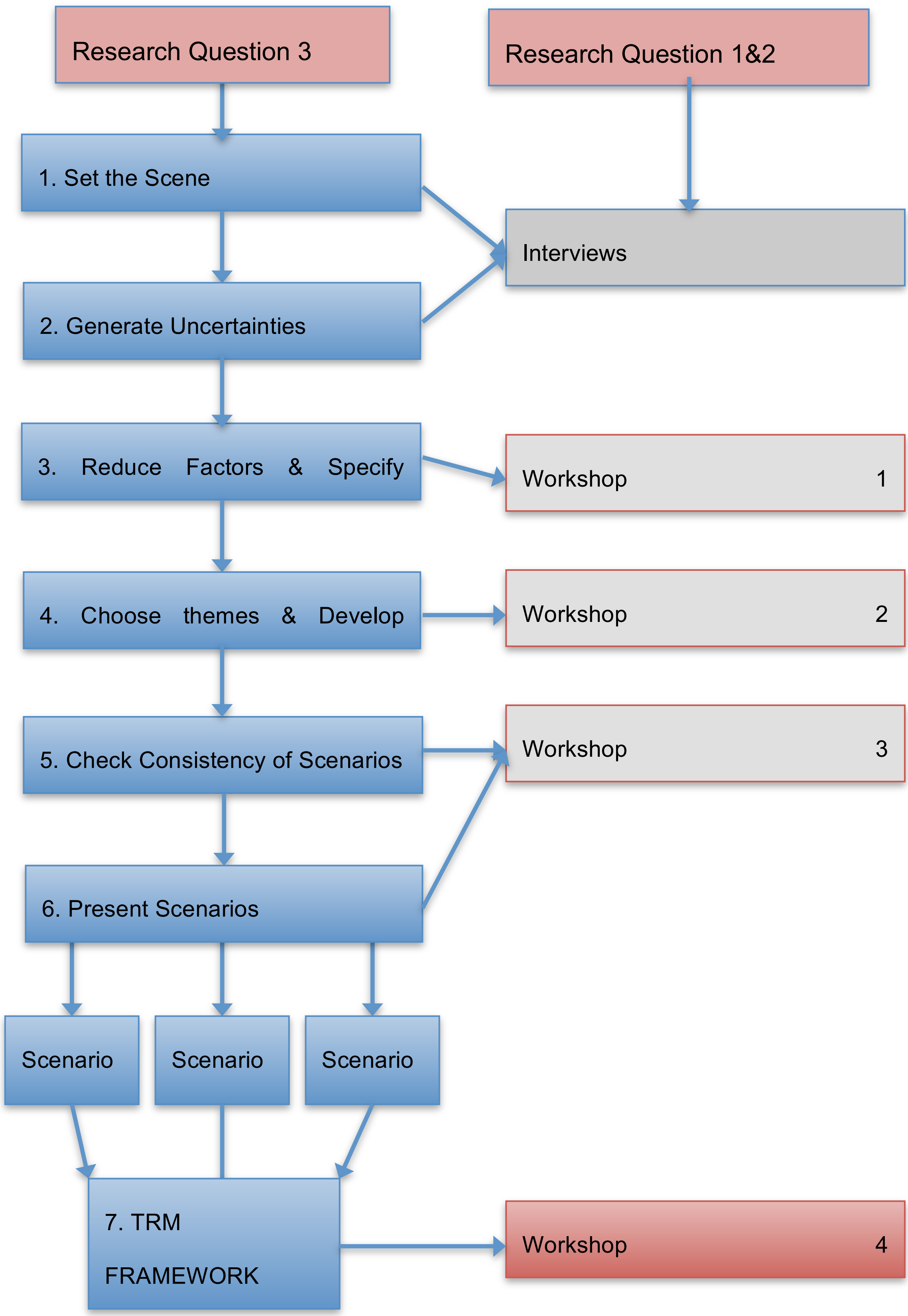


Figure 3. Conceptual Model and Data collection methods

2.5.3. **Interviews**

Qualitative interviews are loosely structured modes of knowledge production (Alvesson, 2003). Kvale and Brinkmann (2009) describe semi-structured interviews as an interview with the purpose of obtaining descriptions of the world of the interviewee in order to interpret the meaning of a certain phenomena. Semi-structured interviews will allow for a list of specific topics, often referred to as an interview guide (Bryman and Bell, 2015) whilst still allowing the interviewee a great deal of leeway on how to reply. Janesick (2000) advises, when choosing who to interview, to avoid a predetermined number but to be guided the aims of the study to select the participants. Alvesson (2003) notes that a high number of interviews does not guarantee high validity, and this present research has aimed to interview participants from different communities of interpretation within the HUG (Boje et al., 2004; Jarzabkowski, 2004).

However considered, prepared and thought through the interview process may have been, the conversations that follow cannot be prescribed; causing anxiousness, excitement and anticipation for researchers (Roulston and Lewis, 2003). Despite the notion of the unknown outcomes of interviewing by Roulston and Lewis (2003), three aspects of preparation as advised by Saunders et al. (2011) were taken into account:

2.5.3.1. **The researcher’s level of knowledge.**

Knowledge about the research topic and the organisational or situational context is paramount in establishing credibility. Due to interviewing participants from differing organisations, diverse backgrounds and from both the public and private sectors, steps were taken to prepare for each interview to make adequate customisations. As well as the knowledge gleamed from the underlying literature review, other aspects were investigated such as background knowledge of each individual’s organisation, job role and work history through informal chat or LinkedIn.

2.5.3.2. **Developing interview themes and supplying information to the interviewee before the interview**

The informed consent form, presented as Appendix 2, showed overall themes sent to the interviewee at least 48 hours before the time of the interview. Also an on-going review of the questions was conducted after each instance.

2.5.3.3. **The appropriateness of the intended interview location.**

The location of each interview was conducted in a private room, away from colleagues and co-workers either at the Head Office of GS1, the interviewee's workplace or at Aston University.

In this present research, a meeting was arranged with initially I1 (Interviewee 1) to ask for access to the HUG, in order conduct the conceptual foresight model developed in Chapter 3 in future face to face meetings. During this meeting, an outline of the development of the conceptual foresight model was presented with its potential benefits and intended outcomes, the literature review already conducted and the research problem. A list of members of the HUG and their email addresses was requested as well as an introduction to the group at the next Face-to-Face HUG meeting. Initially there were a few questions about the nature of what the participants would have to do, but eventually verbal agreements were given to be involved in at least the first stage of data collection; the interviews.

In preparation to present to the HUG, a number of activities were undertaken to gain a wider understanding of RFID technology usage in healthcare settings. Three site visits were conducted at NHS Trusts where RFID pilots were being conducted. These visits gave an insight into how the technology was being accepted by staff and also again an insight in how pilot studies were put together in the hospital setting. A summer research placement to Japan was also completed with the aim of investigating the capability of RFID to aid the reduction of foreign body retention in surgical settings. The benefits of this summer research placement were twofold. Firstly, to see further RFID systems being used in healthcare settings, specifically surgical instrument cleansing and surgical instrument inventory management. Secondly, to try to again an understanding of the difficulties another healthcare system may be facing with RFID adoption in healthcare.

Eight out of ten members of the HUG agreed to be interviewed. Seven interviews were conducted as one member left the appointed post. The posts of interview participants are presented in Table 7.

Interviewee	Organisation	Post	Reasoning for Inclusion in the HUG
1	DoH	Work stream lead	Responsible for RFID adoption in NHS organisations
2	RFID Technology Suppliers	Engagement Lead	Commercial partner
3	Equipment suppliers to the NHS	Engagement Lead	Hospital Supplies Supplier
4	Technology Standards Groups	NHS Engagement Leads	Standards development partner
5	NHS Supply Chain	Supply Experts	Tasked with saving the NHS £2bn through Supply Chain efficiency and central procurement
6	Technology provider where RFID is Widespread in their supply chains	Supply technology managers	RFID Experts
7	DoH	Work stream lead 2	Responsible for RFID adoption in NHS organisations

Table 7. Interviewees

Data quality issues are related to four aspects as discussed by Saunders et al. (2011):

2.5.3.4. **Reliability**

Due to the lack of standardisation in the semi-structured interview technique, assessing and insuring reliability in qualitative research is in contrast to quantitative research. Reliability of quantitative research is often assessed by the criteria of whether or not alternative researchers would reveal similar information (Easterby-Smith et al., 2012; Silverman, 2013). Saunders et al. (2011) conclude that semi structured interviews are not intended to be repeated as they reflect a given reality in a given context at a particular time. Marshall and Rossman (2006) asserted that researchers using non-standardised approaches clearly explain that this perceived weakness is actually strength, in that the flexibility allows for exploration of the complexity of the setting. However, Marshall and Rossman (2006) also advise to make explicit the research strategy and process used in order for other researchers to have the option of reanalysing the data collected, inclusive of the process employed.

2.5.3.5. **Interviewer and Interviewee bias**

There are a number of measures for consideration when overcoming interviewer and interviewee bias as put forward to the researcher regarding how to conduct semi structured interviewed by Saunders et al. (2011):

- The level of knowledge about the context of the organisation or culture of the group within which research interviews will be conducted
- The level of information supplied by you to each interviewee
- The appropriateness of the interview location
- The appropriateness of your appearance at the interview
- The nature of your opening comments at the interview
- Approach to questioning
- Appropriate use of open, probing, specific and closed questions and avoidance of leading questions
- The impact of your behaviour during the interview
- Ability to demonstrate attentive listening skills
- Ability scope to summarise and test your understanding
- Ability to recognise and deal with difficult participants, where this becomes appropriate
- Your ability to record data accurately and fully

These measures were considered when designing, organising, conducting, documenting, and reviewing the interviews. Rapley (2001) called for researchers to include their own words prior to the words of the interviewee as a way of showing how the insight was jointly arrived at. The Rapley (2001) call, considered as a guiding point to present the data, was decided against unless the activating question was directly relevant to the response. In most cases, the notion that the interviewees should talk for most of the encounter was adhered to (Roulston and Lewis, 2003) and allowed the interviewee's talk to far outweigh the interviewer's. Often and especially in the later interviews, an opening question was asked and then through verbal and non-verbal encouragement activities the interviewee was invited to continue speaking, resulting in several minutes into the interviewees response where the most illuminating reflections occur. The understanding, development, and implementation of these verbal and non-verbal encouragement activities improved over time. In critique of the interviewer's on-going skill development, verbal and non-verbal encouragement activities were key aspects in allowing the interviewees to get to the most illuminating and insightful reflections.

2.5.3.6. **Generalisability**

Marshall and Rossman (2006) support the notion of the researcher requiring the ability to relate the research to existing theory, which by definition, also requires the researcher to identify existing theory before data collection. Saunders et al. (2011) go on to point out that when seeking to counter the arguments about the generalisablity of qualitative research studies using semi structured interviews, it is imperative to appreciate that such studies must not be used (and cannot be) to make statistical generalisations of the total population. Generalisability in qualitative research has been described in two aspects by Maxwell (1992); (a) internal generalisability; within the community studied and (b) external generalisability; not for the community studied but of similar characteristics.

2.5.3.7. **Validity**

Validity can be achieved by probing and exploring themes from a variety of angles (Saunders et al., 2011). Maxwell (1992) extols that in the first instance, validity is achieved by describing what the researcher heard and saw, with accuracy. Secondly, as qualitative researchers are not only concerned with providing valid descriptions of what they saw and heard, but interpreting the participants' perspective. Interpreting the participant's perspective relies on the language, terms, and actions of the participants themselves. The researcher, when aiming to achieve interpretive validity can, but construct the participants' perspective in the light of other evidence (Maxwell, 1992).

2.5.3.8. **Developing Interview Themes**

In order to develop the interview questions, firstly themes were developed with the guidance of Dawson (2002 p.69):

- Write down all ideas to do with the research topic. Brainstorm the areas without judgement or analysis.
- Group similar suggestions
- Categorise suggestions
- Order the categories in a logical sequence leaving sensitive or controversial issues until the end.
- Develop some initial questions for each category ensuring they are open and not closed. Keep them natural and to the point, using language that will be understood.

Table 8 details the initial interview themes developed for the interview process. A number of key themes emerged using Dawson (2002 p.69):

Theme	Ideas Generation based on Literature Review and Dawson (2002)
1. Identifying the drivers for RFID adoption	1.1 Internal drivers Policy Increased need for security Patient Safety Increased need for accurate asset management 1.2 External drivers Lowering price of technology Successful applications in other healthcare settings Provision of support from DoH
2. Identifying the inhibitors to RFID adoption	2.1 Internal inhibitors Resistance to change Funding for new IT projects Lack of trust of national initiatives 2.2 External inhibitors Lack of top government support Expense of the technology Standards still in development
3. Operational advantages of RFID	3.1 How benefits are gained Patient safety Staff safety Dosage safety Asset management benefits Decrease in error rate in surgical procedures Strategic advantages of RFID
5. Requirements (milestones) of widespread adoption	4.1 Internal milestones Identify needs for RIFD Assess other options 4.2 External milestones Support from DoH Multiple Trust buy in
6. Scenario Planning	Determine the planning horizon of the scenarios Determine (roughly) the point in the future where existing knowledge cannot help us analyse the environment. How far into the future are resources being committed? When does the environment become uncertain?
7. Uncertainties: Points to consider when discussing PEST	Uncertainties are factors considered by the participants to be beyond the organisation's control, but important to its business/operations

	Brainstorm uncertainties for the future, up to the established planning horizon, based on PEST Uncertainties are not results (i.e. increase in GDP) Ensure that you have a balanced number of uncertainties for each category in PEST

Table 8. Ideas Generation and Initial Abstract Themes.

The Interview Questions used are presented as Figure 4 below.

INTERVIEW QUESTIONS

INTRODUCTION

Describe your role and some of the main responsibilities you have?

Describe your experience with AIDC?

Describe your experience with RFID?

SECTION 1

What do you think the benefits of AIDC adoption are to your organisation?

What do you think the benefits of AIDC adoption are to the English Health Service?

What do you think the benefits of AIDC adoption are to the English Health Service Supply Chains?

What areas do you think AIDC would be the most effective?

Is there an alternative to AIDC that we should be looking at?

SECTION 2 – DRIVERS AND INHIBITORS

What, in your opinion are the drivers for AIDC adoption?

What are the inhibitors to AIDC adoption?

At this stage there would be further questioning and probing to the aspects the interviewee suggests.

SECTION 3 – WIDESPREAD ADOPTION

What do you think, leads to widespread technology adoption in English Healthcare?

Can any milestones be identified which would lead to widespread adoption?

SECTION 4 – SCENARIO PLANNING

Determine the planning horizon of the scenarios

- Determine (roughly) the point in the future where existing knowledge cannot help us analyse the environment.
- How far into the future are resources being committed?
- When does the environment become uncertain?

Uncertainties

- Uncertainties are factors considered by the participants to be beyond the organisation's control, but important to its business/operations
- Brainstorm uncertainties for the future, up to the established planning horizon, based on PEST
- Uncertainties are not results (i.e. *increase* in GDP)
- Ensure that you have a balanced number of uncertainties for each category in PEST

Figure 4. Interview Questions

2.5.4. **Scenario Planning Workshops**

The main purpose of developing scenarios is to broaden the thinking of those involved, therefore the development of scenarios, must be participative (Koshy, 2005; Meyer, 2000). Action research has been used as a guiding strategy for various scenario planning exercises due to its iterative nature and participation inclusion (List, 2006; Van der Heijden, 2005; Wack, 2002). However, there is considerable difficulty in finding participants who hold power and decision authority, who are willing and able to engage in the intensive, protracted inquiry of action research projects (Ahn and Skudlark, 2002; Montibeller et al., 2006). The facilitator must be skilled, moderating the most vocal, articulate, or experienced over those who are more passive in the group (Stevenson, 2002). Munn-Giddings and Winter (2013 p.43) assert that the facilitator provides an outsider perspective, resources, emotional support, practical assistance, a focus for activity as well as assuming the roles of a critic, recorder and methodological teacher, although the good intentions may be counterproductive in simply substituting another form of authoritative expertise.

There are nine intersections between action research and scenario planning: participation, social change, engagement in creation of knowledge, systems thinking, holistic complexity, visions of the future, commitment to democracy, social innovation and an on-going probing of assumptions and reinterpretation of the system under study (Stevenson, 2002). However, there are three clear differences. Firstly, futures studies explore the long term future, while action research projects often have a short-term focus (List, 2006; Ramos, 2002). The second difference is that action research generally involves working with a single organisation with the focus being on the internal environment and not the focus of scenario planning; the external environment (Koshy, 2005; Munn-Giddings and Winter, 2013). A third difference is also established by List (2006), in that action research involves iterative deployment of cycles which is typically not a component of any futures studies method with the exception of causal layered analysis. However, recent process models of scenario planning do engage with iterative components, namely in the stage named the “checking of internal consistency” of the scenarios which is integrated to check the plausibility of the developed scenarios (O'Brien, 2004a). Checking internal consistency and checking the plausibility of scenarios during the scenario planning process used for this present research resonates with the iterative process of action research approaches.

The scenario planning process is conducted, conventionally, as discussed in Section 4.2 of the Literature Review Chapter, during workshops with all the participants present. As explained, access to the members of the HUG was limited due to the inter-organisational nature and its country- wide composition. Therefore a bespoke process was developed, with all the stages of the scenario planning process included as shown in the Literature Review Chapter, Section 4.2. This section sets out the scenario planning process used during this present research, how certain components deviated from the norm but still met the requirements of an effective scenario planning exercise and an appraisal of the selected data collection components deployed. The original scenario planning workshops originally presented to the HUG is presented in Table 9.

Conducted by/in	Stage	Time Requirement
Researcher + Researcher with individual stakeholders	Stage 1: Setting the scene	Researcher’s Own Time + 1 Hr. Interviews
SP Workshop 1 @ HUG in May	Stage 2: Generate Factors of Uncertainty Stage 3: Reduce Uncertainties Stage 4: Choose themes & develop scenarios	3hr
SP Workshop 2 @ HUG in Oct	Stage 5: Check consistency of scenarios Stage 6: Develop narratives – present scenarios	2hr

Table 9. Original Scenario Planning Workshops Proposed

This process required changing due to changes in the research environment. There were a number of issues, which required the data collection process to be adjusted. The issues that arose and how the process was changed, are presented in Table 10 as follows.

Issue	Change Made
The Healthcare User Group (HUG) originally had face-to-face meetings every two months and a conference call scheduled in the months between. From the 1st February 2013, Face to face meetings were changed from once every two months, to once every 4 months. The-face to-face meetings were originally going to be extended to accommodate some of the required workshops.	A workshop on June 6th was arranged with all the participants. However, it was decided that mini workshops were going to be conducted with 3 pairs of two participants as the time in between face-to-face meetings would otherwise be wasted (up to 4 months dead time).
The workshop on June 6th had some people leave early due to needing to get trains and busses.	A mini workshop was organised to gain the input of the two participants who left early.
The scheduled workshop for the 8th of October was poorly attended and could not be conducted.	4 out of 6 participants could not attend on the day.
There were changes made in the Chair positions in HUG in March 2013	1 Participant left the HUG and the data collection process.
A Mini Workshop on the 18th September could not be attended by one of the two participants therefore	Requiring rescheduling on the 20th October
The Face-to-Face to meeting on the 4th February was cancelled due to the London Underground Trade Union Strikes.	Mini workshops were organised in pairs of participants instead. Final Presentation of the Scenarios were done at the next Face to Face meeting of the HUG on June 3rd

Table 10. Issues and changes made during data collection.

Considering all the issued presented in Table 10, Table 11 presents the final scenario planning data collection process used in this study.

Stage	Stage of Scenario Planning	Method
Interviews	Stage 1: Setting the Planning Horizon Stage 2: Generate factors	7 x Semi Structured Interview
Workshop 1	Stage 3: Reduce Factors and Choose Ranges	1 x Focus Group (Face to Face HUG)
Workshop 2	Stage 4: Choose themes & develop scenarios	3 x Pair Workshops
Workshop 3	Stage 5: Check consistency of scenarios	3 x Pair Workshop
Workshop 4	Stage 6: Develop narratives – present scenarios	1 x Focus Group (Face to Face HUG)

Table 11. Final Scenario Planning Data Collection Process

Conducting scenario planning is not without its pitfalls. O'Brien (2004a) suggests three overarching strategies for avoiding pitfalls in conducing scenario planning workshops: participants, content and process. The most pertinent advice for facilitation of the workshops conducted in this present research comes under ‘participants’ and ‘process’. Participants and facilitators are influenced by their personal world-view and life experiences and likewise group dynamics influence the outcome of the process. Action researchers in particular need to be aware of “groupthink and defensive routines distorting their interpretation of their experience” (Yorks, 2009 p.369). Facilitators may not be able to control these influences but must acknowledge their existence. Franco et al. (2013) discuss differing cognitive styles of participants and facilitators in scenario planning workshops, advising that biases can be guarded against by understanding their own style preferences and recognising the style of others. Franco et al. (2013) viewed these styles as dominant, not absolute modes of expression. Cognitive style preferences were organized by Franco et al. (2013) into four categories:

- Sensing–thinking (ST) - factual, logical, process driven
- Sensing–feeling (SF) - people centric, consensus
- Intuition–thinking (NF) - Ignore specific, detailed information of problems or choices. Enjoy structuring complex problems and reducing them to simpler ones by studying patterns in data.
- Intuition–feeling (NF) - Present personal judgment and experience as facts

Although assessment of each participant's cognitive style is beyond the boundaries of this research, these above categorisations were useful in understanding why a person was backing an idea or train of thought during the workshops and even the interviews.

Given the importance of facilitation skills, as a novice researcher, opportunities were sought to develop skills and pilot the proposed approach. A series of scenario planning workshops with MSc & MBA Students were organised in order to gain experience and practice flow and content:

- 1 x MSc Workshops
- 1 x MBA Workshops
- 1 x Dry run of the actual workshop to be delivered with the HUG.

A number of improvements to the mode of delivery, overall impression and efficiency of the workshops to be delivered were advised by this research project's supervisory team and integrated into the design of the workshops. A selection of these are included below:

- Spend less time on explaining the scenario planning process
- Use the time to gain data not teach about the SP process

- Ensure time management, especially during the group discussion elements is kept
- Ensure all participants are given the chance to contribute

The following sections are a breakdown of the separate phases of the scenario planning process used. Each section begins with a table highlighting the stage in focus and then explains the methods and materials used in that particular stage. Stage 1 and 2 involved interviews as explained in Section 2.5.1. The following explanations begin from Workshop 1: Stage 3.

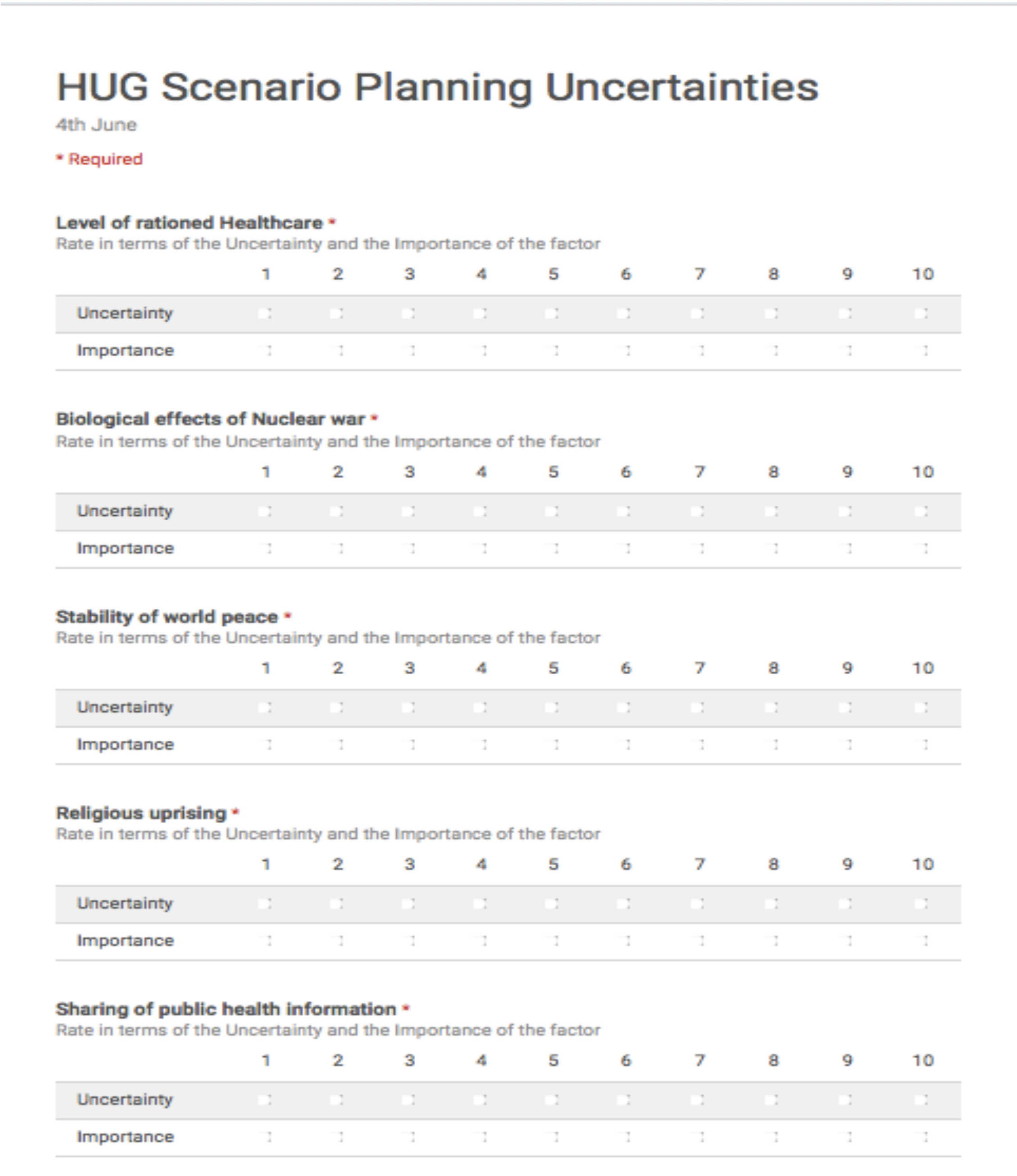
2.5.4.1. **Workshop 1: Stage 3: Reduce Factors and Choose Ranges**

Workshop 1, encompassing Stage 3: Reducing the factors of uncertainty generated in the interviews involved two steps as presented in Table 12.

Step No.	Step Name	Description
1	Reducing the Uncertainties	During the Workshop, the first task was to reduce the 37 generated uncertainties to 12. Handing electronic tablets to all the participants during the workshop completed this aspect. A Google Form created beforehand incorporated rating each Uncertainty on a 2 dimensional 10 point scale of uncertainty and importance. The top 12 Uncertainties would be carried forward into the next stage.
2	Choosing Ranges	The 12 Uncertainties selected were placed in a table to determine the plausible range of values for each Uncertainty; the participants could select either a qualitative or a quantitative range.

Table 12. Reducing Factors of Uncertainty

Step 1 and 2 as highlighted in Table 12 required a Google Form to be created for use by the participants during the workshop, which is presented as Figure 4 below. This workshop involved reducing the factors from 37 to 12. This was achieved by using a pre-developed online Google Form, attached to an Excel file to collate and organise the answers. The form allowed the participants to rate each uncertainty on a scale of 10 in two dimensions. The first dimension was a scale of uncertainty, the second, a scale of importance. The participants picked up how to use this form quickly.



HUG Scenario Planning Uncertainties

4th June

* Required

Level of rationed Healthcare *

Rate in terms of the Uncertainty and the Importance of the factor

	1	2	3	4	5	6	7	8	9	10
Uncertainty										
Importance										

Biological effects of Nuclear war *

Rate in terms of the Uncertainty and the Importance of the factor

	1	2	3	4	5	6	7	8	9	10
Uncertainty										
Importance										

Stability of world peace *

Rate in terms of the Uncertainty and the Importance of the factor

	1	2	3	4	5	6	7	8	9	10
Uncertainty										
Importance										

Religious uprising *

Rate in terms of the Uncertainty and the Importance of the factor

	1	2	3	4	5	6	7	8	9	10
Uncertainty										
Importance										

Sharing of public health information *

Rate in terms of the Uncertainty and the Importance of the factor

	1	2	3	4	5	6	7	8	9	10
Uncertainty										
Importance										

Figure 5. Google Form used in Workshop

2.5.4.2. **Workshop 2: Stage 4: Choose themes and develop Scenarios**

Workshop 2 began with choosing themes, after which the initial development of the scenarios was conducted. Choosing themes and developing the initial 20 scenarios involved two steps as presented in Table 13.

Step No.	Step Name	Description
1	Choosing themes	The 12 Uncertainties selected were given to the participants organised in groups using the PEST headings. The participants, in pairs, were asked to select two uncertainties, one from each section of PEST. Each Pair of participants selected two pairs.
2	Developing Scenarios	Using the matrix given as Figure 5, 5 matrices were produced (originally 6 with one duplicate) producing 20 initial scenarios. Key characteristics as discussed by the participants populated each of the 4 squares in matrix.

Table 13. Choosing Themes and Developing Scenarios

1/12 Uncertainty against another 1/12 Uncertainty	
LOW/HIGH	HIGH/HIGH
Explanation of low range value of 1st uncertainty and high range value of 2nd uncertainty	Explanation of high range value of 1st uncertainty and high range value of 2nd uncertainty
LOW/LOW	HIGH/LOW
Explanation of low range value of 1st uncertainty and low range value of 2nd uncertainty	- Explanation of high range value of 1st uncertainty and low range value of 2nd uncertainty

Figure 6. Scenario Matrix

Workshop 1 was conducted after the last face-to-face HUG meeting with all participants present. However, to wait for the next face-to-face HUG meeting (six months later) was not practical. With the participants originating from different parts of the county, it was also difficult to arrange a date where the participants could all meet again at a different location; the University campus for example. Splitting the participants into smaller groups for this stage is not uncommon during a one-day scenario planning workshop setting. Workshops to be conducted with each pair in a different location and a different time, created the problem of ensuring all the participants gave feedback on all of the work produced in each pair's workshop. This was resolved by emailing the results of each pair's workshop to the other participants for comments. These comments were added to the results and the final matrices produced are presented in the Data & Analysis Chapter.

2.5.4.3. **Workshop 3: Stage 5: Check consistency of scenarios**

Checking the consistency of the scenarios involved 1 step as presented in Table 14 below.

Step No.	Step Name	Description
1	Check consistency of scenarios	Each uncertainty was assessed in terms of its weakness or strength in relationship to every other uncertainty. The range of values that could be assigned to the relationship was a 5 point range from Very Weak to Very Strong, with weak, strong and medium as the middle three points of the range.

Table 14. Check Consistency of Scenarios

2.5.4.4. **Workshop 4: Stage 6: Develop Narratives**

Developing the Scenario narratives involved 2 steps as presented in Table 15.

Step No.	Step Name	Description
1	Select and further flesh out Matrix Pairs	After the consistency check, the participants were asked to select one scenario per pair to develop further. Participants first selected one of the 5 matrix pairs produced in Stage 4 but with the outcomes of the consistency checking exercise to hand to guide their selection. Participants selected the matrix pairs that contained pairs of uncertainties with very strong or strong relationships to develop further. Each matrix pair selected (one matrix per pair of participants) was then further discussed and fleshed out via a discussion.
	Develop Scenario narratives	One quadrant of each matrix was then selected by the participants to discuss further. Some attributes of other quadrants which the participants felt needed to be included done so. This then allowed development of the scenario narratives by the participants stating the other unselected uncertainties would be for the selected matrix quadrant. This allowed three fully developed Scenarios to be established.

Table 15. Developing Scenario Narratives

2.5.5. **Technology Roadmapping Workshop: Stage 7.**

The Scenarios that had been developed as a result of the Scenario Planning Workshops were presented to the participants and some new members of the HUG. Technology roadmapping, as presented in Chapters 2 & 3 is a process of the provision of information to help make better technology investment decisions Kostoff and Scaller (2001). For this present research a widely used framework (Phaal et al., 2004b) will be deployed in a workshop setting. Chapter 3 described how, not only are technology roadmaps and scenario planning complementary, but they can also alleviate some of the inherent weaknesses of each foresight approach. The framework that was used for this present research is based upon Phaal et al. (2004b) framework but with one column out of five and one row out of five already populated. This pre-population can be achieved by conducting the scenario planning exercise before the technology roadmapping process begins. There are five columns on the Phaal et al. (2004b) technology roadmapping framework: Past, Year 1, Year 3, Year 10 and Vision. The first column can already be populated from the data gathered during the scenario planning process. There are also five rows on the Phaal et al. (2004b) framework: External factors, Internal Business Strategy, Products/Services, Technology and Resources. External factors can be populated with data gathered by the scenario planning exercise. This pre-population could be conducted by the participants, or the researcher, depending on the time available in workshops. The framework suggested and the data inputs from scenario planning are presented below as Figure 7:

	PAST	Year 1	Year 3	Year 10	Vision
EXTERNAL MARKET/ENVIRONMENT Trends and Drivers (PESTL)/ Customers / Competitors		Information Input Provide Scenario Planning			
INTERNAL BUSINESS STRATEGY Corporate / Business Units /Goals					
PRODUCT/SERVICES/SYSTEMS Applications/Capabilities / Performance / Features / Components / Families/ Processes /Platforms / Opportunities / Requirements/ Risks					
TECHNOLOGY Skills/Competencies/ Knowledge					
RESOURCES Skills / Partnerships / Suppliers / Facilities / Infrastructure / Organisation / Standards / Finance / R&D Projects					

Figure 7. Technology Roadmapping Framework with Inputs from Scenario Planning

2.6. **Research tools to be used for analysing empirical materials**

The nature of qualitative research is iterative in the sense that there is the collected data but also the data constructed from the analytical process (Alvesson and Deetz, 2000). For this present research, data was collected from observations, interviews, workshops. These data sets are representations of experience and not experience itself (Denzin and Lincoln, 2000). There are three widely used approaches to qualitative data analysis: content analysis, grounded theory and narrative analysis (Silverman, 2011). Content analysis fits neatly with quantitative analysis approaches by providing numerical descriptions, the number of times a word or phrase is present in text, for example. Whereas grounded theory resonates well with the assumptions of qualitative approaches in that a predetermined hypothesis is not tested; instead, a hypothesis is induced through the process of data analysis (Silverman, 2011).

The analysis of the data collected took the overall approach of induction with elements of deduction which, in qualitative research practice, is likely (Saunders et al., 2011). Saunders et al. (2011) collate a number of advised aids to the qualitative researcher in order to record contextual information and developing reflective ideas, five out of six of which have been used for this present research:

- Interim or progress summaries
- Transcript summaries
- Document summaries
- A research notebook
- A reflective diary or journal

A generic approach to analyse the data was adopted due to the requirement of using an overall inductive approach with some elements of the deductive approach. A generic approach conveyed by Saunders et al. (2011) was developed to meet the need of an approach flexible enough to integrate aspects of both deductive and inductive analysis. This generic approach encompassed four points:

- Identifying categories or codes that allow you to comprehend your data
- Attaching data from disparate sources to appropriate categories or codes to integrate these data
- Developing analytical categories further to identify relationships and patterns
- Drawing and verifying conclusions.

This generic approach was used as a guiding framework, with the Gioia et al. (2013) approach utilised to provide a specific process, as presented below.

2.6.1. Identifying categories or codes to comprehend data

Qualitative researchers are advised by Janesick (2000) to use inductive analysis to allow emergent themes, categories and patterns from the data during the process of analysis post data collection. The composition and nature of the categories however, may change as further data emerges so should remain very flexible in an action research based inductive analysis (Johnson, 2007 p.71). The approach taken in this present research is to develop abstract themes constructed before, after and during the process of data collection (Ryan and Bernard, 2000). However, there was a requirement for a further framework to allow the analysis of the data to have structure and help develop meaning.

The framework to provide a specific process was the ‘aggregate dimensions’ coding structure proposed by Gioia et al. (2013). The Gioia et al. (2013) approach as an appropriate way to analyse and present qualitative data rigorously The analysis of the interviews was conducted using the '1st order concepts, 2nd order themes and then aggregate dimensions’ as set out by Gioia et al. (2013) as an appropriate way to analyse and present qualitative data rigorously. First order concepts are defined as are units of analysis used for the initial labelling of data. Second order themes are produced through the organisation and re-labelling of the first order concepts. Groups of second order themes can be then clustered, allowing further ‘aggregate dimensions’ to emerge. This process, according to Gioia et al. (2013) involves the tandem reporting of interactions of both actors (the informant and the researcher) allows for the defining insight of qualitative research. Gioia et al. (2013) also asserted that through tandem reporting of interactions, a rigorous demonstration of the links between the data and the researcher’s theorisations can be achieved.

2.6.2. **Developing analytical categories further**

Gioia et al. (2013) describe the integration of data from disparate sources as unitising data in order to allocate these units to categories or codes. The units themselves can be a number, words, lines from the transcripts, paragraphs from documents, or other segments of textual data that meets the inclusion criteria for a category or code Silverman (2011). As the approach adopted in this present research was to develop abstract themes before, during and after the data collection process, the categories decided upon may be revised during the course of the study, further subcategories may be added and a hierarchy will being to emerge as explanations begin to be generated (Silverman, 2011). Hierarchies with sub categories could be assigned using the Dedoose software platform. Following the process set out by Gioia et al. (2013) of developing the '1st order concepts, 2nd order themes and then aggregate dimensions' allowed for the analytical categories to emerge.

2.6.3. **Drawing and Verifying Conclusions**

Conclusions from the analytical process are collated and compared to the literature review as presented in the Discussion Chapter.

2.7. **Data Collection and Analysis Operations**

2.7.1. **Recording and Transcription**

Each interview recording was listened to within a twenty four hour period of the interview being conducted (Gioia, 2003). During the listening process, notes were made in the research notebook and the reflective diary (both electronic) that supplemented written research notes taken during the interviews. The transcripts provide an artefact representing the interview as a finely co-ordinated interactional work of both speakers (Rapley, 2001) but through the act of transcription, said artefacts become only a partial account of the interview (Silverman, 2011).

This research was conducted in agreement with Tilley (2003), in that researchers find the act of transcribing a mundane and time consuming chore but also recognising that transcription is a vital element of data generation. For this reason, the following considerations and actions were undertaken:

- The layout of the transcripts was jointly agreed upon by the transcriber and the researcher (Hammersley, 2003). For example, it was clear by looking at natural conversations on the page, that we do not speak in neat sentences and paragraphs. The decision here was to transcribe without putting in sentence breaks and paragraph breaks in. The visual result of this was a more faithful depiction of the interview.

- Certain understandings may have been missed during the outsourcing of the transcriptions so regular contact was kept with the transcriber to discuss any decisions (Tilley, 2003).

- Upon receipt of the transcripts, they were listened to again to add any further comments on context or tone.

- During the present research, the audio recording was listened to at least three times; within 24 hours of the interview, upon receipt of the transcripts to check for errors or add contextual notes and finally for the data analysis itself. The outsourcing of transcription gave the audio recordings and the transcripts freshness when it came to conducting data analysis.

2.7.2. **Field Notes**

Field notes manifest as an on-going description and collection of whatever researchers deem most noteworthy, interesting, or telling about their forays into the field (Wolfinger, 2002). What makes an observation noteworthy, interesting, or telling is highly subjective and depends upon what aspects of the context and setting of the research encounters are felt by the researcher to be important enough to record (Wolfinger, 2002). Qualitative researchers are advised to take notes regularly and promptly so they become a parallel record; but to be as inconspicuous as possible if note-taking during encounters in the field, and to analyse these records frequently (Fontana and Frey, 2000). A comprehensive strategy of taking notes sees the researcher attempting to document everything that happened during a particular period of time spent in the field (Fontana and Frey, 2000; Wolfinger, 2002). However, to have documented 'everything' is an ambitious and implausible claim to make.

For this present research, notes were take on electronic devices of either the multi facility recording device used for audio recording when a little more discretion was required and in environments where the researcher was not engaged in a primary task such as conducting an interview, notes were taken in a word processing application on a laptop computer. These notes were the sole technique used for data collection during the scenario planning workshops not audio recorded (Workshops 2-5) and during the face-to-face HUG meetings and other encounters in the field. During my time in the field, I found that these field notes often took the form of what Lincoln and Guba (1985) call "informational residue"; the information details collected without the intention of the researcher.

2.7.3. **Attaching data from disparate sources to integrate these data**

There are number of electronic data management and analysis software packages available for qualitative data analysis; NVivo, Code-A-Text, Dedoose, NUD*IST, and HYPEResearch. , Due to the depth of the data to be analysed, synthesised and integrated, one software aid was chosen. For this present research, an online platform, Dedoose, was chosen for its ease of use, multiple document support, cloud based data storage/backup and free video tutorials.

3. Reflexivity

Reflexivity on the decisions made in Action Research projects such as this present research is critical according to Finlay and Gough (2008) due to how involved the researcher is with the research setting and the differing stakeholders involved. Reflexivity for this study took the form of one of the Finlay and Gough (2008) uses of reflexivity of evaluating the research process, method and outcomes.

This study included the use of two of foresight's most popular techniques: scenario planning and technology roadmapping. Kunseler et al. (2015) discusses challenges for foresight practitioners/researchers and advocates the use of reflexivity in two steps. Foresight practitioners/researchers should aim to make clear the diverse interpretations of salience, legitimacy and credibility are reflected upon by making tacit frames explicit (Kunseler et al., 2015). For example this could be addressed by acknowledging disciplinary preferences for a foresight methodology. The making of tacit frames explicit is the first reflective step of two suggested by Kunseler et al. (2015). The second step involves foresight practitioners/researchers to strategically position themselves towards changing circumstances so that practitioners acknowledge the external influences on the foresight process. The Discussion Chapter contains presentation and discussion of how these two steps are integrated, particularly for the deployment of the Conceptual Foresight Model.Conclusion

The purpose of this chapter was to present the research design, discuss the researcher's philosophical position in relation to other philosophical approaches, illustrate the data collection methods selected, appraise the data analysis methods and detail how those methods were deployed in order to meet the Research Questions set out in Chapter 2.

Section 1 presented the guiding framework used to develop the methodology in the form of five questions that, for the purposes of this present research, have been expanded to incorporate data collection and analysis methods as two separate questions. The five questions and a summary of the answers, which make up the research strategy were:

How will the design connect to the paradigm or perspective?

This question referred to establishing the perspective (or 'world view') of the researcher from which further details of the research strategy could be developed. Ontologically the subjective tradition is taken where subjects interact with the setting, which structures and constrain said setting. Epistemologically, the goal is to understanding the subject's aims, perceptions, perspectives and assumptions. Therefore, the world view of this researcher and how this present research will be conducted is that of the 'Interpretivist'; interacting with the setting and the participants where reality is socially constructed, subjective and can be perceived differently by different people.

How will these materials allow the researcher to speak to the problems of praxis and change?

The problems of praxis in this particular setting are a lack of understanding/confidence of the future landscape and therefore stunted planning capabilities of groups such as the HUG. Deploying a foresight technique in this setting could aid the members of the HUG to better understand future landscapes of the English healthcare system with the aim of better informing future planning. The setting of RFID technology adoption in the English healthcare system is constantly evolving due to the emerging nature the technology. Selection of action research as the overall strategy of enquiry with a focus on scenario planning suited this setting due to this co-evolution of understanding required of an uncertain future.

Who or what will be studied?

The organisation at the focal point of this present research is the UK GS1 Healthcare User Group) HUG. This is a unique group responsible for driving the adoption of RFID technologies in the NHS. This organisation, comprising of members of the NHS, technology providers, standards agencies, pharmaceutical companies and other suppliers to the NHS, presented a unique opportunity to explore the drivers and inhibitors of RFID technology adoption in the NHS. This research setting provided a unique opportunity to deploy a technology foresight activity with practical implications for the English NHS, attain an academic contribution in the areas of (a) drivers/inhibitors of RFID adoption in healthcare from the perspective of those responsible for its adoption and (b) an example of development and deployment of a new technology foresight model.

What strategies of inquiry will be used?

The strategy of inquiry used for this present research is Action Research. As identified in Section 2 of the Literature Review Chapter, RFID adoption in the NHS is isolated to a small number of pilot studies and therefore does not utilise the full potential of widespread RFID adoption. This is an area that requires change and through ‘empowering practitioners’ by adopting an action research approach, this present research could have practical implications for RFID adoption across the English NHS.

What methods or research tools will be used for collecting and analysing empirical materials?

Three main methods of data collection were used: semi structured interviews, field notes and workshops. Seven individual semi structured interviews took place, these typically lasted for 60 minutes and were audio recorded and transcribed. Observation of three HUG meetings were conducted and supplementary to these, informal conversations and observations were conducted during the time frame of the study. The conceptual foresight model comprises of two exercises. For the scenario planning exercise, one workshop with all participants was recorded and transcribed, nine separate workshops with two participants each and a final workshop to gain feedback on the scenarios developed were conducted. Data collection for nine separate workshops with two participants each and a final workshop was conducted through the techniques used in the scenario planning process and the collection of field notes during and after each workshop. The Technology Roadmapping exercise was the final aspect of the data collection process.

Chapter 5: Data and Analysis

1. Introduction

This chapter presents the data and subsequent analysis from the interviews, workshops in the scenario planning process and the technology roadmapping exercise. In general, the chapter structure follows these events chronologically. The data contains the participants' reflections and opinions from the interviews and workshops.. Each section presents the data and then accompanying analysis immediately thereafter. The second section presents the drivers of and inhibitors of RFID technology adoption. The third and fourth sections present the data obtained and the analysis conducted of the conceptual model developed in Chapter 3.. The final section is a conclusion to the chapter containing a summary of the findings and sets the scene for the Discussion Chapter to follow.

2. Interviews and the analysis process

This section presents interviewee and interviewer interactions. The interviews were conducted in order to answer the first two research questions of this thesis and to inform the first stage of the conceptual model developed for this study. The data and subsequent analysis produced, with the aim of answering these questions, was also used to inform the first stage of the Scenario Planning exercise. This is explained further and justified in Section 2.5.4 of the Methodology Chapter. Interviewee talk that illuminates how the scenario planning exercise led to the production of scenarios is presented. The specific examples that are included have had punctuation added but are a faithful interpretation of the actual conversations that took place. Therefore, on occasion, correctly written English is omitted in order to present authentic conversations.

As presented in Section 2.6.2 of the Methodology Chapter, 1st order concepts were formed from the raw data, 2nd order themes were then formed and the aggregate dimensions finally established. A detailed example of the coding process and how one aggregate dimension emerged is presented below. A collection of 1st order concepts that emerged out of the raw data is presented first. The 2nd order themes were decided upon by establishing a summary sentence to describe a unit of data that emerged from the raw data as described in Section 2.5.5.3 in the Methodology Chapter, are then presented. The collection of 2nd order themes are presented thirdly. Finally, the aggregate dimensions are presented.

1st Order Concepts:

- Expectancy of Healthcare being internet enabled
- Requirements for Performance Improvement
- Traceability for Patient Safety
- Efficient use of existing resources
- Accurate Data Migration
- Commitment to one standard provider
- Making adoption of Standards/Technology Mandatory
- Lack of Successful Pilot Studies
- Lack of understanding of the complexity
- Patient confidentiality issues
- RFID somehow removes the Human Care element
- Synergies with other industry processes
- Huge task of Data Migration
- Innovative Teams in Hospitals
- Rate of emergence of new technology
- Refusal to Change
- Not looking beyond current contracts
- Perceived Failures of previous IT projects
- Cost of the technology

- Mandated Technology Drive
- Other Budgetary Requirements
- Clear, detailed regulation and standards
- Different Standards/Regulations at country level
- Global Medical Device Regulation

2nd Order Themes:

- Changing nature of care required
- Constant need to improve the healthcare system
- DoH requirements for cost savings
- Technical improvements and reducing cost of technology
- Successful Pilot Studies
- Communication
- Fire Fighting and Reactive Culture
- Lack of Central Investment
- Legislation, Standards and Regulation
- Planning Horizon

The above lists present the 1st order concepts and the 2nd order themes that emerged from the raw interview data. An example of how a 1st order concept was formed can be illuminated with the 'lack of mandatory technology drive'. This concept was formed due to it being mentioned in various guises during the interviews. Although the phrase 'lack of mandatory technology drive' was not mentioned exactly, it summed up the instances of conversations around one inhibitor of adoption of RFID technology in the English NHS. This allowed the 2nd order concepts to be formed by grouping related 1st order concepts together. Following on from the example of a lack of a mandatory technology drive given above, costs of the technology, and other budgetary priorities formed a group (aggregate dimension) and were labelled as 'Lack of Central Investment'. The figures below show how the 1st order concepts (bullet points) were then organised into 2nd order themes (rectangular boxes) and then further into aggregate dimensions (collection of four rectangular boxes).

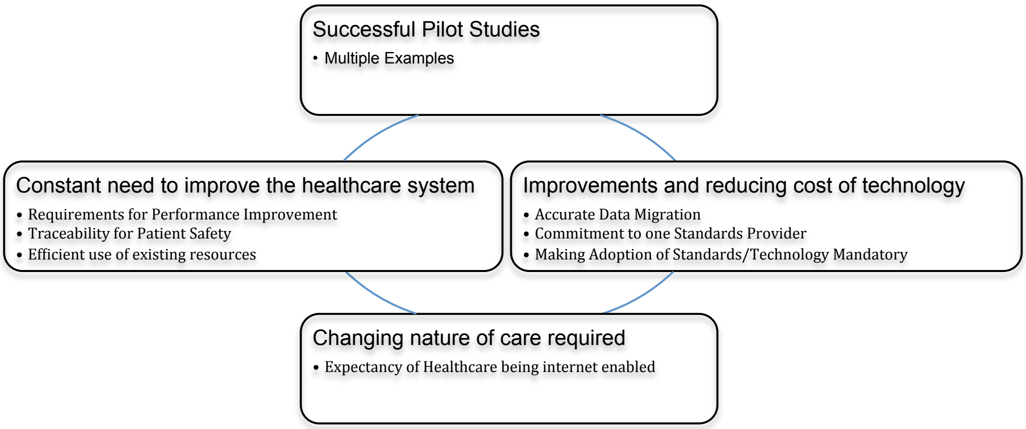


Figure 8. Emergent Aggregate Dimensions: Drivers

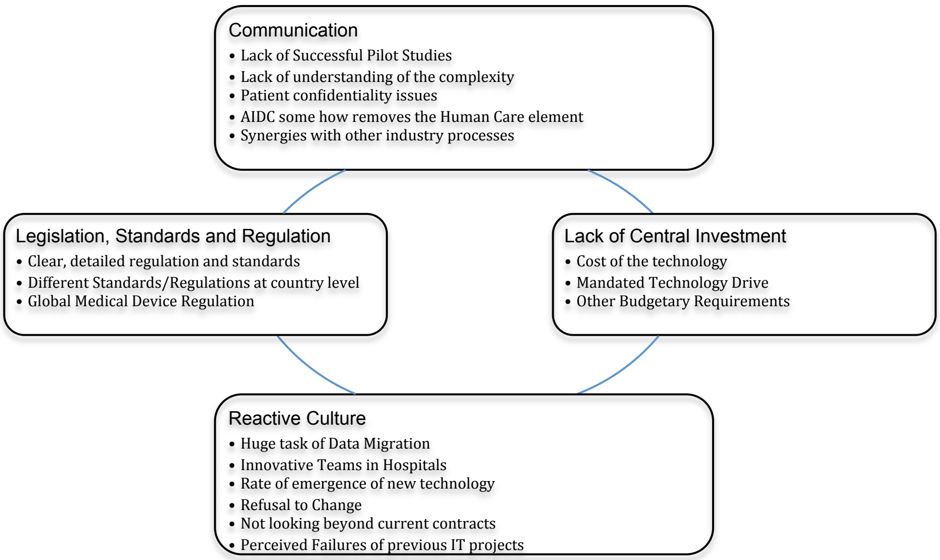


Figure 9. Aggregate Dimensions: Inhibitors

The 2nd order themes were organised into aggregate dimensions. Three aggregate dimensions emerged: Drivers of RFID adoption, Inhibitors of RFID adoption and the Planning

Horizon for the scenario planning exercise. Two aggregate dimensions are presented as Figures 8 and 9 above.

In the following sections, the second order themes that emerged, organised as aggregate dimensions, are presented in order to give detailed insights into the process adopted for this this present research. Each aggregate dimension is presented with the corresponding data first, with the analysis that led to its formation following immediately. This approach was decided upon to give context to the analysis and for referral by the reader if required. This approach of total transparency during the data analysis process is also a recommendation of Gioia et al. (2013). The following Table (16) presents summaries of each interviewee's responses as the raw data for the aggregate dimension of "Drivers of RFID adoption in the English NHS".

Interviewee	Driver
1	The need to have one agreed standard throughout the supply chain
	The inhibitor to that is that they've spent so many years using another system, to data-cleans and clear out everything that's already there and convert it to GS1 is a mammoth task, it's a huge undertaking of work
	Department of Health's commitment to utilizing GS1 and only GS1
	Managers understanding the efficiency gains.
	DoH doing first of type work as examples
	Commissioning Board comes in to power in April, that should be better because they'll actually have the power to legislate, so there will be a true mandate
	Good examples with good data to be able to show people.
2	The need for traceability of products through to use on the patient
	Cost savings and efficiency throughout the supply chain
3	Companies often see RFID as just barcodes and scanning, and they don't actually see behind that in terms of the business benefits
	Regulatory compliance reaction
4	Innovation agenda within a hospital
5	Patient safety
	The economic savings
	Streamlining and smoothing of the supply chain
6	The need to improve patient care
	Reduce costs
	Release time for shop floor staff
7	Cost savings
	Patient Experience

Table 16. Drivers of RFID Technology Adoption by Interviewee.

2.1. **Drivers of RFID adoption**

Drivers of RFID adoption, as an aggregate dimension, encompassed four 2nd order themes:

- Successful Pilot Studies
- Technical improvements and reducing cost in RFID technology
- Constant need to improve the NHS

- Changing nature of care required

Each of these themes are now illuminated and defined with excerpt highlights from the interviews and workshops.

2.1.1. **Successful Pilot Studies**

‘Successful pilot studies’ was one of the potential themes identified from the Literature Review presented in Chapter 2. There are more pilot studies emerging in the English NHS, which are showing signs of, or have shown to be a success. Unclear returns on investments was a barrier identified by Yao et al. (2012). In the context of this present research, unclear returns on investment are diminishing with the ever-increasing number of pilot projects. It seems the success of pilots is also well communicated, as Interviewee 7 illustrates:

> ‘…*So it’s kind of snowballing now … So the widespread adoption is kind of, is hopefully going to take care of itself because as more people use it and they realise how useful it is, that they'll perhaps tell their colleague and then the colleague will use it and then, you know, and in the meantime we’re getting towards a hundred per cent coverage.*’ (Interviewee 7).

There are instances of other projects which, not directly, but through the process of requiring performance improvement, have shown to be suitable to RFID technology adoption:

> ‘…*There was a project called lean theatres or lean thinking or something like that, and as part of that it was about well, you know, how do we make that process leaner, meaner and all the rest of it, you know, how can we take cost out of that process. And again, one of the solutions from that was that you can use some technology to do some of that. So it’s almost a different programme that wasn't specifically looking at adoption of that as the solution, but that was one of the solutions that came out of it.*’ (Interviewee 7).

Through the experience and performance improvements, momentum built behind the prospect of adoption of RFID technologies, as Interviewee 6 sets out:

> ‘…*I think the way we've had to evolve as part of that is we've had, originally it was very salesy, it was very you should do this because this says so, you know, and it’s a great idea, to OK, well if you look at these facts and figures, they show why you should be doing it. And now it’s very much about OK, well now you've established that baseline, you now need to build upon that and do X, Y and Z to push it further on.*’ (Interviewee 6).

It was also mentioned that:

> '…*Now that I think we've got critical mass behind the amount of people who know what we're doing*.' (Interviewee 7).

This present research reveals that the success of pilots is well communicated to those directly involved in RFID technology but a wider audience needs to be reached, especially those responsible for making decisions on which technologies to adopt. There are instances of other projects which, not directly, but through the process of requiring performance improvement, have shown to be suitable to RFID technology adoption. Through the experience and performance improvements, there is momentum behind the prospect of adoption of RFID technologies.

2.1.2. **Technical Improvements and reducing cost in RFID Technology**

A key driver of RFID technology adoption can be described as technical improvements in and the reducing cost of RFID technology. This encompasses improving technology standards, commitment to one standards structure (GS1) by the DoH and the falling cost of RFID technology. Yao et al. (2012) and Ting et al. (2011a) identified interference and ineffectiveness as a barrier to RFID adoption in healthcare settings. Since then, there have been significant improvements in RFID technology for healthcare settings where the issue has moved on from 'interference and ineffectiveness' of the technology itself to 'interoperability' (implementation with existing systems) (Carr et al., 2010). One improvement in RFID technology has been attributed to the data migration success in pilot studies, according to Interviewee 1:

> '… *I think part of the reason the auto ID stuff's worked so well is most of it comes with middleware or translation tables or interoperability toolkits, that can implement new systems as well as pulling up the old legacy IT systems of the NHS and helping improve them better. From a basic technology perspective, it's a strange one*.' (Interviewee 1).

Interviewee 6 sees the commitment from the DoH to one standards provider as a key development:

> '…*Department of Health's commitment to utilising GS1 and only GS1 through the standards'*. (Interviewee 6).

Even with this commitment from the DoH, identified as a key driver of RFID adoption due to a unified standards approach allowing for data and information exchange across multiple systems throughout the country, Interviewee 7 explains the uncertainty around the future of the contract itself:

> '…*And that's sad really because it's only, I think hospitals would get around twelve to fifteen hundred pounds a year for their membership fee, which is nothing really compared to their budget. But I think they're more keen to do it while we're there. Come our moving to the health and social care information centre, if the programme were suspended or we decided not to re-procure, I think there would be a massive period of uncertainty at that point. I would like to think we've enough critical mass now, enough supplier buy in that it would continue, but I couldn't say with any degree of certainty. After that, again it would be the next general election*.' (Interviewee 7).

Interviewee 7 further explains that due to this commitment, manufactures can coordinate their efforts:

> '…*Now we know exactly what's going to be required of us as a manufacturer there for the first twelve months, they'll then review it and see if they want to make any tweaks … So it starts to become a little uncertain, but we don't think there's going to be many tweaks*.' (Interviewee 7).'

Interviewee 1 makes the emphasis on clear standards requirements and adoption of one system even clearer:

> '…*I think from our perspectives the true sort of leap of adoption or the leap of proof of concept wasn't the technology, it was the standards, it was getting the standards approved by the Information Standards Board so that everyone knew they had to do things a certain way.*' (Interviewee 1).

Improvements in RFID technology have been attributed to its success in pilot studies. The DoH has committed to one standards provider. A commitment to one standards provider does exist but there is uncertainty around the future of the contract, but due to this commitment, manufactures can coordinate their efforts.

2.1.3. **Constant need to improve the NHS**

As the Literature Review presented in Chapter 2, there is a constant need to improve the NHS in terms of process efficiency, leaner stock management, freeing up staff time to spend with patients and reducing costs. The key drivers of RFID adoption in healthcare settings identified by Yazici (2014) were; more effective communications among staff, increased asset utilization, enhancement of the patient-care process and better visibility on workflows. The drivers that Yazici (2014) identified were also present in this present research. In particular, the aspects of enhancement of the patient-care process and better visibility on workflows. These aspects were often intertwined when the interviewees discussed them:

> '…*So that's not all about patient care … But likewise the NHS at present is tasked with taking out loads of cost*.' (Interviewee 6).

Leaner stock management and reducing cost was seen as direct reason for RFID adoption:

> '…*Lots of the cost is tied up in inventory that's sat on shelves. Now OK, it's only a one-off cost that you can release but there's a funding cost of having things sat on shelves. RFID for very high value items, rather than allow suppliers just to say we've put the right amount on the shelf, I think that's where you could take out a large amount. And anything that requires say implants, very expensive, a lot of variation, lots of different things, you would control that*…' (Interviewee 6).

Interviewee 5 supports Interviewee 6's assertions of there being an opportunity to improve inventory management across the NHS:

> '…*That isn't core business. So they don't have processes and databases in-house to manage their stock, a lot of it's still paper-based and if it isn't paper-based it's outsourced and the outsource are a step for invoicing and processing and payment, which the Trusts think they're getting benefit from but in the pharmacy process, because we actually cost each box of medicine that comes in to pharmacy out again to where it's being used, there's no, there's added cost in that process by outsourcing your invoice processing*.' (Interviewee 5).

And for supply chain cost reduction:

> '…*Commerce and supply chain is probably where I would address this for the best savings at the moment*.' (Interviewee 5).

An interesting observation made with regard to the economic down turn by Interviewee 7, where NHS Trusts may turn to technology to meet stricter cost saving requirements:

> '…*and then, you know, Trusts – well actually that in my view might work in our favour because Trusts would be more interested in RFID solutions that can save them money. But, you know, who knows, it might do, it might not*.' (Interviewee 7).

Interviewee goes further by suggesting some clear areas where cost savings could be made through the use of RFID:

'…*Now for high value items, how do you control that, how do you control your spend? Well if it's RFID tag, it doesn't matter, you go in and you take it, it records it. Now I think there's a lot of scope there and there's a lot of improvement, there's a lot of cost to be taken out. Some equipment's very expensive but it's portable and what tends to happen is the, the health service tends to have too many of them because they don't know where the things are because they live in say one ward and another one in another ward and we can never get hold of that or we're not quite certain where it is, we best have one of our own*.' (Interviewee 6).

Interviewee 7 joins in with Interviewee 6 with another area where RFID could help to save cost:

'…*Although, you know, you can argue quite easily that by reducing patient safety incidents it reduces litigation and insurance premiums*.' (Interviewee 7).

One of the inhibitors identified in section 3.1.4 was the disparity between the different countries and their requirements for information standards. Here an observation is made by Interviewee 4 that in order to reduce costs, a global system would be needed:

'…*and from a manufacturer perspective, we're trading globally and you can keep, like they keep pushing us to drive costs down and take things out. So the only way to be able to do that effectively is have a big warehouse full of products that can be sold globally... the operation of SKUs you want, the product you can sell globally... you've got to have the technology just to be able to transfer using the same information.*' (Interviewee 1).

Another of the inhibitors identified in section 3.1.3 was the lack of innovative teams or champions in Trusts. Interviewee 4 presents a different view:

'…*And most hospitals have some kind of platform or some kind of process that allows innovation or, you know, efficiency type gains to be put through that process, and in some cases the output of that is to implement some kind of RFID technology in order to – I said it might be for asset tracking, it might be for stock reduction*.' (Interviewee 4).

Leaner stock management and reducing cost was seen as direct reason for RFID adoption. The data suggests some clear areas where cost savings could be made through the use of RFID. Conflicting views were presented with regard to innovative teams in NHS Trusts.

2.1.4. **Changing nature of care required**

The nature of care being required by the population is changing. RFID could meet the need for better participation of the patients in care process as identified by Yazici (2014). The scene is set by Interviewee 1:

> '…*yes, I think the point I was making was that I think people are more interested in their healthcare now … I think the internet has opened up opportunities for people to say that's not right or to challenge things that happen in a certain way*.' (Interviewee 1)

Interviewee 3 goes on to observe the ageing population, and how it presents its own opportunities for RFID:

> '…*So I think there must be more of – the technologies, coming on to technology, it will actually help there because, you know, if we can treat more people in the community, if we can treat more people with tele-health, more walk in clinics where they can be diagnosed over the internet. I think that will help if people don't have to go to hospital to get their, to attend clinics which are expensive and require them travelling, if they can be again treated at home or treated by themselves or turn, you know, unskilled carers into semiskilled carers*. (Interviewee 3).

Interviewee 2 adds the use of video conferencing is going to change the way care is delivered:

> '…*Video conferencing on your phone, that kind of thing, I mean all of that can actually reduce the need for face to face time, you know, physical face to face time. So I think it is about changing the way we care for people, so I think that's going to be a radical change*.' (Interviewee 2).

The instant gratification culture will eventually seep into healthcare as Interviewee 5 sharply puts:

> '…*Because, and it's also the instant culture, which I don't think is good for humanity, is the fact instant gratification – I want something, well I can have it now*.' (Interviewee 5).

The nature of care required by the population is changing. The ageing population presents its own opportunities for RFID. The instant gratification culture will eventually seep into Healthcare requirements especially in the areas of tele-health. Tele-health is an area identified by the data as an area in which RFID technology can have an impact in providing systems to be used in the home of patients.

2.2. **Inhibitors of RFID technology Adoption**

The following Table (17) presents summaries of each interviewee's responses as the raw data.

Interviewee	Inhibitor
1	Using another system, to data-cleanse and clear out everything that's already there and convert it to GS1 is a mammoth task, it's a huge undertaking of work
	The thought of treating patients as numbers was not liked in the NHS
	there's not a lot of trust between the procurement facilities within, certainly within secondary care and the provider market
	the lack of examples of work doesn't help either, and this is why we were doing the first of type work, is to show people that it is as simple as sticking labels on things
	Previous failures in similar projects (Birmingham Child birth coding)
2	delays in getting the legislation out there
	The cost to manufacturers of actually implementing it, the cost to the healthcare providers
	The other thing that comes in to it then is patient confidentiality as well, so that could be a big inhibitor.
3	So it's about quality of data, I think this is the inhibitor, that people don't recognise that master data management and the quality of the data are the important things
	People don't understand it [RFID] well enough
	If you can't standardise the data, then you can't easily interpret the information
	Discontinuity of the use of technology and the use of standards.
	Hospitals need to see evidence of where the technology is being used in other hospitals.
	Hospitals need encouragement from the centre, from the DoH , the NHS, they need to be led, they need to be helped because generally speaking the level of knowledge in technological awareness is lower in hospitals
4	Lack of a centralised mandate
	A region decided to do something completely different to the other region down here and the two region's systems didn't talk.
5	People resources to run pilot projects
	Money resources to do it
	Because we aren't a coherent NHS and we are lots of different organisations with lots of different decision makers, there's no cohesive move forward together.
6	The sheer size of the NHS
	The Department of Health itself because it likes to inform what's best practice and probably there needs to be a mandate on certain things that say this is what you must do, because that will drive adoption
	Trying to change a lot at once, adoption of RFID should be implemented in areas where it is most needed first, as an example of the technology.
7	A lot of people in the NHS don't like change
	A lot of red tape around the purchasing of these systems
	It can be quite practically difficult to implement an RFID solution because, for example, some suppliers' solutions require hospital-wide Wi-Fi. Well how many hospitals in the NHS have site-wide Wi-Fi that's reliable? (underlying infrastructure)

Table 17. Inhibitors of RFID Technology Adoption by Interviewee?

Inhibitors to RFID adoption in the NHS encompassed four main 2nd Order themes:

- Lack of Central Investment
- Communication
- Reactive Culture
- Legislation Standards and Regulation

Each of these themes are now illuminated and defined with excerpt highlights from the interviews.

2.2.1. **Lack of Central Investment**

The lack of central investment was identified as one of the potential themes from the Literature Review presented in Chapter 2. Lai et al. (2014) concluded that the key factors effecting RFID adoption in hospitals were; cost, ubiquity, compatibility, security and privacy risk, top management support, hospital scale, financial readiness and government policy. The following analysis also identifies top management support, hospital scale, and government policy as currently inhibiting RFID adoption in the English NHS.

Analysis of the data formed further sub themes of a lack of a mandatory technology drive, costs of the technology and other budgetary priorities. Each of these sub themes is analysed and presented with key excerpts from the interviews in the following paragraphs.

The lack of a mandatory technology drive by central government encompassing centrally provided, ring-fenced funding became a key line of conversation throughout the interviews. Firstly a centrally mandated RFID adoption drive:

'…*but there's no mandate which doesn't help, it's all done on best practice…'* (Interviewee 5).

Interviewee 4 goes further by giving a hypothetical situation of the how central funding could work the approach the NHS/DoH may take:

> '…*centralised big picture, [Interviewee speaking hypothetically on behalf of DoH to NHS Trusts] this is what is needed, that all of you need, and here's the funding that's ring-fenced for you to do it and if you need some help to do it, then there may be some, I don't know, fifty/fifty funding that allows us to get in an implementation team to help you to do it … But if you've got your own teams that you think are capable to do it, fine, go ahead and do it. But here's the central guidance, this needs to happen by this date, and then it can happen*.' (Interviewee 4).

Interviewee 4, highlights that new IT projects are not core business for NHS Trusts at the moment:

> '…*And unless that investment comes centrally, it's very difficult for that case to be made locally*…' (Interviewee 4).

Interviewee 3 highlights here, the lack of power NHS management organisations have in making initiatives mandatory and the difficulty in coming to decisions:

> ‘…*But because we aren't a coherent NHS and we are lots of different organisations with lots of different decision makers, there's no cohesive move forward together. And the DoH , and maybe the Commissioning Board now, hasn't got that role either because they don't mandate to say you will do this. If they did, then maybe that's part of giving them to tools to do the job.*’ (Interviewee 3).

Interviewee 7 agrees with the already highlighted issue of not being able to make RFID adoption mandatory:

> ‘…*We don't, well we also don't have any say rightly or wrongly in what Trusts implement, there's no overarching power really and any kind of authority to say, you know, we can't say to all Trusts – well we have implemented the standard, you know, we've said the standard must be complied with by 1st September this year, but we don't really have any sort of teeth to say to the Trusts, you know, you must implement this, you must implement that. It’s entirely up to a Trust whether they purchase a particular RFID solution or even pilot an RFID solution*.’ (Interviewee 7).

The current situation of the DoH giving guidelines for NHS Trusts of what is best practice in adopting RFID technologies and paying for membership to GS1 Coding Standards if the trust chooses to use GS1 is indicated by Interviewee 6 to not to be effective:

> ‘…*I think that's a Trust by Trust basis, some will be very good, some won't be very good. And I think a mandate helps a lot, I think giving guidelines is a waste of time, I’ll be completely honest about that*.’ (Interviewee 6).

Interviewee 7 gives further clarification of how the current ‘membership system’ works and the issues of not having one standard coding system in use:

> ‘…*As far as I know Trusts still have to contact GS1 and say they want to be a member and then they get sent the welcome letter and the packs and information. I don't think it’s automatic because I asked this question the other day, and I know that we've reserved five hundred prefixes and paid for three hundred and fifty. Some Trusts haven't got one yet because they haven't asked GS1 for one. So I think that means that Trusts don't get – although their membership’s paid for centrally, they have to approach GS1 themselves to get the unique code. And I don't know how much or how well that communication’s been done in the past. So some Trusts might not be aware of they might not think it’s important even if they are aware. And, you know, one of our long-term aims is to get RFID solutions joined up on a site. So if they're not GS1 compliant, they might find that more difficult in future*.’ (Interviewee 7).

Interviewee 7 further explains that some NHS trusts may not even know that there is guidance and membership to GS1 available and if they do, they may be ignoring it:

> '…*some of it actually is probably not being aware that the solutions are available. There's probably a bit of that as well. In fact thinking about it, there probably is a long list really of all kinds of things. Trusts are going out and purchasing non-GS1 compliant solutions as well, either knowingly or unknowingly. I'd like to think unknowingly*.' (Interviewee 7).

However, simply assigning central funding is not a definite answer to widespread RFID adoption:

> '…*but you've still got all the difficulties that, you know, culture changes, different ways of working*.' (Interviewee 7).

The second aspect of a centrally mandated technology drive is the funding needed to implement RFID technology projects:

> '…*the cost to the healthcare providers of actually making sure they've got everything in place from basic reading or scanning equipment to actual IT systems in place and electronic health records*.' (Interviewee 2).

Interviewee 3 describes how NHS Trusts do not have the funds to put RFID systems in place:

> '…*They [NHS Trusts] need to be able to spend the money upfront to put these systems in place, but they don't have the money to do it.*' (Interviewee 3).

Interviewee 5 agrees but within the context of the current climate:

> '…*If it's not pump-primed [Centrally funded], I find, nothing happens. So if you're asking Trusts to do pilots, they haven't got the resource anymore because they've laid off so many staff, they're running a very, very tight ship*.' (Interviewee 5).

Interviewee 4 highlights that NHS suppliers and those involved with supply and procurement are aware of the benefits of data capture (RFID Technologies) but again agrees that NHS Trusts require the central funding:

> '…*You know, most, certainly again in my experience and in my sort of area, supplies and procurement, understand the benefits of data capture, understand the benefits of using technology not only just within their own little procurement departments but the wider influence within the hospital network. But it's about giving them the tools or giving them the authority or giving, you know, the hospitals that guidance that says look, we know that it might cost you some money to go out and get the technology to do it, but if we're going to do this and if everybody across the NHS is going to benefit, then here's some money for all of you to do it with*.' (Interviewee 4).

The interview data suggests that it is not just funding from the DoH for NHS trusts that is scarce or not allocated, the healthcare industry in general is struggling:

> '…*it's more of a practical application but realistically one of the issues that we have and it will come up time and time again is within this industry it's about having the capital behind it, somebody to finance it*.' (Interviewee 6).

Other priorities in the budget took the form of RFID not being seen as a central, core business aspect to a Trust was also cited as an inhibitor falling into the lack of central budget theme:

> '…*there are competing priorities within hospitals for a vat of cash to implement things, for instance*.' (Interviewee 2).

Interviewee 1 gives further context as to why RFID technology adoption efforts are slow:

> '…*well you look at the way the government does it when there's an economic downshift, everything that goes first is the nonessential stuff like the Arts Council or, you know, grants to sports foundations or they skim off the outer – I think auto ID would be in the outer, sadly but that's the way it is I certainly see it*.' (Interviewee 1).

It is against this backdrop of a lack of central funding, and not just guidance with a small amount of funds for GS1 membership, that the HUG group members seek a change. As indicated by the data, RFID is seen as a secondary concern to NHS Trusts and even if funding was available, there are still other issues that could thwart widespread adoption. The interview data reveals that without central funding, it is difficult for NHS Trusts to invest in new technologies in the current climate. However, not only central funding is required but increased levels of support and guidance should also be made available.

2.2.2. **Communication**

A key 2nd order theme emerging from the data is that of communication. In this context, communication takes the form of a number of subthemes. These subthemes include: not making clear comparisons with other industries where RFID technology is widespread, not clarifying the patient confidentiality issues, not ensuring the actual complexity of implementing RFID is well understood by all stakeholders, and not communicating successful pilot projects. These subthemes are now illuminated with key excerpts from the interviews in the following paragraphs.

Not creating clear comparisons with other industries where RFID is widespread, was discussed as an inhibitor. RFID is used in other industries often without the people who are using it knowing that it is RFID technology. Interviewee 5 begins with the example from libraries:

> '…*that's why I like the library RFID…because who goes to the library these days? Nobody, or very few people. The people who go to the library are old people and young people, students that are in school or studying and old people who have got nothing better to do but that brings really powerful technology in to the realms of the everyday life of those people*.' (Interviewee 5).

Interviewee 6 continues with the RFID used in supermarkets:

> '…*because then people would ask why aren't we using this in hospitals. Why do Tesco know more about me than the NHS do?*' (Interviewee 6).

Interviewee 6 also uses supermarkets to give the example of how we are comfortable with our data being online and used by large organisations but also mentions how comfortable we are with our data being handled by large online retailers too:

> '…*the people at the top don't understand what's needed to happen…there are very few enlightened people. Although we use Amazon and people love it and we use Tesco and people love it*.' (Interviewee 5).

Interviewee 5 comments on how RFID technology has been widely used not only on the customer information gathering aspect, but also to manage the supply chain in the retail industry:

> '…*And Retail Global has acted on the back of Wal-Mart and Tesco in that they demand of their suppliers these processes, otherwise there are penalties to be paid by those suppliers. We don't have that sort of leverage in the NHS and we've piggybacked on that leverage in retail pharmacy, which has then expanded to the whole of pharmacy because eighty per cent of unit doses even in hospitals are oral. So we've been able to build on that and because it's already done, it's easy to do. Medical devices haven't got anything like that advantage to build upon, so it's going to take an awful long time*.' (Interviewee 5).

During the workshops, Participant 3 gave the further example of being comfortable with banks knowing our information:

> '…*what's happening with the banks and really it depends on people being aware of the risk of cyber attacks before their personal information is put there online somewhere. It's just balancing off the safety aspect of you having your personal records online and being able to be treated anywhere in the world*.' (Scenario Planning Workshop 1, Participant 3).

Interviewee 7 cites media technology highlights how far behind NHS information technology is:

> ‘…*I can put a photo on Facebook and my mate in Australia can see it in like two seconds…why should I be impressed that my local GP practice can share information in the hospital*.’ (Interviewee 7).

Not communicating the use of RFID in other industries was also intertwined with a lack of communication that RFID is not actually that complex to implement. Interviewee 1 expels complexity being cited as a reason for lack of adoption:

> ‘…*I think originally there was a lot of complex notions that it was very, very complicated to do this and there was a lot of IT work. It’s really not, and if it was that complicated retail wouldn't do it*.’ (Interviewee 1).

Interviewee 6, moving away from retail, banking, social media and libraries, gives the example of high tech industries having real time equipment tracking technologies:

> ‘…*You could use RFID if you mapped a hospital correctly to say where that piece of equipment was at any one time, take that piece of equipment and move it from one location to another, knowing exactly where it was. So there's a thing about how you control equipment, and then the step I would take beyond that which you – this happens quite a lot in high-tech industries, I've not seen it in the health service but it's the same sort of deployment. Why wouldn't you have equipment libraries and somebody in the centre allows these things out. You know that it’s gone out and you know exactly what it is, you know what the procedure it’s going out to do.*’ (Interviewee 6).

Interviewee 3 make a comment of having online health records as part of what will be expected by society in the future:

> ‘…*You know, I think people going forward will not accept, you know, that they can't have their healthcare records online, they won't accept because, you know, they've got their bank records online, you know, they book all their holidays online, they do all their shopping online. I think they will want to see more information relating to their healthcare and to their admission in hospital and everything to do with their healthcare. I think demand will come actually from, on the social side of things*.’ (Interviewee 3).

However, Interviewee 1’s comments shows how there is evidence that some lessons from other industries have been learned:

> ‘…*Certainly over the last two or three years I'm certainly seeing more evidence of the fact that they're trying to learn from other facets of society, they're trying to take on board what retail have done in terms of customer float and apply that to A and E*.’ (Interviewee 1).

Interviewee 3 supports interviewee 1 in the notion of the NHS already beginning to learn from other industries in terms of innovation:

> '…*And I think people see things in other areas now and think well we could do that and it would help. So I think the innovation of the NHS will speed up as the innovation of everyone speeds up*.' (Interviewee 3).

Patient confidentiality issues also come into the aspect of making comparisons to other industries and their use of personal information by Interviewee 1, particularly how different generations may or may not be more comfortable with confidentiality:

> '…*the worst case scenario, I think a lot of hospitals would step away and say oh no, hang on, until it can be proven it's a hundred per cent proof, then we won't, we'll have nothing to do with it.*' (Interviewee 1).

Interviewee 3 supports Interviewee 1's assertions on how different generations have differing comfort levels with their personal information being online:

> '…*You've got different generations, haven't you? I mean like sort of the younger generation, quite happy to have their information on a computer and on an iPhone and, and they might not want it freely available but they're not frightened of the technology, they're not frightened to put it there*.' (Interviewee 3).

Participant 4 in Scenario Planning Workshop 1 gives an example in support of the comments of Interviewee 3 and Interviewee 1:

> '…*and I think the older generation are more like I don't want people knowing all my private personal business*.' (Scenario Planning Workshop 1, Participant 4).

Interviewee 4 gives the example of society on the whole, accepting the intrusion (if that is the right word to describe the information to be gathered by using RFID) on their privacy, if it is shown that RFID technology is being used for the right reasons:

> '...*Now that is for the patient's own good, but it's a question of whether as society and as that individual, he or she is willing to accept that intrusion or could be seen as an intrusion on their privacy. But it's using RFID technology for the right reasons, or for some people they would see that for the right reasons, as a benefit.*' (Interviewee 4).

Interviewee 4 also speculates there may be over sensitivity to patient confidentiality issues:

> '…*I think that that is probably further out because there is a huge backlash to people's privacy. Or that's, again that's my personal opinion, is that in this country we get in some areas far too hung up about oh that's my, you know, why do you want to know this and why do you want to know that…but in my opinion you just have to, you'd have to get over*

barriers that would allow patients to be able to let go of all this data protection nonsense.' (Interviewee 4).

Interviewee 5 supports Interviewee 4's notion of over sensitivity to privacy issues we have as a society in the UK.

'…*I think the security issues are a red herring, and I think if you have got nothing to hide, then there's no security issue. It's only people who've got something to hide that will.. [cause a fuss]*.' (Interviewee 5).

It was also mentioned that there is also a lack of understanding of the capabilities of RFID technology by smaller enterprises:

'…*I think smaller companies, smaller enterprises don't quite understand it. They probably have a very limited view as to what bar-coding is, I mean they might see bar-coding as just scanning something at the till in a shop and not realise that it's all the way back down the supply chain, and not realise that it's not just the scanning, it's what you do with the data afterwards*.' (Interviewee 3).

It was also mentioned that there is also a lack of understanding of the capabilities of RFID technology by some NHS staff:

'…*I can't be doing with all this scanning stuff. But it he said he'd rather have a book and log it down, but I said to him well what would happen if you lost your book? He says well what would happen if I lost that? I said so is that not connected to a mainframe computer somewhere? He says oh yes, I didn't think about that. A lot of it is about that communication, isn't it, that makes people understand, you know, this technology, this is what it can do.*' (Scenario Planning Workshop 1, Participant 3).

Interviewee 1 advocates that RFID adoptions need time to be able to accurately assess the return on investment and that this needs to be communicated to decision makers beforehand:

'…*You need to do it for a certain period of time before you could actually speculate on the saving. In my experience, I'm yet to see an RFID adoption not return on investment at least, and most of these are twofold, if not more, but it's about convincing upfront*.' (Interviewee 1).

Another issue under the overall theme of communication, is that RFID is not actually that complex to implement, was not having enough visibility of successful pilot projects:

'…I think the lack of examples of work doesn't help either, and this is why we were doing the first of type work, is to show people that it is as simple as sticking labels on things. I think for me the only way to get people to truly buy in to it is to show them how good it can be'… I think if there was a flagship hospital or a flagship Trust of hospitals and, you know, GPs and the whole thing, where they were fully enabled with all the auto ID solutions. So

> *they had bed management, pharma, instrument tracking and, you know, case note tracking and the whole thing, and all the data was provable, it was benchmarked and then it was rerecorded and it showed, you know, it used to cost this and that cost this or it used to take this long and now it only takes this long, and if people could go and see that sort of innovation at work and have access to the data, I think more people would do it*.' (Interviewee 1).

It was also mentioned that there is further lack of awareness of the solutions available:

> '…*some of it actually is probably not being aware that the solutions [successful pilot projects] are available*.' (Interviewee 1).

An illustration of the lack of examples and insight available on the pilot schemes, even within the HUG team was also indicated:

> '…*human nature is such that without incentives, people carry on doing the same things. There are very few people that will go out there and change things because some new technology's come along. And I suppose one of the other problems is nobody really wants to be first, it's always good to be second because you can learn off what the first person's done*.' (Interviewee 6).

Interviewee 3 supports Interviewee 6 in that there would be more confidence if further evidence was available to NHS Trusts of successful RFID projects

> '…*So if you look at Trusts, look at hospitals, and I think they need to see evidence of where the technology is being used in other hospitals*.' (Interviewee 3).

A number of issues were highlighted under the 2nd order theme of communication within the overall aggregate dimension of inhibitors to RFID adoption. Not creating clear comparisons with other industries where RFID is widespread was discussed as an inhibitor. RFID is used in other industries often without the people who are using it knowing that it is RFID technology. Not communicating the use of RFID in other industries was also intertwined with a lack of communication that RFID is not actually that complex to implement. However, there is evidence that some lessons from other industries have been learned. The data also indicated there may be over sensitivity to patient confidentiality issues. Another issue under the overall theme of communication, which is again intertwined with communicating that RFID is not actually that complex to implement, was not having enough visibility of successful pilot projects. An illustration of the lack of examples and insight available on the pilot schemes, even within the HUG team was also indicated.

2.2.3. **Reactive Culture**

The reactive culture 2nd order theme within the overall inhibitors to adoption aggregate dimension encompassed a number of aspects which related to culture. The subthemes contained within the reactive culture theme are: fire-fighting, lack of innovative teams in NHS Trusts, not looking beyond short-term contracts, an institutional objection to change and not addressing the perceived failures of previous large scale IT projects in the NHS. These subthemes are now illuminated with key excerpts from the interviews and workshops in the following paragraphs.

Fire fighting describes the theme surrounding the notion of NHS Trust's core business is saving people's lives and not new IT system adoption. Interviewee 1 describes the difficulty with people taking on additional work in the NHS:

> '…*the other problems are everybody has a day job, so people don't have the time to adopt things ad hoc and it has to be thoroughly planned and budgeted and the rest of it, and it's hard to get people to, I guess join in is the only way you can put it really…It's hard to get people to step outside of their day role or take on additional work to what they're already doing when they don't have to*.' (Interviewee 1).

Forward from RFID adoption not being core business, the data reveals innovative teams or champions not being a priority for NHS trusts. Interviewee 5 describes it as a lack of appetite:

> '…*People resource I'm talking about, as well as money resource. There isn't the appetite to do it*.' (Interviewee 5).

A supporting statement with regards to a lack of a champion followed:

> '…*but what we actually want is a supply chain technology tsar for the NHS. Somebody like [Named Person], who's got experience in the supply chain as it should work*.' (Interviewee 5).

Participant 3 in Scenario Planning Workshop 1 explains how the there is a need for the skill sets a champion figure can bring to drive a project/initiative forward:

> '…*I would suggest lots of the other things and nuances around that because I suppose some of culture, culture-wise, I could put in about skill sets and you need to have people that can be champions and drive it forward and all that sort of thing, that's culture really.*' (Scenario Planning Workshop 1, Participant 3).

However, Interviewee 5 indicates there is an institutional refusal to change and adopt new technologies:

> '…*the NHS are appalling at harnessing new technology*.' (Interviewee 5).

Interviewee 7 subtly supports Interviewee 5's generalisation:

> '…*there's also, yes, there's the fact that a lot of people in the NHS don't like change, there's the threat, I suppose there's the perceived threat of RFID*. (Interviewee 7).

Interviewee 4, in the context of new IT (RFID) projects in the NHS, sets out the NHS's historical cultural landscape where NHS Trusts have been given choice of what technologies to adopt, even if supported by central government, with a sobering explanation culture in the NHS:

> '…*because of perhaps a history of where the NHS has come from, it probably would be too difficult to do. There might be certain pockets of early adopters that might do that, but by and large I think the culture will realistically count against it.*' (Interviewee 4).

Interviewee 1 supports Interviewee 4's view the NHS's culture being against new technology adoption:

> '…*The only other one is around the natural – I'm trying to pick my words – the natural pessimism of the NHS in oh it won't work, you know, oh we've being doing and we've tried things like this in the past and it just won't work*.' (Interviewee 1).

Interviewee 3 states the example of the rate of change of technology as a reason for the "natural pessimism" that Interviewee 1 carefully worded:

> '…*So I think there is a problem with investing now if something's going to change in the future so, you know, I'm putting in a barcode and it's a linear barcode, well we're going to have to use 2D barcodes in the future or maybe some RFID, you know. So there's, but because of change accelerating there's a risk that, you know, that you might make the wrong decision and go down and invest in something and in a way it's wrong*.' (Interviewee 3).

But then places the perspective of the rapid pace of change of new technology emergence in general, rather than in a healthcare setting:

> '…*I think most technological changes will be beneficial, it's just the rapid pace of change [for the NHS to catch up to] rather than any particular technology itself*.' (Interviewee 3).

Interviewee 6 explains the cultural differences towards technology adoption from the perspective of different NHS Trusts:

> '…*If the culture is such that people want to raise new technology and see it as a way of moving things forward, well then you'll win. Culture is virtually important and as an example this last week I've been to two NHS Trusts about the same thing. The one in the morning was all about oh we'll make certain it happens, the one in the afternoon was we can't make that happen. The same problem, two completely different parts of the country. So culture, if people want to make it happen, then the technology will happen*.' (Interviewee 6).

Drilling down further from NHS Trust level to department level, Interviewee 6 illuminates uses of RFID where the culture may be more accepted to new technologies, especially in terms of process improvement:

> '…*now I think for certain places if we say take, I don't know, accident and emergency, something like that where you don't know what you're going to face. Well fine, that probably doesn't lend itself to RFID as such because it's a dynamic environment and you never know what you're going to get, you can't predict what you're going to get, if there's a major accident you need to deal with it there and then. Fine, but for all those other things, all those planned procedures, all those things that you're expecting to happen because the population is the population and you could really forecast in, depending on socioeconomic group, what you're likely to find in any particular area. All those sorts of things could be planned but culturally if people don't want to work within that sort of environment, because it's a little bit of a straightjacket*.' (Interviewee 6).

Also related to the reluctance to change, is the rate at which new technology emerges, and the attitude that there may be something new around the corner anyway, as depicted by Interviewee 1:

> '…*Whereas five years down the line they'll probably all have the relevant equipment and they can read them. But then at the same time, the way technology is moving on so quickly, how soon is it before it's all going to be replaced again and the hospital's going to have the budget to start changing again*.' (Interviewee 1).

However, the data also indicates that, although the institutional reluctance to change is a factor, practical reasons for not being able to adopt new technologies also exist:

> '…*I think to be fair it's not, it's not just, you know, the NHS not liking change and red tape etc., I think a lot of it is practical as well, it can be quite practically difficult. It can be quite practically difficult to implement an RFID solution because, for example, some suppliers' solutions require hospital-wide Wi-Fi. Well how many hospitals in the NHS have site-wide Wi-Fi that's reliable?'* (Interviewee 7).

This highlighting of the issue of existing infrastructure not being suited to RFID technology by Interviewee 7, is supported further by Interviewee 6, also mentioning existing Wi-Fi friendliness (or rather, a lack of) being a factor in a lack of adoption:

> '*…So the whole site was wired-up and, you know, but in contrast you go to a site like the LGI who's the general infirmary here and the buildings are so old, they're just not meant to take IT. And a lot of the problems can be that if it relies on the whole site being networked or either wired or wirelessly or, you know, hole drilling in walls, new server rooms, where to store the technology, you know, there's the practical side to it as well. I mean one supplier's tried to get round that by having their devices connect to each other without there being a network required, and that might appeal to hospitals because there's no, you know, there's no initial outset. So like it might cost them millions to install a Wi-Fi network to try a free product, well it's not really free if you have to do all that, so I think there's that side of it as well*.' (Interviewee 6).

Practical reasons for not being able to implement IT well are synergistic with the next aspect of the reactive culture theme and also ties in with the fire fighting culture; the inability to plan over the long term due to short term contracts. Interviewee 2 gives the perspective of a supplier to the NHS:

> '…*well our company would be planning resources for twelve months out all the time, that we're always planning for the following year and we're planning the projects for the following year*.' (Interviewee 2).

Interviewee 4, also from the perspective of a supplier to the NHS, explains that there may be planning for 3 years but this is not "firm" planning:

> '*…. we may be able to say OK, this is a longer timeline but there will – we'll plan three years out, they do plan three years out but it's not firmed up*.' (Interviewee 4).

Examples of previous failures of IT/Coding projects have also been indicated as an inhibitor, which has been organised under the theme of reactive culture:

> '…*and coding, coding programmes have been tried in the past, there was a pharmacy one eight/nine years ago around births in Birmingham, that failed miserably*.' (Interviewee 1).

Interviewee 4, in the context of the perceived failure of the NHS National Programme for IT, explains the disparity in operations:

> '…*when the whole start of the project was this is what we want nationally and if we are truly about being a national health service, it needs to operate in some areas nationally. And that's the biggest barrier for me, is that we call ourselves the National Health Service*

and that is what as patients we, in my opinion, wrongly perceive is the case.' (Interviewee 4).

The reactive culture (2nd order code), as part of the aggregate dimension of inhibitors to RFID adoption included a number of sub groups (groups of 1st order concepts). Fire fighting described the code surrounding the NHS Trust's core business is saving people's lives and not new IT system adoption. Forward from RFID adoption not being core business, the data alluded to innovative teams or champions not being a priority for NHS trusts. Also indicated by the data is that there is an institutional refusal to change and adopt new technologies. However, although the institutional reluctance to change is a factor, practical reasons for not being able to adopt new technologies also exist. Practical reasons for not being able to implement IT well are synergistic with the next aspect of the reactive culture theme and also ties in with the fire fighting culture; the inability to plan over the long term due to short term contracts. Examples of previous failures of IT/Coding projects have also been indicated as an inhibitor that has been organised under the code of reactive culture.

2.2.4. **Legislation Standards and Regulation**

A key inhibitor to RFID adoption emerging from the interview and workshop data was the lack of coordination in legislation, data standards and regulation of medical devices. Rosenbaum (2014) also highlight the development and adoption of an adequate data standard ensuring security is a factor for RFID technology's considerable benefits to be utilized. The two sub themes within the 2nd order code of legislation standards and regulation are firstly a clear detailed information requirement for standards databases and secondly the differing regulation and information standards emerging in different countries. These subthemes are now illuminated with key excerpts from the interviews in the following paragraphs.

Interviewee 2 gives the example of Europe, where there is legislation but it is not adequately detailed enough:

> '…*within Europe it's slightly different because there's new legislation come out on the same sort of thing, again with traceability of products and patient safety, but there's no detail in it… and if we choose to use GS1, then GS1 have got specifications, they've got standards there that we can follow. That's fine, but then it depends on how much detail they're going to want within the information. So if we have a bar code on a product, what detail has got to go in to that barcode. So we can make an assumption now for then, sort of three years down the line, that could all change*.' (Interviewee 2).

Interviewee 3 further highlights, in the context of Europe, how the independence of countries when it comes to selecting a coding standard is a hindrance:

> '…*So just because one country adopts it, actually it may be that another country decides not to do it because it's being done in England, you know, there's this whatever they do, we do the opposite. And so there's that entire dynamic of what's going on outside of health at a political level which, and – but the problem obviously is that they are totally independent and no one can tell them how to spend their money in other countries, you know, in other parts of the UK. So it's that aspect of it*.' (Interviewee 3).

Interviewee 4 gives a global perspective how important legislation and, one global standard across healthcare is the way forward but it does not look like being the case in reality:

> ' …*I think it's the risk that this whole thing with unique device identification and the databases and everything else which, which is basically what needs to be in place for RFID to happen within the healthcare sector, if that gets too far disjointed from different regions and if it's not harmonised globally, then that is a massive risk because it's not going to work and give us the vision that we want for healthcare and the whole patient safety and stopping sort of gray train and stopping counterfeit products coming in to the system in certain areas. It's not, unless it's harmonised and we've got one system that's working together, it's not going to happen properly. And I think that is a massive risk where we're at the minute, because you've got the US releasing theirs – well they've released their legislation which will come into force in a few months. You've then got the European Commission doing theirs*.' (Interviewee 4).

There is uncertainty in the area of what information, especially detailed information, will be required for regional "master databases" and in the area of differing regulation and information standards emerging in different countries.

This concludes analysis on the theme of the inhibitors to RFID adoption. Subthemes and further subthemes were identified using highlighted excerpts from the interviews. The four main 2nd order themes presented in the analysis of inhibitors to RFID adoption were lack of central investment, communication, reactive culture and legislation standards/regulation.

2.3. Relationships between Drivers and Inhibitors

2.3.1. Successful Pilot Projects vs. Communication

The relationship between Pilot Projects and Communication presents an interesting and insightful situation to consider. In the first instance, the way in which pilot projects and their results are currently disseminated, online news outlets, GS1 information bulletins and internally with members of the HUG are effective within the RFID/AIDC community. However, there are more stakeholders and in particular, decision makers (Financial Leads of NHS Trusts) could be included in this community in order to give visibility to, not only RFID technology itself but also the services and operational improvements it could provide.

RFID is used in other industries often without the people who are using it knowing. Confidential information being transmitted wirelessly is indeed a cause for concern. These concerns could be met with examples of RFID technology from other industries. The relationship between Communication and Successful Pilot Studies is an area the HUG take steps in; increase awareness of RFID’s applications in Healthcare but also how this technology is widely used elsewhere.

2.3.2. Lack of Central Investment Vs. Technical Improvements and reducing cost of RFID Technology

The analysis of this relationship takes the form of the question that if RFID technologies reduce in cost, would the lack of central investment be such an inhibitor to RFID adoption? The cost of the isolated RFID system itself is not the major inhibitor; it is the surrounding infrastructure costs. As NHS Trusts are being built or updated to be supportive of wireless technology and the information age, these infrastructure costs become less of an issue but currently, existing hospitals and NHS sites that are not “e-enabled” have to install the supporting infrastructure to support RFID systems. This is where the lack of central investment holds back the adoption of RFID systems.

2.3.3. Changing nature of care required Vs. Reactive culture

Considering this relationship allows the opportunity to analyse the culture of the NHS in terms of how it changes (reactive) with the changing nature of care required. The changing nature of care i.e. ageing population, increase in demands of homecare and the rise of e-health applications could lead to the NHS having to be increasingly adaptive to deal with the changing nature of healthcare needs. However, through the fruits of public health research, could the NHS in England be more pro-active in the face of changing demands such as the increasingly ageing population. This is not a question this present research can answer, but the identification of the question will provide a platform for exploration in the Discussion Chapter.

2.4. Drivers and Inhibitors Analysed through PEST

The purpose of this section is to establish if the drivers and inhibitors lean towards a certain quadrant of the PEST structure to further the analysis by allowing comparison of the uncertainties produced by the scenario planning process with the drivers and inhibitors identified by the interviews. The unit of analysis for this section is the 2nd order themes established. The following table sets out how the drivers and inhibitors, identified through the interviews, fall into the PEST structure. Some drivers and inhibitors span two or more quadrants of PEST. The quadrant(s) that a particular driver or inhibitor occupies is identified with a tick (✓).

Drivers	Inhibitors	Political	Economic	Socio-Cultural	Technological
Successful Pilot Studies	-	✓			✓
Technical Improvements and reducing cost in RFID technology	-				✓
Constant need to improve the NHS	-		✓	✓	
Changing nature of care required	-			✓	
-	Lack of Central Investment	✓			✓
-	Communication		✓		
-	Reactive Culture	✓			
-	Legislation, Standards and Regulation	✓			✓

Table 18. Drivers and Inhibitors Analysed through PEST

Table 18 leads on to the assessment of which quadrant(s) of the PEST structure, the drivers and inhibitors identified through the interviews lean towards. Although at the heart of this present research is a technology, the main quadrant of the PEST structure the inhibitors and drivers fall into is the Political sphere. However, somewhat expectedly, the Technological Sphere is also dominant. The Economic and Socio-Cultural Spheres share the remaining drivers and inhibitors between them. Overall there is an even spread with a slight leaning towards the Political and Technological Spheres.

2.5. **Drivers and Inhibitors Analysed as External and Internal**

In this section, the drivers and inhibitors are viewed through the lens of 'external' and 'internal' forces. This analysis is conducted to identify, the aspects that the NHS and specifically the HUG can control internally and can prepare for externally.

	Drivers and Inhibitors	Internal	External
Drivers	Successful Pilot Studies	✓	
	Technical improvements and reducing cost in RFID technology		✓
	Constant need to improve the NHS	✓	✓
	Changing nature of care required		✓
Inhibitors	Lack of Central Investment	✓	
	Communication	✓	
	Reactive Culture	✓	
	Legislation, Standards and Regulation		✓

Table 19. Drivers and Inhibitors Analysed as External and Internal

Table 19 shows that three of the four inhibitors identified as 2nd order themes are internal to the NHS. This suggests that the majority forces holding back RFID adoption in the NHS can be influenced by the NHS. One 2nd order theme identified as an inhibitor, 'Legislation, Standards and Regulation', is an external force. Internal drivers identified are the 'Constant need to improve the NHS' and 'Successful Pilot Studies'. However, the constant need to improve the NHS has also external elements. Table 19 identifies three out of four drivers are external to the NHS: 'Technical improvements and reducing cost in RFID technology', 'Constant need to improve the NHS' and 'Changing nature of care required'. Analysing the drivers and inhibitors through the lens of internal and external forces identifies what the NHS can influence internally in the adoption of RFID technology.

2.6. **Findings – Drivers & Inhibitors to RFID Technology Adoption**

In conclusion to the analysis on the aggregate dimension of the inhibitors to RFID adoption, 2nd order codes and further subthemes were identified using highlighted excerpts from the interviews and workshops. The four main themes presented in the analysis of inhibitors to RFID adoption were a lack of central investment, communication, reactive culture and legislation standards and regulation. The interview data reveals that without central funding, it is difficult for NHS Trusts to invest in new technologies in the current climate. However, not only central funding is required but increased levels of support and guidance should also be made available. A number of issues were highlighted under the 2nd order theme of communication. Not creating clear comparisons with other industries where RFID is widespread was discussed as an inhibitor. Not communicating the use of RFID in other industries was also intertwined with a lack of communication that RFID is not actually that complex to implement accredited to improvements in the technology itself. However, there is evidence that some lessons from other industries have been learned. The data also indicated there may be over sensitivity to patient confidentiality issues. Another issue under the overall theme of communication was not having enough visibility of successful pilot projects. An illustration of the lack of examples and insight available on the pilot schemes, even within the HUG team was also indicated.

The reactive culture (2nd order code), as part of the aggregate dimension of inhibitors to RFID adoption included a number of sub groups (groups of 1st order concepts). Fire fighting is a reflection of NHS Trust’s core business of saving people’s lives and not new IT system adoption. Forward from RFID adoption not being core business, the data alluded to innovative teams or champions not being a priority for NHS trusts. Also indicated by the data is that there is an institutional refusal to change and adopt new technologies. However, although the institutional reluctance to change is a factor, practical reasons for not being able to adopt new technologies also exist. Practical reasons for not being able to implement IT well are synergistic with the next aspect of the reactive culture theme. This theme also encompasses the fire fighting culture; the inability to plan over the long term due to short term contracts. There is uncertainty in the area of what information; especially detailed information will be required for regional “master databases” and in the area of differing regulation and information standards emerging in different countries.

In conclusion to the analysis on the aggregate dimension of the drivers to RFID adoption, 2nd order themes and further subthemes were identified using highlighted excerpts from the interviews and workshops. The key drivers of RFID adoption identified by this study are successful pilot studies; improvements and reducing cost in RFID technology, constant need to improve the NHS and the changing nature of care required. Improvements in RFID technology have been attributed to its success in pilot studies. There are more and more pilot studies emerging that are showing signs of or have shown to be a success. There are instances of other projects which, not directly but through the process of requiring performance improvement, have shown to be suitable to RFID technology adoption. Through this previously gained experience and performance improvements of the technology, there is momentum behind the adoption of RFID technologies.

The DoH has committed to one standards provider (Thuemmler and Buchanan, 2010). A commitment to one standards provider does exist but there is uncertainty around the future of the contract but due to this commitment, manufactures can coordinate their effort. Leaner stock management and reducing cost was seen as direct reason for RFID adoption. The data suggests some clear areas where cost savings could be made through the use of RFID. Conflicting views were presented with regards to innovative teams in NHS Trusts. The nature of care required by the population is changing. The ageing population presents its own opportunities for RFID. The instant gratification culture will eventually seep into healthcare requirements especially in the areas of tele-health. Tele-health is an area identified by the data where RFID technology can have an impact in providing systems to be used in the home of patients.

There are a number of key relationships between the identified drivers and inhibitors. Successful pilot studies and Communication represents a relationship that the NHS and the HUG can control. The wider communication of pilot studies outside of the RFID community in the NHS does not currently take place. The relationship between the 'Lack Of Central Investment' and 'Technical improvements And Reducing Cost In RFID Technology' gives a clear indication towards the actual RFID systems are becoming cheaper and more reliable but NHS sites, especially older estates, do not have the support infrastructure required. Central investment is not necessarily required for the RFID systems themselves but the surrounding infrastructure in NHS buildings. The changing nature of care i.e. ageing population, increase in demands of homecare and the rise of e-health applications could lead to the NHS having to be increasingly adaptive to deal with the changing nature of healthcare needs. This relationship sits deeply in the Socio-Economic sphere of the PEST structure. When considering the identified drivers and inhibitors through the lens of external and internal forces, three out of four inhibitors can be internally controlled by the NHS.

3. Conceptual Model

The conceptual foresight model developed in Chapter 3 aimed to alleviate the key weaknesses of scenario planning and technology roadmapping. Here, the data collected from deployment of the model is presented and analysed as set out in Section 2.6 of the Methodology Chapter.

3.1. Stage 1. Establishing a planning horizon

The first stage of scenario planning involves setting a planning horizon. This stage can be conducted within a workshop environment (O'Brien, 2004a) but in this present research, it was conducted during individual interviews (Van der Heijden, 2005) in order to gain independent and diverse results and further allowed each participant to fully grasp the task.

Initially, placing the participants outside of their comfort zones with the planning horizon questions was met with surprise, a little trepidation and reluctance.

The planning horizon was established by asking the interviewees three questions during Section 5 of the interviews: Planning Horizon. Table 20 depicts how the planning horizon of 15 years emerged. The average response of years to of each question was between 13-15 years. Table 20 presents each interviewee's answer in a condensed format with the questions included.

-	Interviewee Responses (Years)						
Planning Horizon Questions	1	2	3	4	5	6	7
Determine (roughly) the point in the future where existing knowledge cannot help us analyse the environment.	5	5	4	16	35	15	25
How far into the future are resources being committed?	5	4	5	17	25	10	25
When does the environment become uncertain?	4	5	5	15	30	15	20

Table 20. Interview Section 5: Planning Horizon

One interviewee asked to pause the interview to further clarify what was meant by a 'planning horizon' even though this had been explained in the initial presentation of the proposed scenario planning exercise in the previous face-to-face HUG meeting. Interviewee 1, for example, was surprised at the question of determining the point in the future where existing knowledge cannot help us analyse the environment:

> '…*Well that's a question. So is it where's the next knowledge gap in terms of – that's a very, very good question*.' (Interviewee 1).

Interviewee 5 responded to the question of "How far into the future are resources being committed?" with:

> '…*I think that's a really difficult question*' (Interviewee 5).

This initial reluctance was present in all but one of the interviews (Interviewee 6) where the participant had previously engaged in an unnamed long-range planning activity with his own organisation.

One of the pitfalls of the scenario planning process identified by O'Brien (2004b) was that the participants do not look past the immediate issues facing their organisation. This was one of the starting points of analysing the data around setting the planning horizon in terms of how the participants may react to the line of questioning. The interview questions for the planning horizon were set out in order to support the participants to think past the immediate issues facing their organisations. Interviewee 4 was sceptical of a planning horizon of further than 10 years:

> '…*And so you might have, you know, some organisations within like you said, that healthcare environment that might have a ten-year plan, but I would imagine most wouldn't. Given the rate of change within our industry, I would say anything further than ten years out really is sort of blue sky thinking*.' (Interviewee 4).

Interviewee 7 stated that beyond even 5 years is difficult to plan for:

> '…*Probably, you know, beyond ten years is probably difficult. I think five is probably easier to plan for, I think we almost certainly know what we'll be doing in five years but in ten, it's difficult to know what we might have to be catering for, you know, we might not even have an NHS.*' (Interviewee 4).

The planning horizon for this present research emerged by asking the interviewees three questions as presented in Table 20 above. These three questions and their responses were collated to establish the 15 year planning horizon. Each of the three questions in Table 20 was explored as a conversation (through the semi structured interview format) and not a simple response in years from the participant. Each question allowed for and was designed to help push the participants to think beyond one of the pitfalls of scenario planning as set ot by O'Brien (2004b) in that the participants do not look past the immediate issues facing their organisation.

In summary, two key findings emerge from the "Establishing the planning horizon" stage in the scenario planning process. The participants did find the 'out of the comfort zone' line of questioning difficult to answer at first. However, through careful design of the questions around exploring a planning horizon, the participants were able to grasp the concept well enough to come up with a timeline outside of their immediate focus. Conducting the planning horizon stage during the interviews allowed for a democratic, free of group dynamics, planning horizon to be set by each individual participant.

3.2. Stage 2: Scenario Planning uncertainties

Questions in section 5 and 6 of the interview schedule were designed for the scenario planning exercise. The following uncertainties were generated from the interviews for use in further stages of the Scenario Planning process. The total uncertainties collected through the interviews numbered 37, with 13 in the technological quadrant, 9 in the socio-cultural quadrant, 7 in the economic quadrant and 8 in the political quadrant. Table 21 presents a collation of the uncertainties raised from all 7 Scenario Planning interviews.

Political	Economic	Socio-Cultural	Technological
• Level of rationed healthcare	• Level of availability of Energy resources	• Migration of people from different parts of the world	• Level of quality online Patient records
• Stability of world peace	• Semi privatization of healthcare	• Level of population growth	• Virtualization of healthcare
• Biological effects of Nuclear war	• Security in assets (housing)	• People take more interest in their healthcare: visibility, self-prescription etc.	• Quicker paradigm shifts (e.g., information in books and knowledge to information on the internet)
• Religious uprising	• Level of Privatization	• Understanding of RFID amongst the general public	• Healthcare records stored on person
• Sharing of public health information	• Level of security of Major technology providers	• Comfort with technology of the general public	• Impact of cyber attacks
• Level of importance placed on global data standards	• Fluctuations in exchange rate.	• Level of care expected	• Level of capability of RFID technology
• Level of global technology regulations	• Level of capital budget to adopt new technologies for NHS hospitals	• Comfort of having healthcare records online	• Level of shared data standards
• Change of lead political party		• Level of reliance on Tele-health	• Level of quality Patient records
		• Health of the population in terms of obesity, mental health, aging issues	• Change in coding structure
			• Greater availability of RFID technologies due to increased competition
			• Level of sharing of established processes from other industries e.g. warehouse management, pharmaceutical supply chains
			• Global adoption of the same data standards across healthcare
			• Fluctuations in technology regulation

Table 21. Collection of Uncertainties

The process of conducting this section of the interviews over time did changed as more and more familiarity was gained with the types of sticking points or instances of a lack of understanding of what was being asked of the participants. For example, the explanation of what is defined as being an “uncertainty”; for the purpose of a scenario planning exercise became increasingly concise during the final interviews. Longer explanations confused the participants and deflected from the objective; that an uncertainty is a factor that affects the NHS but is outside of its direct control.

In order to generate a wide range of uncertainties from the external environment, PEST analysis was used to help the participants. Conducting this part of the scenario planning exercise during interviews allowed for detailed probing and discussions to take place for all 4 quadrants of PEST, allowed for all respondents to have a voice and the generation of uncertainties free of group dynamics.

It was noted from the first few interviews the participants were more at ease speaking of uncertainties within the technical quadrant. It should be taken into account that the majority of the participants are from a technical background, responsible for the technical aspects of RFID in their respective organisations. However, for the purposes of the scenario planning exercise, in subsequent interviews it was ensured that the other three quadrants were well defined and enough emphasis/time was allocated to them. The technological quadrant yielded the highest number of uncertainties (13).

3.3. **Stage 3. Reducing the factors of uncertainty**

3.3.1. **Workshop 1: Reducing factors and choosing ranges**

All the participants rated all 37 Uncertainties generated on a scale of uncertain/important as discussed in Section 2.5.4 in the Methodology Chapter. The 12 Uncertainties to be used throughout the remaining scenario planning exercise were as follows with their PEST categorisation identified, presented in Table 22.

Num	Uncertainty	PEST Category
1	Level of rationed healthcare	Political
2	Level of ‘capital’ budget to adopt new technologies for NHS hospitals	Economic
3	Health of the population in terms of obesity, mental health, aging issues	Socio-cultural
4	Level of availability of Energy resources	Economic
5	Level of quality online Patient records	Technological
6	Level of privatization of healthcare services	Political
7	Migration of people from different parts of the world	Socio-cultural
8	Level of global technology regulations	Technological
9	Level of care expected	Socio-cultural
10	Cyber attacks	Technological
11	Global adoption of the same data standards across healthcare	Technological
12	Fluctuations in technology regulation	Technological

Table 22. The top 12 Uncertainties.

3.3.1.1. **Choosing Ranges**

During the Workshop, the first task was to reduce the 37 generated uncertainties to 12. Handing electronic tablets to all the participants during the workshop to gain independent responses completed this aspect. A Google Form created beforehand, as presented in the Methodology Chapter in Section 2.5.4.1, incorporated rating each Uncertainty on a 2 dimensional 10-point scale of uncertainty and importance. The top 12 Uncertainties would be carried forward into the next stage. The 12 Uncertainties selected were placed in a table by the facilitator and then the participants proceeded to determine the plausible range of values for each Uncertainty. The participants could select either a qualitative or a quantitative range. The results are presented below in Table 23.

	Uncertainty	Low	High
1	Level of rationed healthcare	No rationing All care is free including free prescriptions	Like US – emergency care only; rest through insurance Allocated budget, patient decides, with optional top up
2	Level of ‘capital’ budget to adopt new technologies for NHS hospitals	Minimal/none Funded through revenue, or distributor and manufacturer	‘Mandated/dictated /central /ring fenced capital budget.
3	Health of the population in terms of obesity, mental health, aging issues	High obesity etc. problems Causality of these of problems; shorter life span	Population well With Increase in taking ownership by each individual
4	Level of availability of Energy	Depleting stores of current resources	New technology/sources on line. Less

	resources	Shift to different resources and possibly renewable	resource intensive
5	Level of quality online Patient records	What is on line is poor (setting aside what % online) Lack detail; incorrect records	Much better than now; more detail, correct coding (clinicians do better; done in a timely way, correctly coded)
6	Level of privatization of healthcare services	As now Limited private provision of some care support services, some hospitals (but still free at point of use) Outsourcing	Fully privatised care provision Mixed economy
7	Migration of people from different parts of the world	Current net migration; similar level of impact on services as now – all people are treated Health service has the ability to cope	Much more inward migration and strict limits on who get what care Health service does not have the ability to cope
8	Level of global technology regulations	No global regulations, because of political barriers and lack of desire	Global guidelines and standards with free flow of information if driven by patient safety agenda (superbugs etc. drive political will/mind-set)
9	Level of care expected	As is now – post code lottery. NICE influence	People will expect higher levels of care than of today
10	Cyber attacks	Happen and people get put off on line records	Lots of them, but people accept the risk because they value the benefits
11	Global adoption of the same data standards across healthcare	Non – as is – change --fragmented	Driven by patient safety agenda: a future requirement of the Global society
12	Fluctuations in technology regulation	Non – as is	Manual processes overtaken by tech Driven by patient safety agenda: a future requirement of the Global society

Table 23. Defining Ranges

The uncertainties had been generated and a few of the participants had mentioned that it would be interesting to see what factors other participants had generated and what planning horizons had been suggested. It had been decided, as part of the presentation, to include definitions of the key terms of the scenario planning process, in order to refresh the memories of the participants. Although this aspect of the session was indeed useful and served its purpose well, it took too much time during the workshop, which did run over schedule. In future exercises, facilitators should send the participants an email a few days before in order to refresh their memories of the key terms and more detailed outline of the session in order to save time and use the session to produce the intended outcome, instead of using time in a short session to go over already covered ground.

Despite this time consuming ‘key terms’ refresher, the participants engaged well with the content of the workshop. The first stage of the workshop was to present the planning horizon, collated from the all the interviews. In order to expand the participants thinking beyond the immediate issues in their focus, the planning horizon was set to 15 years. The average time that the participants had set from the interviews was 12.7. Immediately, this timeframe startled Participant 1:

'…*I'm not going to be worried about what's happening in fifteen years' time, I'm not going to be even thinking about, I'll be on a beach'* (Participant 1).

However, Participant 2 was happy with the planning horizon set as the 15-year timeframe was close to what he had suggested:

'… I can go happy after this' (Participant 1).

It was uncertain how the group would react to a timeframe set far in advance of some of the conversations but the workshop moved along without too much dissent to this timeframe. The formulas and processes built into the Google Form produced the top 12 ranked uncertainties. These were presented to the participants on a slide in the presentation with 5 minutes allocated for comments on the 12 selected uncertainties. The process of transferring the 12 uncertainties from the Google form to the PowerPoint slides was a manual process that, the next time should be automated. At least a table on a pre-prepared slide in the same format and style of the existing presentation should be produced. Then, the facilitator can simply copy this slide into the existing presentation.

For the next phase of the workshop, the lowest and highest value range for each of the 12 selected uncertainties was to be decided by the participants.

The discussions in the workshop of what constitutes the lowest and highest value ranges for each scenario encompassed considerations of different factors and all participants contributed well. When deciding the range for the 'level of rationed healthcare' for example, the participants considered what highest value of the range could be through an open discussion:

'…*So OK, there's obviously strong opinions and that's why we've got you in the room. So if we did have to come to a middle ground of what we all think, how would you…*' (Interviewer)

'…*I think if you look at the scenarios though, your worst case scenario is that the high level would be everything is fully rationed and you don't have an NHS in the UK...*' (Participant 1)

'…*A bit like America's got now, isn't it?'* (Participant 2)

'…*Yes, emergency care only, isn't it?*' (Participant 3)

'…*America's trying to – yes'* (Participant 4)

'…*Yes'* (Participant 1)

'…*And is that plausible in fifteen years, do we agree on that?*' (Interviewer).

'…*Yes, I'd have thought so*….' (Participant 4)

'…*Yes'* (Participant 1)

The participants discussed what the potential maximum and minimum value ranges would be. All 12 uncertainties were given ranges of values during the workshop.

3.4. **Stage 4. Workshop 2: Choose themes & develop scenarios**

This stage, developed and presented in 2.5.4.2 in the Methodology Chapter sees the scenarios begin to take shape by generating themes and developing outlines of scenarios. The process of choosing themes produced 5 matrices, presented as figures below:

Uncertainties to be Combined: Level of Privatization of Services/Health of the Population	
LOW/HIGH	HIGH/HIGH
- Less use of national standards	- Privatization creates a System based on business need not care based need
LOW/LOW	HIGH/LOW
- Private healthcare is not better - Timely Services	- Government not popular due to dismantling the NHS - Privatized too quickly

Figure 10. Matrix 1

Uncertainties to be Combined: Level of Capital Budget to adapt new Technologies/Level of quality Online Patient records	
LOW/HIGH	HIGH/HIGH
Redirection of existing resources where there is patient ownership of health records Money is an incentive for adoption Islands of information/system quality but still disjointed Lots of data but very little useful information Quality data is only in pockets	More individual ownership Healthcare provided on basis of lifestyle choices Well trained population Electronic records problem solved Greater capability of what you can do with the information gathered
LOW/LOW	HIGH/LOW
Only privately paying patients receive high levels of healthcare Government not popular at all but not plausible	Information gathering more towards what manufacturers/distributors want Information collected for the facilitation of business Healthcare becomes no longer free at the point of use Poor system management due to lack of mandating

Figure 11. Matrix 2

Uncertainties to be Combined: Level of Care Expected/Level of Privatization of Healthcare Services	
LOW/HIGH	HIGH/HIGH
Expectation increasing with better healthcare as in history = Healthcare improves=expectations improve End of life care to be better	Expectations remains high What people want now Limitations on health tourists
LOW/LOW	HIGH/LOW
Implausible	Health services there to make a profit and not care driven. Still has the NHS name, may well be provided by the private sector but paid for by the NHS. Expectation still very high

Figure 12. Matrix 3

Uncertainties to be Combined: Level of Capital Budget to adopt new technology/Health of the population	
LOW/HIGH	HIGH/HIGH
Prevention Schemes to adapt new technology Screening for quality life issues not just end of life issues Faster intervention Assisted Suicide technology if patient health records exist to a high enough level of detail Well being educational programs Incentivized healthcare programs	More technology driven health assessment Interactive care of aging population Monitoring of health Prevention Schemes to adapt new technology Screening for quality life issues not just end of life issues Faster intervention
LOW/LOW	HIGH/LOW
Greater amount of deaths at a younger age Greater need for healthcare for those who are alive Reactive as opposed to proactive healthcare Higher stress levels Greater susceptibility to postcode lottery Downward spiral; risk of increased substance abuse	Class divides Talent skills divide Health is pushed but sports Active lifestyle Low cost sporting activities Competitive pricing for healthy food Supply and demand of healthy food Personal responsibility Taxes on processed food

Figure 13. Matrix 4

Uncertainties to be Combined: Level of global technology regulations/Global adoption of the same data standards across healthcare	
LOW/HIGH	HIGH/HIGH
Continental data standards with no alignment to exploit the shared data standards Legislation restricts technology data standards Industry lead adoption of one data standardization system Language barriers for usage of healthcare practitioners	Traceability of products in healthcare Electronically enabled traceability accountability Greater visibility over multiple systems and platforms Standard information available High quality master data product information
LOW/LOW	HIGH/LOW
No standard information requirements Restricted flow of information Stifles innovation	Regional adoption Data migration issues Sub optimal use of technology Costly workarounds for industry Knock on cost of potential treatments Lack of innovation Lack of speed to market Lack of traceability accountability visibility

Figure 14. Matrix 5

The participants were split into pairs at random. Workshop 2 was conducted with each pair at different locations and times, for practical reasons, as discussed in the Methodology Chapter in Section 2.5.4. Choosing the themes of the scenarios involved presenting the 12 uncertainties written on Post-IT notes to the participants on a worksheet. Each pair was then asked to choose two uncertainties to place on the matrix, initially producing 4 scenarios for those two uncertainties chosen. This process was repeated again, with the participants choosing two more uncertainties to place on second matrix, producing an additional 4 scenarios. These 8 scenarios of 2030 were then fleshed out and participant's descriptions were written down in each quadrant (each quadrant on the matrix represented 1 scenario). This process should then have produced two matrices per pair, resulting in 6 matrices all together. However, two participant pairs choose the same two uncertainties to place on one matrix, the results of which were collated into one matrix instead of two separate ones. This resulted in a total of 5 matrices being produced with a total of 20 initial scenarios.

The participants were then guided to consult the range table produced in the previous workshop and no matter how extreme the scenarios seemed, the participants were not allowed to go higher or lower past the ranges they had already set as 'plausible'. This process of consulting the range table previously produced and describing each quadrant of the matrix was conducted for each initial scenario. Once each pair had produced the two matrices, all 8 scenarios were considered and two were chosen using the criteria of plausibility for further development.

Some of the pairs wanted to include some of the factors from other quadrants when 'fleshing out' the chosen two scenarios from the 8 generated. This was allowed, as each quadrant does not represent a complete scenario, more so, a snapshot of an extreme. The two scenarios that each pair selected were marked and then emailed to the other participants for comments.

In critique of the process used for this Workshop there are a number of factors that would have improved the results. Firstly conducting the workshop with all the participants in the room would have been ideal from a time saving point of view. However, this allowed for spending the whole workshop with 1 pair enabling explanation and engagement each pair which would not have been the case had the workshop been conducted with all the pairs present. Secondly not having to email participants for feedback of other pair's work would have been better in terms of data collection as some of the comments gave the impression of hastily produced and some participants took a longer time to reply. The delay in replying is due to busy schedules but this highlights a limitation of the process followed in this present research. Thirdly, for the first pair, the participants were not allowed to write down the descriptions of each initial scenario. It is difficult to facilitate the workshop and make concise notes of the participant's responses. This creates a sticking point in the flow of the workshop.

For the next two workshops, the participants were allowed to handle the writing of the descriptions; this ensured that concise, descriptions were written down. The participants were requested to ensure succinct responses. This allowed concentration on facilitating and explanation, rather than transcription.

If all the uncertainties were paired with each other (66 combinations) and each combination was to produce 4 scenarios (264) initial scenarios, it would take the participants a significant amount of time to work through each matrix. In the present research, each matrix required 40 minutes to work through. This would mean that if all 66 matrices were used, it would take 44 hours of workshops to complete. The participants select which uncertainties to pair to produce scenarios and then the checking of consistency allows the participants to choose those pairings with strong relationships creating plausible scenarios to be developed further.

3.5. **Stage 5. Workshop 3: Checking Consistency of Scenarios and developing Narratives**

From the matrices produced in Workshop 2, the participants were asked to choose (from any 1 of the 5 matrices) a theme for further development. The scenario planning process used in this present research requires the participants to check the internal consistency of the themes chosen to help guide the participants to not develop themes that have Uncertainties with ‘Weak’ or ‘Very Weak’ relationships. Checking the internal consistency is achieved by assessing each uncertainty and its relationship to other uncertainties. The range of values available to each pair were: VW (Very Weak), W (Weak), M (Medium), S (Strong), VS (Very Strong). Each pair worked through the matrix and discussed each uncertainty in relation to another one by one. The results of each pair’s matrix is presented as Appendix 1.

Workshop 3 involved checking the consistency of the 20 scenarios produced in the previous step. Each pair was assigned different scenarios than the ones they had chosen to be put forward as part of the last Workshop. This step allowed for other participants to comment and provide input on scenarios that they did not produce. This in turn alleviated the issue of conducting this Workshop in the same manner as Workshop 2 in pairs, in different locations at different times.

Each pair was assigned two scenarios matrices and the uncertainties that had been used to create them. Each pair completed one consistency grid. The mechanics of the grid were presented in Section 2.5.4.3 in the Methodology Chapter and the results of the grid are presented as Appendix 1. The purpose of the grid was to assess the strength of the relationship between two uncertainties used to produce each selected scenario. For example if the two uncertainties selected were deemed to have a ‘Very Weak’ relationship then the scenario that was produced from those two uncertainties was discarded by the participants during the workshop. This process eliminated a number of scenarios and the participants selected three scenarios to move forward with to the next stage. The three chosen scenarios were deemed to have ‘Very Strong or ‘Strong’ relationships in terms of the uncertainties used to create them.

In order to compare results of each pair’s consistency check grid, Figure 14 was produced. The first Scenario Matrix developed by Pair 1 compared the uncertainties ‘Level of Privatization of Services’ and ‘Health of the Population’. Pair 1 assessed the relationship of ‘Level of Privatization of Services’ and ‘Health of the Population’ as ‘Weak’ as did Pair 2. Pair 3 however, assessed the relationship of ‘Level of Privatization of Services’ and ‘Health of the Population’ as ‘Medium’. The second Scenario Matrix developed by Pair 1 compared the uncertainties ‘Low Level of Capital Budget to Adopt New Technologies’ and ‘Low Level of Quality Online Patient Records’. All three pairs assessed the strength of the relationship of ‘Low Level of Capital Budget to Adopt New Technologies’ and ‘Low Level of Quality Online Patient Records’ to be ‘Strong’.

Pair 2’s first Scenario Matrix compared the uncertainties ‘Level of Care Expected’ and ‘Level of Privatization of Healthcare Services’. Pair 1 assessed the relationship ‘Level of Care Expected’ and ‘Level of Privatization of Healthcare Services’ as ‘Very Strong’ and Pair 2 assessed it as ‘Medium. Pair 3 assessed the relationship of ‘Level of Care Expected’ and ‘Level of Privatization of Healthcare Services’ as ‘Strong’. The second Scenario Matrix developed by Pair 2 compared the uncertainties ‘Level of Capital Budget to Adopt New Technology and Health of the Population’ and ‘Low Level of Quality Online Patient Records’. Pair 1 and Pair 3 assessed the strength of the relationship of ‘Level of Capital Budget to Adopt New Technology and Health of the Population’ and ‘Low Level of Quality Online Patient Records’ to be ‘Very Strong’. Pair 2 assessed the strength of the relationship as ‘Weak’.

Pair 3’s Scenario Matrix compared the uncertainties ‘Level of Global Technology Regulations/Global Adoption of the Same Data Standards Across Healthcare’. Pair 1 assessed the relationship ‘Level of Global Technology Regulations/Global Adoption of the Same Data Standards Across Healthcare’ as ‘Strong’ and Pair 2 assessed it as ‘Medium. Pair 3 assessed the relationship of ‘Level of Care Expected’ and ‘Level of Privatization of Healthcare Services’ as ‘Strong’.

Uncertainty	Level of rationed healthcare	Level of ‘capital’ budget to adopt new technologies for NHS hospitals	Health of the population in terms of obesity, mental health, aging issues	Level of availability of Energy resources	Level of quality online Patient records	Level of privatization of healthcare services	Migration of people from different parts of the world	Level of global technology regulations	Level of care expected	Cyber attacks	Global adoption of the same data standards across healthcare	Fluctuations in technology regulation
Level of rationed healthcare	X	M	S	VW	W	S	M	W	M	VW	W	W
Level of ‘capital’ budget to adopt new technologies for NHS hospitals	X	X	M	W	S	M	W	M	W	W	M	M
Health of the population in terms of obesity, mental health, aging issues	X	X	X	W	M	W	M	VW	S	VW	M	W
Level of availability of Energy resources	X	X	X	X	VW	VW	VW	VW	W	VW	VW	VW
Level of quality online Patient records	X	X	X	X	X	M	W	M	S	M	S	M
Level of privatization of healthcare services	X	X	X	X	X	X	W	M	S	W	M	W

Migration of people from different parts of the world	X	X	X	X	X	X	X	M	S	VW	S	M
Level of global technology regulations	X	X	X	X	X	X	X	X	W	M	S	S
Level of care expected	X	X	X	X	X	X	X	X	X	VW	M	W
Cyber attacks	X	X	X	X	X	X	X	X	X	X	M	W
Global adoption of the same data standards across healthcare	X	X	X	X	X	X	X	X	X	X	X	S
Fluctuations in technology regulation	X	X	X	X	X	X	X	X	X	X	X	X

Figure 15. Consistency Check Grid

Once the general theme was selected (from 1 of 5 matrices) the individual quadrants were further analysed by the participants for plausibility. The selection of the quadrant and assessment of the plausibility was conducted in reflection of the strength of the relationship established between uncertainties in Workshop 3. Once each quadrant had been discussed in terms of plausibility, one quadrant was selected by each pair as a scenario for further development as Scenario Narratives. The scenarios emerged by the participants then using the range table produced in Stage 3 to go through each of the 12 main uncertainties and describe how that uncertainty may manifest in the quadrant (initial scenario) selected from the matrix. The descriptions were noted down in as much detail as possible in order to be presented in the mediums prefered by the participants as described below.

3.5.1. **Scenario Presentation Mediums**

During a scenario planning workshop as identified in Section 4.2 in the Literature Review Chapter, the scenarios are presented to the participants through a relevant medium for the participants. For example a TV advert from 2030 or an article from a future newspaper. During Workshop 3, each pair was asked how the scenarios should be presented. The following Table (24) presents each pair’s responses.

Pair	Mediums Suggested
Pair 1	- Video on touch screen phone - Online news channel via Google Glass type device (e-health insider) Video on a billboard
Pair 2	News flashes on big screen (like the film “Minority Report” New article on screen in flying car – E health bulletin?
Pair 3	Online news article Panorama report

Table 24. Scenario Presentation Mediums

The prevailing response was an online news bulletin. Previously, when considering which formats/mediums would be relevant and appropriate for this scenario planning exercise, the idea of using an “E-Health Insider” article emerged during a discussion in a face to face HUG meeting whilst the participants were commenting how often they read E-Health Insider. E-Health Insider is an online news channel where the speciality of reporting is the healthcare industry but in particular, technology related news. E-Health Insider is also a National Conference, which many healthcare professionals, especially those with a technical orientation often attend for developments, commentary and networking. From the participant’s responses, it was decided to go ahead with this format for the final presentation of scenarios as presented in Section 3.3 of this Chapter. The participants felt that this type of medium would not only resonate well with those involved in this present research but other people in the wider healthcare community, particularly those with a technology orientation. The Scenarios were prepared to be presented to the participant group in the format of a “E-health insider article” as a PDF file.

3.6. **Stage 6. Workshop 4: Developing Narratives**

Workshop 4 involved developing the narratives of each of the 3 selected scenarios. Again, each pair was given a different scenario to the ones worked on in previous workshops to ensure all the participants contributed to each of the final scenarios produced. The final scenarios were now considered in light of all the uncertainties. This was achieved by each pair working through the tables, as presented in the following sections. These tables involved the participants describing what point from the range table produced in Workshop 1 each uncertainty would occupy.

During the first workshop, it was ensured that the participants were provided the resources they needed in order to work through the table. However it was difficult to write down the participant's descriptions as well as facilitate the workshop. This was rectified in subsequent workshops by allowing the participants to write a concise entry to the table after a few minutes of discussing each uncertainty amongst themselves, during which time field notes were made. After each workshop, these notes were consulted in order to flesh out the participant's entries.

The first table presented for each pair is the final, refined description of what was discussed for each quadrant. The range table (Table 23) presented in section 2.4 of this Chapter was used as a reminder of plausible ranges for each uncertainty and then the participants discussed what the uncertainties would "look" like under the quadrant selected. The second table for each pair contains a more descriptive account of the points discussed for each uncertainty. The second table is where the scenarios are built and 'fleshed out' by the participants. The results of each pair's workshops are presented in the following sub-sections.

3.6.1. **Pair 1**

The quadrant selected by Pair 1 is as follows: Low Level of Capital Budget to adapt new Technologies/ Low Level of quality Online Patient records.

Num	Uncertainty	Further Explanation and Details by Participants
1	Level of rationed healthcare	Capability of centralised decision making not local
2	Level of 'capital' budget to adopt new technologies for NHS hospitals	Industry/Government shared projects. Greater sharing and availability of evidence = greater investment.
3	Health of the population in terms of obesity, mental health, aging issues	More preventative measures in place
4	Level of availability of Energy resources	Sell back of Energy and increased alternative resources available and utilised.
5	Level of quality online Patient records	Good transparency between regions and Trusts. Highly easy to enter highly accurate data

6	Level of privatization of healthcare services	Increased privatisation, less barriers
7	Migration of people from different parts of the world	Decreased migration, greater tractability.
8	Level of global technology regulations	Hand in Hand development of data standards, increased collaboration
9	Level of care expected	Only ever increases, global expectancy increases
10	Cyber attacks	Greater security and accountability with tiered levels dependant on need of organisations involved.
11	Global adoption of the same data standards across healthcare	Significant global adoption driven by legislation
12	Fluctuations in technology regulation	As the global platform increases, fluctuation decreases.

Table 25. Refined Description of Pair 1's Selected Quadrant.

Num	Uncertainty	Further Explanation and Details by Participants
6	Level of privatization of healthcare services	More services which are public/private partnerships Many services still on the NHS but provided by private institutions as outsourcing continues to grow.
1	Level of rationed healthcare	Rationed healthcare for some Higher income = high level of healthcare Government not popular Since the 2026 healthcare reform the rationing system has been a controversial policy adopted by the government. The rationing system, where each person is given a 'healthcare budget' each year and the cost of further treatments must be covered by additional mandatory insurance. Those on higher incomes still enjoy excellent healthcare services provided by the private sector, an increasingly popular option for many higher earners partly due to the NHS still not having a nation wide summary care record service.
3	Health of the population in terms of obesity, mental health, aging issues	Overall health in decline as people are not getting the care they want Total healthcare package – communities suffer 'steady western decline'
9	Level of care expected	Far more that what can be afforded, patients always wants more Breakthrough research and development continues to be supported by private companies, universities and research institutes but is increasingly being sourced from abroad. Healthcare service levels around the world have increased, especially in China, India and Brazil. There is increasingly rising pressure on the government to deliver better healthcare services now that rationing and the mandatory insurance system has been imposed.
7	Migration of people from different parts of the world	Not enforced healthcare tourism Healthcare tourism has been increasing over the last 20 years with the government being criticised for poor information management in regards to those who may only visit England for healthcare treatment. A DoH statement released last week read, "the current landscape with disparate IT systems with incomplete and often poor quality data is the priority. A new information system to deal with health tourism would take a considerable portion of public spending and collaboration with a number of departments which is feasible in the new healthcare model". Those at the DoH then, as well as the NHS staff delivering care to patients it seems are just trying to fight fires.

4	Level of availability of Energy resources	Energy prices continue to escalate – Not related
2	Level of 'capital' budget to adopt new technologies for NHS hospitals	Low capital budget for new technologies Increased private use for those who can pay Centralised attempts for nationwide technology adoption have been decreasing over the last decade with the DoH acting as advisory, supporting bodies, rather than driving mandatory implementation.
10	Cyber attacks	As is Cyber attackers have largely avoided healthcare systems to date.
5	Level of quality online Patient records	Lack of quality online patient records Localised systems continue to hold records with limited national sharing. Data quality issues and missing data are accredited for decreasing confidence in the NHS. Many patients from middle and higher income families are opting for private healthcare schemes.
8	Level of global technology regulations	As is
11	Global adoption of the same data standards across healthcare	No need for it, is it required? A long time in the future. Achievable within a country but not globally ever!
12	Fluctuations in technology regulation	N/A

Table 26. Full Description of Pair 1's selected quadrant.

3.6.2. **Pair 2**

The quadrant selected by this pair had the following conditions: High level of Global Technology regulations/ High level of Data Standards across Healthcare.

Num	Uncertainty	Further Explanation and Details by Participants
1	Level of rationed healthcare	Rationed healthcare for some Higher income = high level of healthcare Government not popular
2	Level of 'capital' budget to adopt new technologies for NHS hospitals	Low capital budget for new technologies Increased usage private use for those who can pay
3	Health of the population in terms of obesity, mental health, aging issues	Overall health in decline as people are not getting the care they want Total healthcare package – communities suffer 'steady western decline'
4	Level of availability of Energy resources	Energy prices continue to escalate – Not related
5	Level of quality online Patient records	Lack of quality online patient records

6	Level of privatization of healthcare services	More services which are public/private partnerships
7	Migration of people from different parts of the world	Not enforced healthcare tourism
8	Level of global technology regulations	As is
9	Level of care expected	Far more that what can be afforded, patients always wants more
10	Cyber attacks	As is
11	Global adoption of the same data standards across healthcare	No need for it, is it required? A long time in the future. Achievable within a country but not globally ever!
12	Fluctuations in technology regulation	N/A

Table 27. Refined Description of Pair 2's selected quadrant.

Num	Uncertainty	Further Explanation and Details by Participants
1	Level of rationed healthcare	Capability of centralised decision making not local
6	Level of privatization of healthcare services	Increased privatisation, less barriers
3	Health of the population in terms of obesity, mental health, aging issues	More preventative measures in place
9	Level of care expected	Only ever increases, global expectancy increases
7	Migration of people from different parts of the world	Decreased migration, greater traceability.
4	Level of availability of Energy resources	Sell back of Energy and increased alternative resources available and utilised.
2	Level of 'capital' budget to adopt new technologies for NHS hospitals	Industry/Government shared projects. Greater sharing and availability of evidence = greater investment.
10	Cyber attacks	Greater security and accountability with tiered levels dependant on need of organisations involved.
5	Level of quality online Patient records	Good transparency between regions and Trusts. Highly easy to enter highly accurate data
8	Level of global technology regulations	Hand in Hand development of data standards, increased collaboration
11	Global adoption of the same data standards across healthcare	Significant global adoption driven by legislation
12	Fluctuations in technology regulation	As the global platform increases, fluctuation decreases.

Table 28. Full Description of Pair 2's selected quadrant.

3.6.3. **Pair 3**

This workshop was where process improvements were made by asking the participants to refine the answer to each uncertainty themselves resulting in a fuller, refined table negating the need to produce two tables. The quadrant selected by this pair had the following conditions: High Level of capital budget to adopt new technologies/low health of the population.

Num	Uncertainty	Further Explanation and Details by Participants
1	Level of rationed healthcare	Lifestyle choices rationing Well being-educational programs Further class divides in terms of health standards Incentivized healthcare/active lifestyle programed Taxes on processed food
2	Level of 'capital' budget to adopt new technologies for NHS hospitals	Technology driven health assessment Interactive care of aging population Monitoring of health Technology driven screening
3	Health of the population in terms of obesity, mental health, aging issues	General health of the nation continues to decline as it 'is all too little to late'
4	Level of availability of Energy resources	N/A
5	Level of quality online Patient records	Accurate, standardised, shared responsibility, patient grants access
6	Level of privatization of healthcare services	The NHS may not be here in 15 years time. Cross party support for NHS being disbanded
7	Migration of people from different parts of the world	Still be migration
8	Level of global technology regulations	As is
9	Level of care expected	Lifestyle changes required as aging population expects higher level of care and have been developing more and more chronic/life threatening conditions
10	Cyber attacks	As is
11	Global adoption of the same data standards across healthcare	Standardised way of capturing/sharing information
12	Fluctuations in technology regulation	Fluctuations are more harmonised but still some small and larger mavericks

Table 29. Full Description of Pair 3's selected quadrant.

3.7. **Stage 6. Present Scenarios**

The three final scenarios produced; encompassed a wide range of uncertainties through a systematic process including an interview, 4 workshops and a final presentation. The three scenarios took different forms. The first, a scenario where data quality issues persist, IT adoption is still left to local decision makers, the general health of the population is in decline and the government is being criticised for the increased rationing/privatisation of healthcare services. The second, a scenario where healthcare records quality deemed “excellent” and “shareable”, the DoH drives local and national technology partnerships, health assessment and screening programmes excel, and the general health of the population is stabilising. Finally in the third Scenario, health assessment and screening programmes are successfully implemented but due to late implementation of healthcare screening, the health of the population is in decline.

Once the tables from Workshop 4 had been completed, production of the final scenarios began. The following sub-sections present the scenarios in the format they were presented to the participants.

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3.8. **Stage 7. Technology Roadmapping**

The development of how to integrate technology roadmapping into the scenario planning exercise is presented in Chapter 3. The following sections present the data and analysis of the technology roadmapping phase.

The Technology Roadmapping exercise was conducted via individual interviews with the participants. The final three scenarios produced in the final stage were presented to the participants via a PDF file that was sent before the interview time to give the participants time to read and digest the scenario summaries. The technology roadmapping framework developed in Chapter 3 was used as the structure for the interview with each level of the framework (presented on the left of the table below) guiding each question. The populated frameworks from each interviewee are presented in Appendix 3. The results of each technology roadmapping interview were collated onto one framework as presented below.

	Year 1	Year 3	Year 10	Vision
External			Scenarios	Scenarios
Internal Business Strategy	DoH / NHS England gains mandating rights and takes the lead Working with large, successful customer information organisations (i.e. IBM) Define what the NHS is actually responsible for? I.e. public health, physiotherapy. Satellite public health issues. Policy level change	Health Assessment and Screening programs to be a priority for the NHS agenda Qualified persons making decisions Planning for the healthcare system over a longer term than the current election cycle	Rationing/Sharing a budget for each person of healthcare costs Centralisation enabled on decisions of all aspects of the healthcare system. Local requests can be assessed by DoH	A singular decision making process Mandated IT standards by DoH
Products/Services/Systems	Relevant stakeholders informed of centralized system change. Roadmaps produced to bring clarity for the path to Centralisation	Pre-emptive screening for major diseases Delicate balance in Broad brush/highly targeted screening Central Systems available with multiple interfaces depending on type of person/organisations using the system Centrally developed database for identification of products and shared standards between proprietary systems	Pre-emptive screening for major diseases Centrally governed systems. Migration systems for paper Policy level change implemented by systems Working with stakeholders on technology and information standards	Getting away from any paper processing Product identification/ information management systems shared by the healthcare industry
Technology		Home monitoring Further papers for stakeholders of specifics of technology. Central Systems available with multiple interfaces depending on type of person/organisations using	Home monitoring	- Home monitoring - Visibility to the general public of episodes of care i.e. audit tools Technology products and systems guided by the (reactive development of

		the system		systems)
Resources	Subject matter expertise, not clinical leads dealing with other aspects such as information standards Technology capability assessment projects Applied product development research	Industry led tech project but with health service collaboration Contracts with multi purpose interface system providers. Working level staff involved with the design of the system. Decision making staff decide which staff members require access to which interface.	Industry led tech but with health service collaboration	Industry led tech but with health service collaboration Working with similar stakeholders to today but with more use groups

Figure 19. Technology Roadmap Combined Framework.

Throughout the interviews, the participants were asked also to consider flex points where specific events or a lack of an event would lead to one of the three scenarios being realised. The responses are collated in Table 30 below.

Flex Points	Time Frame	Leading to Scenario Number
If centralised funding does not occur	0-5	Scenario 1
If health screening programs are not implemented	0-10	Scenario 1
The provision of Central funding for IT projects	0-5	Scenario 2
If health screening programs are implemented too late	10-50	Scenario 3
If decision makers are not adequate for the job	0-5	Scenario 1

Table 30. Flex points

The analysis of the technology roadmapping phase has been organised into 4 strands: internal business strategy, products/services/systems, technology, resources. The first four strands follow the levels of the technology roadmap encompassing excerpts from the interviews to illuminate key issues and themes. A critique of the process used to develop the technology roadmaps is presented in the Discussion Chapter.

Internal business strategy over the short term had synergies with what was identified as an inhibitor to technology adoption, namely in the DoH /NHS England gaining mandating rights to centrally fund technology projects. Participant 1 and 2 observed:

> '…*the DoH / NHS England needs to gains mandating rights and takes the lead on pushing new technology in the NHS*' (Participant 1).

Participant 1 agrees with Participant 2 in that within the short term, the DoH needs to gain more power to mandate and centrally fund technology projects:

> '…*We could do with a policy level change policy level change towards central funding and mandation from the DoH if we really want to push RFID'* (Participant 2).

For the mid-term (3-10 years), the technology roadmap indicates a call for qualified persons in decision-making positions. This resonates with the data from the interviews where one of the reasons for a lack of adoption was deemed to be a lack of champions to drive technology adoption. Health screening programs to be developed and implemented and planning activities to reach beyond the current cycles. Health screening programs were an integral part of the scenarios developed. What these health screening programmes involved was not discussed at great length during the scenario development process or technology roadmapping process.

Over the longer term (10 years – Vision) the technology roadmap produced indicated a call for singular decision making processes and mandated IT standards by the DoH. The notions of central standardisation have been presiding themes throughout this research.

For products, systems and services, in the short term, the technology roadmap indicates that initially relevant stakeholders should be informed of centralised system change and that Roadmaps (not necessarily technology roadmaps) need to be produced to bring clarity for the path to Centralisation. Indeed if there was a shift from local decision making and isolated pilot studies, as the case at the moment, to a centralised decision making and funding programme, a roadmap would have to be shared as to how this process would develop. Again the roadmap highlights one of the central themes of this research of a central budget being made available for mandated technology adoption.

Over the mid-term, pre-emptive screening programmes, centralised IT systems and centralised product databases are the key aspects the technology roadmap indicates. All of these aspects were key 2nd order themes in the interview stages at the beginning of this present research. It is now, due to the application to and the context of, the technology roadmapping that these themes are fleshed out and a plan can be developed as to how these aspects can be achieved, from the ‘vision’ to short term planning.

For technology, the factor of the ageing population was identified in the scenario planning stage and although not ranked within the top 12 uncertainties, becomes a factor here on the technology roadmap when the long term vision of what technologies would be needed by 2030. Home monitoring and Tele-health are the key technologies the technology roadmap indicates. Home monitoring and Tele-health were integral parts of Scenario 1 and 3 also but in the context of shifting expectations of how technology is used in society at large as opposed to a step to tackle to the issue of the ageing population. Whether it is the ageing population or the shifting expectations of society, tele-healthcare and home monitoring are technologies the roadmap and the scenario planning exercise revealed as an integral part of healthcare in 2030.

When surveying the ‘resources’ indicated by the technology roadmapping exercise, it is clear that industry led technology projects, with health service collaboration, covers the short term, mid-term and long term timeframes. The wording specifically used was “industry led”. This would indicate that the research and development should be carried out by industry but working closely with the NHS for guidance on standards and irradiating previous implementation issues such as not working with all levels of staff effected by new technology.

The flex points identified by the roadmapping stage can be centred around the issue of central funding for IT projects (RFID is included in IT). Central funding provision or the lack there of has been identified as a key point of divergence back to one of the scenarios.

Chapter 6. Discussion

1. Introduction

This Chapter discusses the findings presented in Chapter 5. The chapter is organised by each section relating to the Research Questions posed in this thesis. Research Questions 1 & 2 aimed to identify the drivers and inhibitors of RFID in the English NHS. The third Research Question aimed to ascertain plausible futures of RFID adoption in the English NHS of 2030. This third Research Question required a new technology foresight model to be developed, a discussion of which is presented in this Chapter. In accordance with the Action Research strategy of enquiry, a reflexive discussion is also presented.

2. Drivers and Inhibitors

This section presents the discussion of drivers and inhibitors identified by this study, and compares and contrasts the findings with the relevant literature identified in Chapter 2. New insights to Drivers and Inhibitors to RFID adoption in healthcare identified by this study are then presented. Identifying the drivers and inhibitors to RFID adoption in the English NHS pertain to Research Questions 1 & 2 of this thesis.

The key drivers of RFID adoption identified by this study are successful pilot studies, technical improvements and reducing cost in RFID technology, the constant need to improve the NHS and the changing nature of care required. Yao et al. (2012) identify the cost of RFID technology as a major barrier to adoption. The costs include hardware/software, training, and infrastructure maintenance. In contrast to findings from this current research, ‘cost’ was not used in context of the cost of technology but in areas where the participants of the study perceived the cost of not adopting RFID technology. For example, inventory management for high value items (Interviewee 6). The technical improvements in RFID technology have been key to its success in pilot studies. There are more and more pilot studies emerging that are showing signs of, or have shown to be a success as shown in Section 3 of the Literature Review Chapter. Through this previously gained experience and performance improvements of the technology, there is momentum behind the adoption of RFID technologies in the English NHS. The success of pilot studies of RFID adoption in the English NHS gives other adopting organisations indications of the potential benefits (Interviewee 7). In this context, Lee and Shim (2007) are in alignment with this present research. Lee and Shim (2007) called on researchers to embark on qualitative studies to better understand the wide-ranging influences on RFID adoption. This present research meets this call by contributing to the identification of drivers and inhibitors to RFID adoption in the English NHS and then gaining an understanding of the wider context through deployment of the conceptual model. Another driver is that the DoH has committed to one standards provider (Interviewee 6, Literature Review Chapter, Section 3). A commitment to one standards provider does exist, but there is uncertainty around the future of the contract but due to this commitment, manufacturers can now begin to coordinate their efforts (Interviewee 7).

The need for leaner stock management and reducing cost was seen as a direct driver for RFID adoption (Interviewee 5 and Interviewee 6), also put forward by Yazici (2014). Unclear returns on investment was another barrier identified by Yao et al. (2012). In the context of this study, unclear returns on investment are diminishing with the ever-increasing number of pilot projects. However, as identified in the literature review in Chapter 1, isolated pilot projects do not take full advantage of the widespread adoption benefits of shared information systems and data transparency. The nature of care required by the population is changing (Interviewee 1 and Interviewee 3). The ageing population presents its own opportunities for RFID. The instant gratification culture (Interviewee 5) will eventually seep into healthcare requirements especially in the areas of tele-health. Tele-health is an area where RFID technology can have an impact in providing systems to be used in the homes of patients.

The four main inhibitors to RFID adoption were a lack of central investment, communication, reactive culture and legislation standards, and regulation. Without central funding, it is difficult for NHS Trusts to invest in new technologies in the current economic and political climate. However, not only is central funding required, but increased levels of support and guidance should also be made available as also advocated by Lai et al. (2014). A number of issues were highlighted under the inhibitor of communication. A discussion of these issues will help define the inhibitor of communication within this study. These were: not creating clear comparisons with other industries where RFID is widespread and not communicating the use of RFID in other industries, which was also intertwined with a lack of communication that RFID is not actually that complex to implement, as significant recent technical improvements have been made to the technology itself. Communication was identified as an inhibitor in the context of not making clear comparisons with other industries where RFID technology is widespread, not clarifying the patient confidentiality issues, not ensuring the actual complexity of implementing RFID is well understood by all stake holders (Yazici, 2014) and not communicating successful pilot projects. The nature of this inhibitor should be however considered in the confined, contextual setting of this study in the English NHS.

The limitations of RFID technology itself have been inhibitors of RFID adoption in the past. The definition here in the context of this study is not the limitations or capability of the technology, but if it can be implemented with existing systems. Yao et al. (2012) identify interference and ineffectiveness as a barrier as did Ting et al. (2011a). Since then, there have been technical improvements in RFID technology for healthcare settings, and this study indicates that the issue has moved on from 'interference and ineffectiveness' of the technology itself to 'interoperability' (Carr et al., 2010) (interaction with existing systems) of the RFID technology available. This study reveals that manufacturers of the technology are beginning to work closely with the NHS in order to deal with interoperability. This study also indicated there might be over-sensitivity to patient confidentiality issues. Rosenbaum (2014) concluded that privacy of patient data is the most important obstacle in allowing the healthcare industry to take advantage of the numerous benefits RFID technology affords in support of the work conducted by Lai et al. (2014). Here it is revealed that patient confidentiality issues are a concern but should not be the most important obstacle. As wireless security systems constantly improve, this did not seem to be of major concern to the

HUG members. Another issue under the overall theme of communication was not having enough visibility of successful pilot projects. Developing a clear understanding of the capabilities of RFID, advocating recent successes of pilot studies to decision makers, the successes of interoperability and finally developing clear understandings of the actual patient confidentially issues are steps that could be taken to address the inhibitor of communication.

A reactive culture is defined as a potential imbalance between workforce, technology and business strategies with consequences on patient health and care due to a healthcare organisation taking a three year short term view of their operational futures (Astley, 2009). The inhibitor of a reactive culture and fire fighting is a reflection of the NHS Trust's core business of saving people's lives and not new IT system adoption. This study revealed innovative teams or champions not being a priority for NHS trusts (interviewee 4). Also revealed is that there is an institutional refusal to change and adopt new technologies trusts (interviewee 5, Literature Review Chapter, Section 3. However, although institutional reluctance to change is a factor, practical reasons for not being able to adopt new technologies also exist such as; ageing underlying physical infrastructure in NHS sites. Practical reasons for not being able to implement IT are synergistic with the aspect of the reactive culture theme. Closely related is the fire fighting culture; the inability to plan over the long term due to short term contracts. There is also uncertainty in the area of what information, especially detailed information, will be required for regional "master databases" and in the area of differing regulation and information standards emerging in different countries.

Standardisation was a barrier present in the findings of this study in line with those from other studies. This inhibitor was also identified by Yao et al. (2012 p. 3520) with "lack of industrial standards on RFID data structure, air-interface, and local interface is a major obstacle for the deployment of RFID systems in hospital and currently there is no consistent or common standard for [the] healthcare industry". This inhibitor was also identified by Ting et al. (2011a) as well as by Rosenbaum (2014). In the setting of this study, standardisation has been identified as both a driver and an inhibitor. Adoption of RFID technology has been driven in England by The DoH committing to GS1 standards for RFID technology. However, even with this commitment from the DoH, there is still uncertainty around the future of the contract itself. This is identified as a key driver of RFID adoption due to a unified standards approach allowing for data and information exchange across multiple systems throughout the country. There are still issues of regional “master databases”. In the example of Europe, there is legislation but it is not adequately detailed enough (Interviewee 2). There is also the issue of independence of countries when it comes to selecting a coding standard for healthcare. Although the DoH and NHS England have made steps to deal with the issues of standardization, with commitment to GS1 and support for Trusts who adopt RFID technology using GS1 systems, there is still uncertainty on a global level and unified standards across the healthcare industry are still unlikely.

The barriers identified by (Yao et al., 2012) of ‘interference and ineffectiveness’ have now developed into ‘interoperability’ and the barrier of the cost of the hardware/software, training and infrastructure, to have turned into the discussions of cost of not adopting RFID in the areas of patient safety and tracking of high value items in hospitals. Although the DoH and NHS England have made steps to deal with the issues of standardization with commitment to GS1 (Interviewee 6), unified standards across the healthcare industry is unlikely. There are different barriers identified by Yao et al. (2012) and this present research. The barriers identified by Yao et al. (2012) that are not present in this research are; interference, ineffectiveness and privacy/legal issues. The inhibitors identified by this research which were not identified by Yao et al (2012) are ‘communication’ and ‘reactive culture’. The highly contextual nature of this study of RFID adoption in the English NHS, being a nationalised system, could be the reason that these inhibitors have been identified by this research and not by the work conducted by Yao et al. (2012) in a private hospital in the USA.

2.1. New insights to Drivers and Inhibitors to RFID adoption in healthcare

In contrast to previous studies Yao et al. (2012) findings from this current research indicate 'cost' was not used in context of the cost of technology but in areas where the participants of the study perceived the cost of not adopting RFID technology. For example, inventory management for high value items (Interviewee 6).

The technical limitations of RFID technology itself have been inhibitors of RFID adoption in the past, in particular, Yao et al. (2012) identify interference and ineffectiveness as a barrier as did Ting et al. (2011a). The definition here in the context of this study is if it can be implemented with existing systems. This study reveals that the issue has moved on from 'interference and ineffectiveness' of the technology itself to 'interoperability' (Carr et al., 2010) (interaction with existing systems) of the RFID technology available.

In the setting of this study, standardisation has been identified as both a driver and an inhibitor. Adoption of RFID technology has been driven in England by The DoH committing to GS1 standards for RFID technology. However, even with this commitment from the DoH, there is still uncertainty around the future of the contract itself. This particular example gives insight into how interdependent the drivers and inhibitors are. The relationships and interdependencies present between the drivers and inhibitors are discussed in the following sections.

2.2. External and internal drivers and inhibitors

There are a number of key relationships between the identified drivers and inhibitors. 'Successful pilot studies' and 'Communication' represent a relationship that the NHS and the HUG can influence. The wider communication of pilot studies outside of the RFID community in the NHS does not currently take place. The relationship between the 'Lack of Central Investment' and 'Technical improvements and Reducing Cost in RFID Technology' gives a clear indication towards RFID systems becoming cheaper and more reliable but NHS sites, especially older estates, do not have the supportive infrastructure required. Central investment is not necessarily required for the RFID systems themselves but the surrounding infrastructure in NHS buildings, the changing nature of care i.e. ageing population, increase in demands of homecare, and the rise of e-health applications could lead to the NHS having to be increasingly adaptive to deal with these healthcare needs. This relationship sits in the Socio-Economic sphere of the PEST structure. When considering the identified drivers and inhibitors through the lens of external and internal forces, three out of four inhibitors can be internally influenced by the NHS.

The drivers and inhibitors identified by this study were also considered through the view of external and internal. Internal being drivers or inhibitors which the NHS can influence. Table 19 showed that three of the four inhibitors identified were internal to the NHS. This suggests that the majority of the factors identified by this present research which are holding back RFID adoption in the NHS can be influenced by the NHS. One identified inhibitor, ‘Legislation, Standards and Regulation’, is an external force.

Internal drivers identified were the ‘Constant need to improve the NHS’ and ‘Successful Pilot Studies’. However, the constant need to improve the NHS has also external elements. This also highlights the complexity of the setting, as reflected in Section 5.2 of this Chapter. Table 19 showed three out of the four drivers identified by this present research are external to the NHS: ‘Technical improvements and reducing cost in RFID technology’, ‘Constant need to improve the NHS’ and ‘Changing nature of care required’. Analysing the drivers and inhibitors through the lens of internal and external forces identifies what the NHS can influence internally in the adoption of RFID technology. These findings of which factors the NHS can influence in order to enable widespread RFID adoption gives useful insights to decision makers in the NHS. These insights could take the form an aide to help decide where to allocate efforts (factors that the NHS can influence) to enable widespread RFID adoption.

2.3. **Interrelationships between drivers and inhibitors**

There are various factors with complex interdependencies driving or inhibiting the adoption of RFID technologies in the English NHS. These factors can be best shown as a causal loop diagram presented as Figure 20. Figure 20 shows the effect an increase or decrease the drivers or inhibitors have on each other as they are today, at the current level of adoption. This can be further explained by describing the individual relationships Figure 20 shows between drivers and inhibitors. For example, the relationship between successful pilot studies and the effective communication of their results/issues/successes was initially explored in section 2.3.1 of Chapter 5. With increased communication of the results of existing pilot studies to decision makers, the evidence base to conduct a pilot would also increase. This relationship is shown in Figure 20 below. Another depiction on the causal loop diagram is the relationship between a lack of central investment and technical improvements and reducing costs of RFID technology, as further explored in section 2.3.2 in Chapter 5. Central investment is here defined as ring fenced funding from the government to aid in the adoption of RFID technologies in areas where the technology has proven positive results. Central investment is also a key inhibitor identified by this present research. Central investment in providing membership fees to GS1 standards for any NHS Trust wishing to adopt RFID technology has positive effects on increasing the number of pilot studies. Central investment does occur indirectly in other areas of the NHS as part of the constant need to improve the NHS as shown by Figure 20 below. The relationship between the changing nature of care required and the NHS's reactive culture was introduced in Section 2.3.3 of Chapter 5. The changing nature of care required can have a positive effect on the NHS's reactive culture with gaining the understanding that the efforts of public health forecasting can provide.

Key to the interrelationships between the drivers and inhibitors is the factor of successful pilot studies, as shown in Figure 20. The meaning behind the factor of successful pilot studies is the number of pilot studies deemed as showing positive results. The current drivers of RFID adoption in the English NHS are the constant need to improve the NHS, improvements/cost reduction of RFID technology and the changing nature of care required. These drivers contribute to the formation of increased RFID pilot studies as shown by Figure 20. However, pilot studies and subsequently the widespread adoption of RFID technologies in the English NHS is negatively impacted upon by the inhibitors of legislation, standardisation and regulation as well as the lack of central funding and communication issues. Figure 20 gives us three key insights. Firstly the insight that pilot studies are central to the success of widespread RFID adoption in the English NHS. Secondly the insight that if there is an increase in the drivers of RFID adoption in the English NHS, pilot studies will also increase in numbers. However if the effect of the inhibitors increases, pilot studies will remain at the current level of adoption. The third insight is that the drivers and inhibitors to RFID adoption in the English NHS are deeply interrelated and present in a highly complex setting.

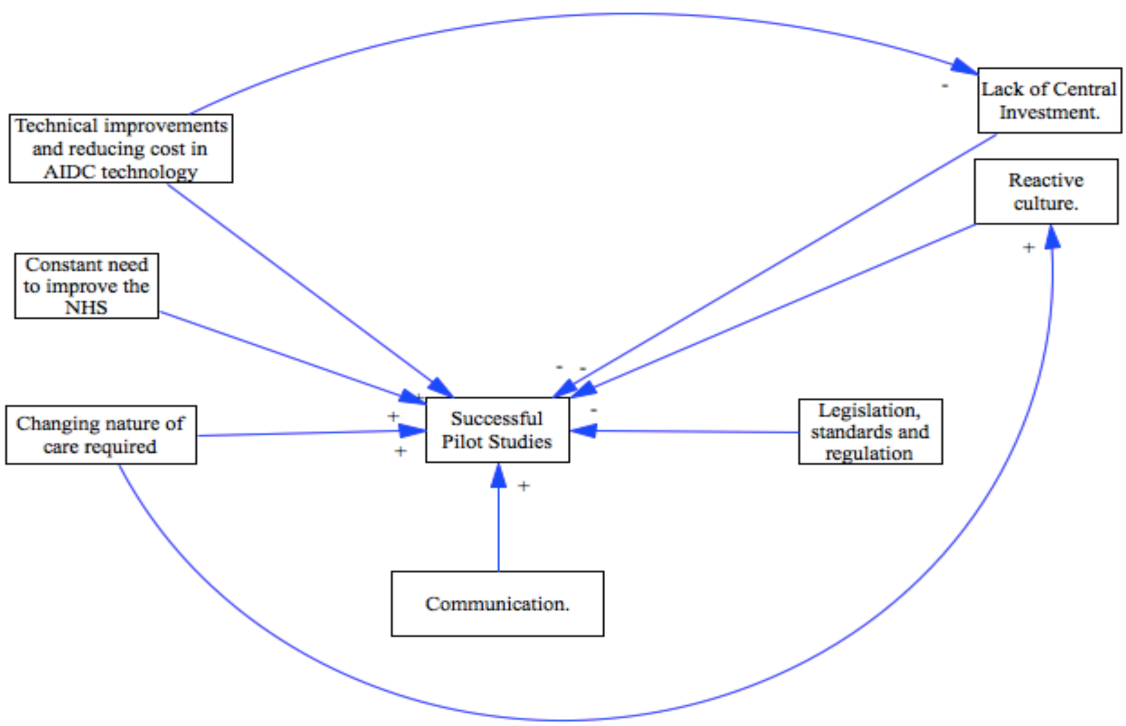

Figure 20. Causal Loop Diagram of interrelationships between drivers and inhibitors.

3. Conceptual Model

The conceptual model developed in Chapter 3 of this present research, aimed to integrate two foresight methods in order to:

- Provide the HUG members with foresight that helped them plan their activities over a longer period of time
- Give an insight into potential future states of RFID adoption in the NHS.
- Develop a foresight method that addressed the weaknesses of Scenario Planning and Technology Roadmapping whilst capitalising on their respective inherent strengths.
- To improve the practice of technology foresight by developing a technique, which provides, not only multiple plausible futures, but also flexible roadmaps with flex points leading to the scenarios as key events/indictors develop over time.

The findings of developing and deploying the conceptual model are discussed in the following sections.

3.1. The conceptual model's placement in technology foresight

The challenges faced by technology foresight can be summarised in calls for practitioners to present empirical impacts of techniques deployed and calls to researchers to develop the field conceptually/methodologically. This summary stems from a number of works which had the aim of categorising, organising and arranging foresight methods as presented and reviewed in Section 4 of the Literature Review Chapter (Costanzo, 2004; Cuhls, 2003; DenHond and Groenewegen, 1996; Rohrbeck and Gemünden, 2011; Salo and Cuhls, 2003). The model developed in this present research addresses the call for methodological and conceptual advances by attending to some of the weaknesses in two of foresight's widely used methods (Rohrbeck and Gemünden, 2011; Salo and Cuhls, 2003). The contribution to knowledge in the field of technology foresight is the development of a conceptual model that attends to the weaknesses technology roadmapping through a novel combination with the strategic foresight tool of scenario planning. Scenario planning is also indicated to be a technology foresight tool in various categorizations of technology foresight activities. Through the novel combination, the key weaknesses of scenario planning are also addressed. The following sections discuss the two methods and their placement in various categorizations of technology foresight activities.

Saritas and Aylen (2010) organized foresight methods into groups of: understanding, synthesis and models, analysis and selection, transformation and actions. In consideration of Saritas and Aylen (2010) categorization of foresight methods, the conceptual model developed and deployed in this present research spans all five categories which is very rare for one model on its own. The conceptual model develops understanding by; conducting interviews, analysis of macro environments through PEST analysis, selection through employing an internal consistency-checking step. The conceptual model then synthesizes by creating scenario narratives and provides a platform for transformation through developing a roadmap integrated with flex points. Magruk (2011) developed a classification of technology foresight techniques with 10 classes based on a cluster analysis: consultative, creative, prescriptive, multi-criteria, radar simulation, diagnostic, analytical, survey, strategic. The model developed in this present research falls into the ‘strategic ’class. Magruk (2011 p.70) presented a view of the ‘strategic’ class as encompassing “evidence-based cognitive, insightful methods relating to the future of the object being analyzed”, which in the context of the model developed in this present research, is the future of RFID technology in the English NHS. Georghiou (2008 p.72) presents a ‘Foresight Diamond’ where the four tips of the diamond, not intended to be independent, present four categories of technology foresight techniques defined as ‘expertise’, ‘creativity’, ‘evidence’ and ‘interaction’. The conceptual model developed and deployed in this present research spans these two areas of ‘expertise’ and ‘creativity’. Georghiou (2008 p.80) called for combined models that encompass various sources of knowledge. The model developed and deployed in this present research, by virtue of combining models from two different areas of the 'Foresight Diamond' has contributed to the growing field in answering this call. Porter et al. (2004) present technology foresight as encompassing a broad menu of methods, often involving a blend of quantitative and qualitative approaches, in order to compensate for the weaknesses in any one approach. Placing the conceptual combination of scenario planning and technology roadmapping into perspective within the broader menu of TFA methods available, Porter et al. (2004) describe scenario planning as belonging to "Scenarios" and technology roadmapping as belonging to "Descriptive and matrices" respectively out of 13 'families'. The conceptual foresight model developed and deployed by this research spans all five of Saritas and Aylen (2010) groupings of foresight techniques, two of areas within Georghiou (2008) foresight diamond and brings together two out of 13 families as described by Porter et al. (2004). The conceptual foresight model has met the call to develop and deploy combined models encompassing multiple techniques.

This present research deployed a conceptual model producing three internally consistent scenarios and roadmaps, including flex points. The following section discusses if and how the model developed and subsequently deployed, addresses the weaknesses inherent in each foresight method, if deployed as separate exercises. There are a number of weaknesses of scenario planning (O'Brien, 2004a; Saritas and Aylen, 2010; Tapinos, 2012; Varum and Melo, 2010; Wright et al., 2013a) and technology roadmapping (Phaal et al., 2004a; Saritas and Aylen, 2010) summarised below:

Scenario Planning - Key Weaknesses:

- Is frequently used to describe one or a set of future circumstance(s). Do not necessarily give a pathway into the future. Therefore may not fulfil the expectations of Foresight, which is an action-oriented activity
- Takes longer to grasp particularly when presented in textual format
- Is more open ended and may lead to multiple interpretations

- Facilitators need to have awareness of potential pitfalls of the scenario development process
- Has little evidence to suggest improved decision making, to inform strategy development.

Technology Roadmapping - Key Weaknesses

- Normative — more target oriented, therefore, focuses on the desirable future
- More difficult to communicate with non-participants of the process as results too technical
- Suggest linear and isolated thinking
- Multiple specific forms exist which have to be tailored to the needs of the organisation and can create more questions than answers initially

The conceptual model aimed to address the weaknesses of each method by a devising a combination that also did not diminish their respective inherent strengths. Each identified weakness of both scenario planning and technology roadmapping is discussed in the following sections. The following sections present an assessment of how the conceptual model addressed or did not address the weaknesses in both models as identified (O'Brien, 2004a; Phaal et al., 2004a; Saritas and Aylen, 2010; Tapinos, 2012).

3.2. **Addressing the weaknesses of scenario planning**

Scenario planning has a number of weaknesses and through developing and deploying a conceptual model, discussion of whether or not each weakness was addressed follows.

3.2.1. **Frequently used to describe one or a set of future circumstance(s). Scenarios developed via the intuitive logics process do not necessarily give a pathway into the future.**

The key aspect of this weakness is that scenario planning does not necessarily give a pathway into the future. This means that intuitive logics scenario planning in itself does not define a clear route to any one of the depictions of the futures it produces. By combining the development of the scenarios with the development of a technology roadmap there are clear short, medium and long term action points as well as ‘flex points’ identified. Based upon the three scenarios developed through the conceptual model, the technology roadmap acts as a pathway to the scenarios. One of the advantages of recent technology roadmapping processes is that of ‘flex points’ (Strauss and Radnor, 2004). These ‘flex points’ are turning points in the roadmap, which can lead to a one of the three scenarios developed. The technology roadmapping workshops explicitly asked this of the participants and the flex points are included in the final roadmap produced. The ‘expectations of foresight’ as Saritas and Aylen (2010) describe it are: creating multiple futures, linking the future with the present and providing participation. On its own, scenario planning only delivers the first and third expectations. By the combination in the conceptual model proposed in this present research, the second expectancy of foresight is also fulfilled.

3.2.2. **The scenarios take longer for the participants to grasp, particularly when presented in textual format.**

This weakness, (Amer et al., 2012; Chermack, 2005; Keough and Shanahan, 2008; O'Brien, 2004a; Saritas and Aylen, 2010) has to do with how the final scenarios are presented to the participants and other users of the scenarios. O'Brien (2004a) asserts that the participants should consider audience, format, and language of the final scenario narratives. These assertions were implemented in this present research whereby the participants were asked what type of formats would be pertinent and who the audience of the scenarios would be. Presenting the scenarios as an ‘E-health Insider article’ was the format chosen by the participants as the format. This was a format they all understood and the audience of the scenarios should be the technical community in the healthcare industry responsible and involved in technology adoption. One assertion that O'Brien (2004a) made that was not present in this research was that of the language style of the presented scenarios. This was not asked of the participants explicitly but by selecting an ‘E-health insider’ article as the presentation format, the language style was implicitly selected by matching the style of an 'E-health insider article'.

3.2.3. More open ended and may lead to multiple interpretations

The scenarios produced in this research are open-ended and could lead to multiple interpretations dependent on the audience/users of the scenarios. This is an inherent weakness of scenario planning and was not directly remedied by adapting the assertions of O'Brien (2004a). However, through the conceptual model, although the scenarios themselves did not become less open ended or any less subject to multiple interpretations, the process of using the scenarios to develop a technology roadmap does produce foresight in the context of RFID adoption in the NHS. Therefore, if the scenarios and technology roadmap are considered as a set, the outputs of the conceptual model do address the issues of 'open-endedness' and 'multiple interpretations'. However, if the scenarios are considered as an entity alone, this inherent weakness of scenario planning remains intact.

3.2.4. Facilitators need to have awareness of potential pitfalls of the scenario development process.

The potential pitfalls of the scenario development process (Amer et al., 2012; Bradfield, 2008; Chermack, 2005; Keough and Shanahan, 2008; O'Brien, 2004a; Saritas and Aylen, 2010) and how these pitfalls were avoided in this present research are as follows:

3.2.4.1. Predictability of a limited set of factor choices

This present research used PEST analysis for the generation of uncertainties. This has been extensively covered in the Methodology and Analysis Chapters, but for the purposes of discussion, asking the participants to go through each quadrant of PEST allowed the formation and generation of a wide range of factors.

Further questions reminding the participants to think over a longer time when establishing the planning horizon and generating the uncertainties were also ways in which a limited set of factors were avoided in this present research. Establishing the uncertainties and planning horizon during the interviews allowed for one-on-one explanation of the purpose and reasoning for pushing the planning horizon beyond the immediate future and the generation of a wide range of factors. By asking questions as listed further in this section, a limited set of factor choices was avoided. In addition, due to the presence of stakeholders from multiple organisations, the research setting allowed for the explanation in a variety of uncertainties as multi-organisational perspectives were called upon.

3.2.4.2. **Predictability of theme selection**

Using unimaginative names such as "optimistic" and "pessimistic" (O'Brien, 2004a) for the scenarios was avoided by encouraging the participants of this present research to develop news headlines type names for the scenarios which were the main headers in each 'E-health Insider' scenario.

3.2.4.3. **Focus on current/next big issues**

The perceived failure of the National Programme for IT (NPfIT) was a common talking point in the workshops of this present research, particularly, when it came to discussing why RFID technology adoption will not be centrally funded. The topic of a change of government was also often touched upon, as a change in government would have a direct effect on how the NHS is organized, funded, and managed. This factor has a minimum time-frame of four to five years and it would have been easy for the participants to not think beyond a change in government. The participants were pushed to consider some questions to help move their attention and mind sets beyond this short time frame:

- Determine (roughly) the point in the future where existing knowledge cannot help us analyse the environment?
- How far into the future, are resources being committed?
- When does the environment become uncertain?

These questions were effective in moving the participants on from the immediate time-frames of current or future big issues.

3.2.5. Little evidence to suggest improved decision making, to inform strategy development.

There is little evidence (Tapinos, 2012; Varum and Melo, 2010; Wright et al., 2013a) to suggest that scenario planning improves decision-making and robustly informs strategy development. Of the few examples available; Phelps et al. (2001) and Chermack et al. (2007), both studies were based on a small sample and were inconclusive. This present research does not further the case for scenario planning in improving decision-making. This is due to the output of the conceptual model developed in this present research, namely scenarios and a technology roadmap do not in themselves improve decision-making. However, in the case of informing strategy development, the conceptual model does provide a set of internally consistent scenarios with a roadmap as to how those scenarios may unfold. This output of the conceptual model does therefore could provide a robust platform for strategy makers compared to employing scenario planning or technology roadmapping as isolated, individual exercises.

3.3. Addressing the weaknesses of Technology Roadmapping

3.3.1. Normative — more target oriented, therefore, focuses merely on the desirable future

The roadmap produced by the conceptual model is built upon three scenarios and not one of them is the ‘desirable’ future (Saritas and Aylen, 2010). However, there are targets depicted by the roadmap in the form of programmes of development and resources required. Through the integration of ‘flex points’ (Strauss and Radnor, 2004 p.1445) on the roadmap, there is scope for users of the roadmap to identify these points as they occur and adjust planning/development activities accordingly. This has built flexibility and consideration of multiple futures into the roadmaps as the scenarios had been produced beforehand. The final roadmap identifies ‘flex points’ where if certain events occur, this would lead to one of the three scenarios produced.

3.3.2. **More difficult to communicate with non-participants of the process as results too technical.**

It was a running reminder throughout the deployment of the model, in the workshops and interviews that not too much technical language was being used so to appeal to a wider audience. Specifically in the roadmapping phase, the programs/technologies described were worded with a wider audience in mind. On the occasions few occasions of digressing into technical details, the participants were reminded of the audience of the outputs.

3.3.3. **Suggest linear and isolated thinking**

The roadmap developed out of the conceptual model is based upon three scenarios of the future. This defeats the weakness of linear and isolated thinking as the roadmap builds upon the three plausible scenarios produced through an internally consistent process. Added to this is the ‘flex points’ on the roadmap, again allowing for flexibility and multiple paths to be followed by the users of the roadmap. By integrating scenarios and roadmapping, this key weakness of roadmapping is tackled through this present research. Linear and isolated thinking is alleviated at the very start of the process of the conceptual model’s deployment as the scenario planning process opens up multiple depictions of the future and engages the participants to think of alternative possibilities. This then carries on into the technology roadmapping phase with the inclusion of flex points. The addition of flex points to the roadmap can be fully realized with the development of multiple scenarios the flex points could lead. Without the scenarios, the flex points would indicate a different pathway needs to be taken but with no depictions of the future to guide the development of the pathway.

3.3.4. **Multiple specific forms exist which have to be tailored to the needs of the organisation and can create more questions than answers initially**

An architectural framework as developed by Phaal et al. (2004a) was used for the conceptual model for its simplicity. It encompasses the key aspects of roadmaps on the left hand side as rows and timeframes as columns across the top. As discussed in Chapter 4, there are multiple forms of roadmaps (Farrukh et al., 2003; Kappel, 2001; Kostoff and Scaller, 2001; Phaal et al., 2004a; Probert et al., 2003). The architectural framework as developed by Phaal et al. (2004a) was a good choice for the conceptual model developed and deployed in this present research for three reasons. Firstly, the framework is simple and easy to understand for the participants. Given the circumstances during the roadmapping exercise, a simple, easy to use framework was crucial in populating the roadmap with content of useful quality in the allotted time. Secondly, the simplicity and clarity of the framework used in this present research was imperative so as the participants could relate the scenarios to the framework. Usually in a technology roadmapping exercise, there is one projected view of the future whereas in this present research there were three. A complex framework could have led to a situation where the participants required more time to gain clarity of the purpose and process of populating the framework. Thirdly, the conceptual model developed and deployed in this present research expanded the norms of what a typical technology roadmapping exercise would have expected from the participants in requiring more than one future to be considered when populating the roadmaps. Again, the simplicity of the Phaal et al. (2004a) framework was an advantage in the present research due to the requirement of considering multiple scenarios.

The conceptual model encompasses a scenario planning process including the common steps of the intuitive logics school and a technology roadmapping architectural framework including the main requirements of a roadmap. Due to this, there was not a need to engage in a decision making process with the participants to select which technology roadmap type or which scenario planning process should be used. This allowed the process devised for the conceptual model through a literature review to be followed almost immediately in the research setting with little time wasted on selecting the type of roadmap or scenario method.

3.4. **Comparisons with other combinations of scenario planning and technology roadmapping**

There have been a number of conceptual and empirical examples of other combinations of scenario planning and technology roadmapping. Section 3.2 of Chapter 3 presented both conceptual and empirical examples of previous combinations of scenario planning and technology roadmapping. Here, the empirical examples are compared and contrasted with the model developed and deployed by this present research.

The combination used by Pagani (2009) employed cross-impact analysis and trend extrapolation (quantitative) to define scenarios upon an overall framework of a roadmap. The combination in this instance leans on the principles of systems thinking. The conceptual model developed and deployed in this present research used intuitive logics scenarios (qualitative). Therefore a direct comparison of models would prove difficult, especially when considering Pagani (2009) also employed the principles of systems thinking which has not been considered in this present research. Abe et al. (2009) integrated technology roadmap with business modelling for engineering and research organisations in Japan. Scenario planning was used to gain an understanding of the relevant uncertainties through deploying PEST analysis in a workshop setting, akin to the intuitive logics school of scenario planning. However, this as far as the scenario planning process went. This instance involved a holistic combination of technology roadmap and other business modelling techniques where technology roadmap is used as a framework to integrate other techniques such as scenario planning. The model developed in this present research differentiates from the work of Abe et al. (2009) in that an overall technology roadmap approach with aspects of scenario planning to supplement the roadmap is not the approach taken. The approach of the conceptual model developed and deployed in this present research was to develop full scenarios through the intuitive logics school and then to develop a technology roadmap based on those scenarios. Kajikawa et al. (2011) used risk analysis (RA) and scenario planning for technology roadmapping for the Japanese energy sector. In this instance, scenario planning was used to identify uncertainties for multiple technology roadmaps, namely one for each technology of relevance, to be developed. This example of combining technology roadmapping and scenario planning also integrated risk analysis. The risk analysis was conducted for each technology of relevance. Compared to this present research, the scenario planning approach used by Kajikawa et al. (2011) was trend extrapolation and not intuitive logics. Although the generation of uncertainties was conducted through PEST analysis during a workshop, narratives of the scenarios were not produced, rather a probability assigned to each uncertainty identified. The technology roadmapping aspect of Kajikawa et al. (2011) was similar in design to the framework deployed in this present research.

In comparison to the combination deployed by Saritas and Aylen (2010), the conceptual model in this present research differs in various details. Firstly, as an overall framework, Saritas and Aylen (2010 p.1073) use scenarios at “three different phases in the roadmapping process: to set the context for roadmapping before we start; to fill out aspects of a road map while it is underway; to put ‘flesh on the bones’ of a final roadmap and to check the robustness of the resulting roadmap to different outlooks ahead of strategy formation, or as part of public policy advice”. Scenarios are used in the model developed in this present research only once and used as a guide for the technology roadmap. The combination Saritas and Aylen (2010) used, created multiple scenarios to test the robustness of multiple roadmaps. The scale and setting of this combination of scenario planning and roadmapping was for a long-term, multi-audience environmental research project requiring consideration of various emerging and existing technologies. The model developed and deployed in this present research, although also had multiple audiences, concentrated on one technology, RFID alone. The scale therefore, of this present research, is smaller than that of the example given by Saritas and Aylen (2010). However, the scenarios were also developed in order to “flesh out” and alleviate linearity of the roadmap. This was the reasoning behind an integrated approach used by Saritas and Aylen (2010) with scenarios produced at three stages within a overall technology roadmapping framework. The reasoning is the same in this present research, simply achieved by adopting a different process adapted for the setting and present circumstances. The participants used for the deployment of the model in this present research were the same throughout the process whereas Saritas and Aylen (2010) involved various differing technology experts for the roadmaps and policy makers for the scenarios.

Previous attempts at combining technology roadmapping and scenario planning are highly contextualised. They are driven by what the setting requires and what the needs of the organisation conducting the foresight project are. Previous combinations are driven by practice based requirements. The inspiration for trying to address the weaknesses of each respective technique came from both techniques giving valuable foresight to the HUG and other interested parties on the future of RFID adoption in the English NHS. However, as standalone techniques, there were various weaknesses requiring addressing before the outputs would be of enough value to remain robust and flexible enough over the long term. The model developed in this present research was therefore developed with the aim of addressing the weaknesses of scenario planning and technology roadmapping from a conceptual/procedural standpoint as shown in Sections 3.2 and 3.3 of this Chapter.

A contribution to technology foresight as a whole has been made by developing a conceptual model improving the practice of technology foresight by developing a technique, which provides not only multiple plausible futures but also a flexible roadmap with flex points leading to the scenarios as key events/indictors develop over time. By deploying the model whereby the two methods in question have been improved via a novel combination has made a methodological contribution to the field of technology foresight.

4. Conceptual Model Outputs Discussion

This section discusses the implications, strengths and weaknesses of the outputs of the conceptual model, beginning with the scenarios. The first scenario “IT has not saved the NHS” takes the form of data quality issues continuing to persist, IT adoption is still left to local decision makers, the general health of the population is in decline and the government is being criticised for the increased rationing/privatisation of healthcare services. If this scenario manifested, 2030 would not look too dissimilar to the state of the NHS today. As shown in Section 2 of the Literature Review Chapter, IT is left to local decision makers, with limited central support and the level of quality in terms of healthcare records is mixed. The low level of quality in healthcare records and a lack of unified IT adoption in NHS Trusts leads to an NHS of 15 years time that is similar to what it is today. The similarities are in terms of not being able to view patients healthcare records anywhere in the country and a lack of visibility of how IT systems are performing in one site compared to another. The increased privatisation of healthcare services leads to further costs to individuals creating criticism of government. Furthermore, a decreasing level of overall health of the English population is creating increased strain on the NHS with the IT issues discussed, adding to a diminishing quality of service.

Scenario One “IT has not saved the NHS” has several implications in context of the inhibitors to RFID adoption identified by this present research. Legislation, standards and regulation remain interspersed as the current situation. The inhibitor of a lack of central investment in IT systems, as is seen in the current NHS, largely remains and therefore taking full advantage of the capabilities of widespread RFID adoption does not materialise in Scenario One. The inhibitor of communication, in the context of not making clear comparisons with other industries where RFID technology is widespread, remains intact. Examples from retail, not clarifying the actual patient confidentiality issues, not ensuring the complexity of implementing RFID being well understood by all stake holders and not communicating successful pilot projects remains largely unaddressed in the NHS of 2030 in Scenario One. A reactive culture remains in Scenario One encompassing fire fighting, lack of innovative teams in NHS Trusts, not looking beyond short-term contracts, an institutional objection to change and not addressing the perceived failures of previous large scale IT projects in the NHS. Scenario One paints a picture of the future, not too dissimilar to what can be identified today. In this scenario many of the inhibitors to RFID adoption identified by this study in the current NHS remain. The technology roadmapping exercise identified flex points in the roadmap what could lead to Scenario One. The flex points leading to Scenario One included events such as centralised funding does not occur, health-screening programs are not implemented and if decision makers are not adequate for the job. The flex points identified by the technology roadmap, which lead back to this scenario, were included if centralised funding does not occur, if health-screening programs are implemented too late and if decision makers are not adequate for the job. These flex points were identified within the short to medium terms (0-10 years).

Scenario Two "If the National Programme for IT worked" depicts where healthcare records quality deemed "excellent" and "shareable", the DoH drives local and national technology partnerships, health assessment and screening programmes excel, and the general health of the population is stabilising. This scenario presents an NHS of 2030 where electronic patient care records are accessible anywhere in the country and of very high standard. This was the original aim of the National Programme for IT as presented in Section 2 of the Literature Review Chapter. A key feature of this scenario is that health screening and health assessment programmes are introduced in 2015 and by 2030, the overall health of the population is no longer in decline but stabilising. The point of divergence identified by the technology roadmap leading back to this scenario was the 'provision of central funding'. The implications for RFID in this scenario would be that RFID is widespread in the English NHS. RFID technology, in this scenario, makes information sharing in the supply chain ubiquitous. RFID technologies are also widely used in hospital settings to reduce medical errors and contribute to operational efficiency. The understanding of the capabilities of RFID in both the management of the NHS and in the general public are well understood. Confidentially concerns are largely non-existent amongst the general public based on the success of other IT initiatives in the NHS. RFID technologies are trusted for use in the home for healthcare purposes.

Finally Scenario Three “Great IT, poor public health” depicts health assessment and screening programmes were rolled out but due to late implementation and other public health factors, the health of the population is in decline. Here the NHS is under increasing pressure to deliver the services required by the declining health of the population, although the underlying IT infrastructure is effective. Global standards in this scenario have been established and overall, there is harmony in healthcare data standards worldwide. The point of divergence identified by the technology roadmap that lead back to this scenario is if health screening programs are implemented too late. RFID technology in this scenario is widespread in the NHS and has similar implications as in Scenario Two.

The strengths of the scenarios created are threefold. Firstly, they are internally consistent through checking the consistency and plausibility of the work conducted throughout the scenario development process. Secondly the scenarios give a rich picture of the future in 2030 with detailed descriptions of how each of the 12 uncertainties manifest under each scenario. Thirdly the scenarios are presented in a format and medium which the audience (not only the GS1 HUG but also those interested in technology adoption in the NHS) can relate to and recognise. The weakness of the scenarios developed involves the (very limited) overlap of what happens in the scenarios in 2030. This could indicate that the very extreme ranges or considerations were omitted at various parts of the development process, leading to closer related scenarios.

5. Reflexive Discussion

Reflexivity for this study took the form of one of the Finlay and Gough (2008) uses of reflexivity of evaluating the research process, method and outcomes. The following sections present a reflexive discussion of the research process, method and outcomes.

5.1. Process

5.1.1. Interviewing: field experiences

This section presents an reflective account of experiences gained from conducting the interviews. The interviewing process allowed for a number of differing experiences; gaining the participants engagement with the project, organising interviews themselves and the aspects of preparation in terms of design, pre and post activities, facilitation of the interview, management of relationships with the interviewees and reflecting on this data collection phase as a whole.

The interviews varied in length but on average lasted one hour. All participants were contacted by email to arrange a time and place of interview convenient for them. In this communication I reiterated my role as a PhD student and the broad aims of the research (Taylor, 2001). I found that once the interviews had been organised and in principle all the participants agreed to participate in the study, both the interviewer and the interviewee, as Alvesson and Deetz (2000) note, wanted the interview to go well. I was often asked, in general terms, if the interview was 'ok for me' and if it was what I had wanted.

Throughout the interview process I kept in mind that the proportion of talk between the interviewee and the interviewer should be in favour of the participants as much as practically possible and as a percentage should be in principle 80/20 (Roulston and Lewis, 2003). I found in the first few interviews that managing the rhetoric in my mind, making notes on my laptop, keeping an eye out on the audio recorder, thinking of the next question and listening intently to the interviewer, taxing, and indeed reflective of the difficulties of novice researchers discussed by Roulston and Lewis (2003). Maintaining this balance was not equal in that I gave the majority of attention to the conversation, as this was the most valuable aspect of the interview. However, notes from every interview were made after the event, on both the conversation and other observations; entries to the researcher's diary on my own performance were made.

The learning experience during the interview process was not solely focused on the phenomena being studied. I learned that during the interviews I assumed various identities during my conversations: "male", "researcher" and so were my interviewees: "female", "programme manager". In my field notes taken during and after the interviews I attempted to record overt, non verbal communication as an indicator of the emotional state of the participant and the power relations present (Fontana and Frey, 2000).

I aimed to show interest in the interviewees as individuals, not only during the interview but also in any communication and interaction outside of the interview setting. Specifically during the interviews, I often used phrases such as "what do you think?" or "what is your opinion?" to show interest in the interviewees as individuals (Rapley, 2001). If clarification was required, I rephrased the participant's expressions back to them. During some of the later interviews I referred to other conversations I had and to the other interviewees in terms of the discussion held during my questioning (Alvesson and Deetz, 2000). In general, each section of questions began with a topic initiator to open up issues for discussion with follow up questions used to seek out increasingly detailed and comprehensive insights on specific issues.

After each interview I sent each interviewee a brief email thanking them for their contribution to the study and their time. The main reason for conducting interviews was to gain qualitative insight for this study. It was imperative to establish rapport during the interviews in order to put the participants at ease in being able to talk about experiences and therefore gain rich data. I did not stop interaction on professional and even personal levels with the participants after encounters specific to data collection.

5.1.2. **The Conceptual Model Process**

The following sections are reflections on the process used for the scenario planning phase of this present research. These reflections are in line with the steps suggested by Kunseler et al. (2015) as presented in Section 3 of the Methodology Chapter in greater detail. The making of tacit frames explicit in order to maintain salience, credibility, and legitimacy is the first reflective step and the second step involves strategic positioning towards changing circumstances so that practitioners acknowledge the external influences on the foresight process.

In terms of maintaining salience, credibility and legitimacy, a number of reflections are relevant. The first stage of scenario planning involves setting a planning horizon. This stage could have been conducted within a workshop environment (O'Brien, 2004a) but in this present research, it was conducted during individual interviews (Van der Heijden, 2005) in order to gain independent and diverse results and further allowed each participant to fully grasp the task. Conducting this step through the interviews allowed for each participant to fully give their views without the factors of group dynamics and power relationships present. During the subsequent workshop the participants were given the chance to see all the uncertainties collected and discuss them.

The process of transferring the 12 uncertainties from the Google form to the PowerPoint slides was a manual process that, in future workshops, should be automated. Then, the facilitator can simply copy this automatically produced slide into the existing presentation. Secondly, concise explanations needed to be used during the workshops where the effective use of the little time available was of essence. For example during workshop 1, what a ‘range’ was, what was exactly meant by the lowest and highest value and to what time-frame they were working to. Facilitators should have precise definitions of these terms in the context of scenario planning prepared beforehand that also take into consideration the perspectives if the audience. Valuable time can be saved during the workshops with this preparation step. Thirdly, if all the uncertainties were paired with each other during Workshop 2 (66 combinations) and each combination was to produce 4 scenarios (264) initial scenarios, it would take the participants a significant amount of time to work through each matrix. Each matrix required 40 minutes to work through. If all 66 matrices were used, it would take 44 hours of workshops to complete. The process adopted in this present research for the scenario planning workshops followed the model outlined by O'Brien (2004a) where scenarios are taken forward after the checking of consistency using the consistency check grid.

In terms of strategic positioning towards changing circumstances so that the practitioner acknowledges the external influences on the foresight process Kunseler et al. (2015), a number of reflections can be made. Firstly, workshop 2, 3 and 4 required the participants to be split into pairs. Conducting the workshop with all the participants in the room would have been ideal from a time-saving point of view. However, separating the pairs allowed the facilitator to explain and engage each pair with full attention which would not have been the case had the workshops been conducted with all the pairs present in the same room at the same time. Secondly, during workshop 2, for the first pair, participants were not allowed to write down the descriptions of each initial scenario; instead, the facilitator had to manage the workshop and make concise notes of the participant’s responses. To avoid a sticking point in the flow of the workshop, for the next two workshops, the participants were allowed to handle the writing of the descriptions. The participants were encouraged to provide succinct responses. This allows the facilitator to concentrate on facilitating and explaining rather than transcribing. Thirdly, one suggestion made by the participants was that checking the consistency of the relationships between uncertainties could be conducted before the selection of the two scenarios, with which each pair must choose to move forward. This could allow for the participants to select uncertainties for pairing that they knew already to have strong relationships due to conducting the consistency grid beforehand. Checking consistency of the scenarios by using the ‘consistency check grid’ then proved to be a valid exercise to determine the strength of relationships between the uncertainties in this scenario planning process. However, further consideration needs to be given to the point at which in the overall process it is introduced. If for example, the ‘consistency check grid’ is introduced earlier in the overall process, it could save considerable time and avoid potential frustration of the participants due to conducting work that ultimately gets discarded upon reflections of the results of checking the strengths of the relationships between uncertainties.

The technology roadmapping stage of the conceptual model also produced discussion points in terms of reflexivity. There are a number of process improvements that could be made if a technology foresight practitioner was to conduct a technology roadmapping exercise using the conceptual model in the future:

- The technology roadmapping interviews were conducted via Skype to save resources and travel time. This led to some issues of video quality and Internet connection speeds when using such technology.

- For future projects where the conceptual model is used, a workshop instead of interviews for the technology roadmapping phase should be conducted. However, the one on one interviews for the technology roadmapping phase could be explored by future research as group dynamics and power relationships were not an influence on the outputs.

Despite the relatively small number of participants in the technology roadmapping phase, because the technology roadmapping process was based on an extensive scenario planning exercise, the participants were still able to identify key flex points and fully populate the technology roadmapping framework. The four layers which make up the framework: internal business strategy, products/systems/services, technology and resources all were populated completely on their individual frameworks allowing for rich data to be collected.

5.2. **Method**

5.2.1. **The 'Two Track' Action Research approach**

There were two tracks to how Action Research was used in this research project. Firstly, for Research Questions 1 and 2, the use of the action research guidelines presented by Yorks (2009 p.379) were limited to the first four steps. For Research Question 3, all 6 steps were used in this present research. Here, each of the six steps are reflected upon in order to identify the advantages and disadvantages of the Action Research approach adopted in this research project.

Category 1: Initiating and organizing the project.

- Defining the problem and the research questions: presented in Chapter 2, Sections 7.1 and 7.2.
- Defining roles and relationships amongst those actively engaged in the Action Research process: presented in Chapter 4, Section 2.3.
- Deciding how the problem will be studied and choosing methods that will provide the data necessary for answering the research questions: presented in Chapter 4, Section 2.4.

- Category 2: Implementing the project
    - Gathering and interpreting the data through an appropriate analysis process: presented in Chapter 4, Section 2.6
    - Identifying appropriate and meaningful actions: Presented in Chapter 3.
    - Deciding on how the findings should be disseminated and used. Presented in Chapter 3.

The first three steps in Category one, as outlined above were similar for all three research questions. Defining the problem had two aspects. The first aspect of defining the problem came from the literature review conducted in this thesis for both the drivers and inhibitors of RFID adoption in the English NHS and the development of a new technology foresight model. The second aspect of defining the problem came from the setting where this research project was conducted. This step is not too dissimilar to other modes of inquiry and is not exclusive to an action research project. This step was about scoping the project.

Step two involved identifying the subjects of this study, their roles and relationships, as well as the researcher's role throughout the process. The subjects of this study were both interviewees and workshop participants. The researcher was both interviewer and workshop facilitator. I was interesting to see how different participants behaved during workshops and interviews and how I was treated during my role as a facilitator or interviewer. The participant's power relationships were present during the workshops. However, through mechanisms such as obtaining the ratings of uncertainties individually, those with perhaps a less imposing voice or influence in the group were still facilitated to give input.

Step three involved deciding how the problem will be studied and choosing methods that will provide the data necessary for answering the research questions. Reflection on this step is twofold. Firstly, how the problem was studied requires a brief assessment of the literature review conducted. The literature review explored the current level of adoption in the English NHS. This section presented a synthesis of the literature on RFID in English Healthcare, the strategic value of RFID in supply chains, a collation of the main issues associated with technology adoption in the English healthcare system and a collection of examples of RFID usage in hospitals in England and an outline of the structural changes in NHS supply chains. What could have been added to the literature review is an assessment of the common drivers and inhibitors for RFID adoption in other industries and then to compares the findings of this research project to other industries in greater detail. This could be an interesting direction for future research projects. Secondly, the methods chosen are to be reflected upon. Semi structured interviews were selected for the first two research questions due to the relative number of participants and the nature of setting, explored further in this chapter. A focus group could have been used but it was decided to use interviews as this also allowed for stronger relationships and trust to be built with the participants, which was invaluable during the subsequent workshops.

Step four involved gathering and interpreting the data through an appropriate analysis process. This step has two aspects to reflect upon. The first is the framework selected was ‘aggregate dimensions’ coding structure proposed by Gioia et al. (2013) for the analysis. This process advises researchers conducting qualitative studies to gain rigor through being transparent in the process and to use a three tier thematic analysis technique to develop emergent themes. Transparency was achieved in this research project by explicitly setting out the process used and giving an example of how one of the themes emerged in the Analysis Chapter. The second aspect of this step which requires reflection is the analysis process used for the conceptual foresight model developed in this study. The analysis techniques deployed were governed by the techniques inherent in each given tool i.e. technology roadmapping and scenario planning. Each tool and the parts used for the new model contain their own analysis techniques. For example, the participants analyze the outputs of each stage of the scenario planning process in order to produce the content for the next stage. So, the aspect of ‘interpreting the data through an appropriate analysis process’ for the conceptual model part of this research project was influenced by the researcher by appropriating the generic steps of intuitive logic based scenario planning and technology roadmapping into a new model but was conducted by the participants of the study.

Category 2 of the Yorks (2009 p.379) Action Research Steps is where the approach differed for Research Question 3. Step five required the identification of appropriate and meaningful actions. Throughout the deployment of the conceptual model, the participants were required at various stages to think beyond the time horizons of current planning activities. Appropriate and meaningful actions for this project were to ensure that the planning horizon was not too far into the future and the scenarios developed were checked for plausibility. To further this research project, the impact of the outputs of the model could be assessed up to the planning horizon of 15 years.

Step six involved how the findings should be used. The findings of this research project are threefold: identification of drivers and inhibitors to RFID adoption in the English NHS, the development of a new foresight model and the outputs of deploying the model. In this research project the outputs of the model have not been disseminated wider than the participant group and their organization. There could be further areas of dissemination and audiences who would be interested in the outputs of the model. A further research project could explore the uses of outputs of the model and potential audiences.

5.3. **Outcomes**

5.3.1. **The complexity of the environment**

In Section 2 of the Literature Review Chapter (Chapter 2), overall challenges which give insight to the complexity of the environment this study was conducted in were presented. A summary of these challenges is presented below and commentary is given how each of these complex challenges has effected this study.

- How to improve an organisation's decision-making processes and systems with regard to the adoption of technological innovations.

This is a broad challenge involving bringing clinicians and managers together to consider technical innovations in order to engage all relevant stakeholders. One such avenue in achieving this is to establish Healthcare Technology Adoption (HTA) committees whom sole task is drive the adoption of technological innovations. These committees then, should consider technological, organisational and social concerns together. For example, not only the impact on patient care but to seek substantial engagement and regular feedback on improvements from the specific groups of staff the technological innovations effect. These committees would be also responsible for seeking good practice guidance from bodies such as the National Institute of Clinical Excellence (NICE) and the National Technology Adoption Centre (NTAC). Creating HTA committees can be a recommendation made to the NHS to drive RFID adoption. This recommendation us included in Section 4 of Chapter 7.

- How to increase an organisation's absorptive capacity for new knowledge about technological innovations.

This challenge specifically addresses the training, recruitment and development of staff in healthcare organisations. Skills such as the capacity to 'horizon-scan', comfort with working within a 'questioning culture' and capture new ideas should be sought after and developed. Developing training for nurturing adoption champions and leaders is also seen as crucial. The organization may need to create new or extended roles that cross traditional boundaries. Mechanisms developed to establish/strengthen internal exchange of both tacit and explicit knowledge.

- How to ensure a receptive organisational context for technological innovations.

This challenge concerns the strength of the relationships between stakeholders. This can heavily influence the outcome of the adoption process. As discussed earlier, establishing Healthcare Technology Adoption (HTA) committees whom sole task is drive the adoption of technological innovations by bringing together stakeholders can be recommended not only at individual NHS Trust level but also at the system level.

- How to improve organisational readiness for a specific technological innovation.

This challenge is focused around preparation for adoption of a specific technological innovation. This challenge is perhaps the most complex to tackle of the challenges set out by Robert et al. (2009) due to the considerable difficulty of the sub-challenges involved. First is to identify the decision system(s) most critical to the adoption and assimilation of the specific innovation. Second is to overlay the stakeholder relationships and governance to the process of care. Third is to consider the relative distribution of expertise within the organization and identify significant gaps in organizational knowledge. Fourth is to ensure that there is a, evidence based business case for the innovation, reflective of the effect to the various organisational levels, stakeholders and patient care processes involved. Sixth is to dry-run and test systems as adoption often depends upon successful assimilation of the technology with existing systems and processes. Seventh is to hold ‘go live’ events as a symbol of the importance being attached to the innovation by the organization.

Despite this complex setting, to understand and gain foresight into the healthcare requirements of future populations through scenario studies (and other foresight techniques) is emerging (Bezold, 2014). This could allow the NHS to not only react faster to the population’s needs but to pre-empt the healthcare requirements of the future.

Chapter 7: Conclusion

1. Introduction

This Chapter concludes this thesis by presenting the empirical findings, the implications for both research and practice, limitations of this study and finally recommendations for future research directions.

This study identified that RFID adoption in the English NHS is limited to isolated pilot projects. There is a growing body of evidence for RFID technology as a key enabler of reducing errors, improving patient safety, information sharing throughout the supply chain, better inventory management and improving healthcare information flows. As much as the reported pilot projects currently existing in the English NHS have improved processes, reduced operational costs and provided opportunities for learning at a local level, they cannot be expected to provide the momentum for widespread adoption, and as yet, have not done so. RFID adoption at the local level within the English NHS, no matter how successful, has been missing the opportunity of realising the full benefits of widespread adoption of RFID technology.

Here, an investigation into what factors not only drive but also inhibit RFID adoption in the English NHS provided a qualitative addition to the existing literature on RFID adoption in healthcare settings from around the world. The unique contribution this made to the existing literature in this area was an example of identifying drivers and inhibitors of RFID adoption in a nationalised system, facing the added complexities of needing to collaborate and coordinate efforts across organisational boundaries, and across boundaries between the publically- funded health and commercial sectors. The first two research questions of this study were devised to investigate the current drivers and inhibitors of RFID technologies in the English NHS:

1. What are the drivers of RFID technology adoption in the English NHS?

2. What are the inhibitors of RFID technology adoption in the English NHS?

The GS1 Healthcare User Group's members were the informants of this study. The HUG are a unique group responsible for driving the adoption of RFID technologies in the NHS at the system level. The HUG and other interested parties such as RFID technology developers/suppliers, policy makers, hospital operations managers, clinical care directors, inventory managers and healthcare supply chain actors would benefit from insight from the deployment of foresight techniques. In this case, techniques which can deliver insight of what the NHS may be like in 10-20 years time and what implications the future would have on the requirements of RFID technology.

Section 4 of the Literature Review Chapter showed how technology foresight methods can help identify future states of a given industry or potential pathways of evolution of a particular technology. The second aim of this study was to utilise the techniques of foresight to provide insight over a longer period of time (10-20 years) to those responsible for RFID technology adoption in the English NHS. In parallel, the academic community concerned with the field of foresight would be presented with an empirical example of a foresight exercise combing two methods.

Deployment of scenario planning and technology roadmapping in the research setting of this study provided members of the HUG and wider practice based audiences the benefit of outputs of foresight exercises in the relatively early stages of RFID adoption in the English NHS. However, there are a number of inherent weaknesses of each respective technique, as stand-alone practices, that this study addressed before deployment. Chapter 3 identified previous attempts to combine scenario planning and technology roadmapping largely relied on an overall roadmapping framework with only limited aspects of scenario planning activities integrated to explore macro environment uncertainties. Therefore, a new technology foresight model needed to be developed. The new model aimed to alleviate the weaknesses of each respective technique but keeping respective strengths intact achieve. This model was developed in order to answer the third research question of this study:

3. What are the plausible futures of RFID adoption in the English NHS of 2030?

2. Empirical findings

This section synthesises the empirical findings that answered the three research questions of this thesis. The empirical findings have been set out for each research question.

1. What are the drivers of RFID technology adoption in the English NHS?

The key drivers of RFID adoption identified by this study were:

a) Successful pilot studies
b) Technical improvements and reducing cost in RFID technology
c) Constant need to improve the NHS
d) The changing nature of care required

2. What are the inhibitors of RFID technology adoption in the English NHS?

There were four main inhibitors identified in this study of RFID adoption in the English NHS:

a) A lack of central investment
b) Communication
c) Reactive culture
d) Legislation standards and regulation

Various factors with complex interdependencies driving or inhibiting the adoption of RFID technologies in the English NHS were identified. As shown by Figure 20 in Section 2,1 of the Discussion Chapter, an increase or decrease in a driver or inhibitor can affect the amount of successful pilot studies. However, pilot studies and subsequently the widespread adoption of RFID technologies in the English NHS is negatively impacted upon by the inhibitors of legislation, standardisation and regulation as well as the lack of central funding and communication issues. The relationship between successful pilot studies and the effective communication of their results/issues/successes was explored in section 2.3.1 of Chapter 5. With increased communication of the results of existing pilot studies to decision makers, the evidence base to conduct a pilot would also increase. Central investment is here defined as ring fenced funding from the government to aid in the adoption of RFID technologies in areas where the technology has proven positive results. Central investment is also a key inhibitor identified by this present research. Central investment in providing membership fees to GS1 standards for any NHS Trust wishing to adopt RFID technology has positive effects on increasing the number of pilot studies. The changing nature of care required can have a positive effect on the NHS's reactive culture with gaining the understanding that the efforts of public health forecasting can provide. The ability to understand and gain foresight into the healthcare requirements of future populations through scenario studies is emerging (Bezold, 2014). This could allow the NHS to not only react faster to the population's needs but to pre-empt the healthcare requirements of the future.

3. What are the plausible futures of RFID adoption in the English NHS of 2030?

A conceptual foresight model was developed in Chapter 3 and deployed as presented in Chapter 4 to gain empirical evidence to answer Research Question 3. The conceptual foresight model's outputs comprised of three internally consistent scenarios created via the common steps in the intuitive logics school of scenario planning. The first, a scenario where data quality issues persist, IT adoption is still left to local decision makers, the general health of the population is in decline and the government is being criticised for the increased rationing/privatisation of healthcare services. The second, a scenario where healthcare records quality deemed "excellent" and "shareable", the DoH drives local and national technology partnerships, health assessment and screening programmes excel, and the general health of the population is stabilising. Finally, in the third Scenario, health assessment and screening programmes are successfully implemented but due to their late implementation, the health of the population is in decline.

The final two steps of the intuitive logics school of scenario planning were replaced with a technology roadmapping exercise, inclusive of flex points. Flex points lead back to one of the scenarios dependent on events unfolding over time. Some of these events were identified during the technology roadmapping exercise and are included in the resulting outputs of the roadmap. The outputs of the technology roadmapping framework are comprised of four strands: internal business strategy, products/services/systems, technology and resources.

Internal business strategy over the short term had synergies with what was identified as a key inhibitor to technology adoption, namely in the DoH/NHS England gaining mandating rights to centrally fund technology projects. For the midterm (3-10 years) the technology roadmap indicated a call for qualified persons to be placed in decision-making positions. This resonates with the data from the interviews for Research Questions 1 and 2 where one of the reasons for a lack of adoption was deemed to be a lack of champions to drive technology adoption. Health screening programs were an integral part of the scenarios developed and were identified on the roadmap as part of the mid-term strategy. Over the longer term (10 years – Vision) the technology roadmap produced, indicated a call for central decision making processes and mandated IT standards by the DoH. The notion of local adherence to singular standardisation has been a recurring theme throughout this research.

For products, systems and services, in the short term, the technology roadmap indicated that initially, relevant stakeholders should be informed of centralised system change and that roadmaps (not necessarily technology roadmaps), need to be produced to bring clarity to the path for Centralisation of IT. The roadmap highlights one of the central themes of this research of a central budget being made available for mandated technology adoption. This would facilitate reaching the full potential of RFID technology adoption. Over the mid-term, pre-emptive screening programmes, centralised IT systems and centralised product databases are the key aspects indicated by the technology roadmap. It is due to the technology roadmapping exercise that these themes are fleshed out and users of the roadmap can develop plans about how these aspects can be achieved, all the way through from the short term to the 'vision'.

For technology, the factor of the ageing population was identified by the scenarios and although not ranked within the top 12 uncertainties, becomes a factor on the technology roadmap when considering the longer-term vision of what technologies would be needed by 2030. Home monitoring and Tele-health are the key technologies indicated by the technology roadmap. Home monitoring and Tele-health were integral parts of Scenario 1 and 3. The context was in the shifting of expectations of how technology is generally used in society, as opposed to a step to tackle to the much larger issue of the ageing population. Whether it is the ageing population or the shifting expectations of society, tele-healthcare and home monitoring are technologies that the roadmap and the scenarios revealed as an integral part of healthcare in 2030. RFID technologies have a huge role in delivering these types of services and products.

When surveying the 'resources' indicated by the technology roadmapping exercise, it is clear that industry-led technology projects, with health service collaboration, covers the short-term, mid-term and long-term timeframes. The wording specifically used was "industry-led". This would indicate that the research and development should be carried out by industry but working closely with the NHS for guidance on standards and irradicating previous implementation issues such as failing to work with all levels of staff effected by new technology.

3. Implications for Research

The implications of this study are two-fold. Firstly, as a contribution to the existing literature on RFID adoption in healthcare settings, this study has provided empirical research, which investigated and identifies the drivers and inhibitors within a nationalised health service. Drivers and inhibitors have also been identified by other studies (Carr et al., 2010; Lai et al., 2014; Lee and Shim, 2007; Rosenbaum, 2014; Ting et al., 2011b; Yao et al., 2012; Yazici, 2014). The approach taken for this study in its research design, for Research Questions 1 and 2, was to deploy qualitative methods. This is also a way that differentiates this study from previous studies. Studies employing qualitative approaches have been called for by Lee and Shim (2007) in order to identify and acknowledge the wide range of factors affecting RFID adoption in healthcare settings. Researchers in the field of RFID adoption in healthcare can begin to contrast the findings from qualitative studies such as this and quantitative studies.

In order to answer Research Question 3, the conceptual foresight model was developed. The development of this model has theoretical implications for the field of foresight and technology foresight. The conceptual foresight model combined scenario planning and technology roadmapping with the aims of a) improving the practice of technology foresight and b) alleviating the inherent weaknesses of each technique through a novel combination without losing any of their strengths. Recent theoretical discussions (Tapinos, 2012; Wright et al., 2013a) of the intuitive logics school of scenario planning are centred on the 'planning' aspect of the process, which is not well established in terms of actionable guidance and empirical examples. The discussion concludes that 'scenario development' is different to 'strategy development'. Wright et al. (2013a) suggested that the scenario development steps should be called 'scenario thinking'. The conceptual foresight model builds on this suggestion, by not only keeping the 'scenario development' aspect separate, but eradicating the 'strategy development' steps and replacing them with a completely different technique which has been proven to successfully support strategy development. The technique chosen was not only for replacing the 'strategy development' steps but its propensity for supporting technological strategy development.

4. Implications for practice

With the outputs of the research conducted for this study, there are a number of implications for practitioners. Firstly, the inhibitors and drivers of RFID adoption identify a baseline of the current situation in the English NHS. Pilot studies have been identified by this study, as central to the increase in RFID adoption in the English NHS. There are implications for managers responsible for RFID adoption in both the NHS and its commercial partners. Managers can leverage the insights gained from identifying the drivers and inhibitors to RFID adoption by making efforts to influence the removal of inhibitors and supporting the continuation of the drivers. This study identified that pilot studies and the dissemination of their results is central to widespread RFID adoption in the NHS. Managers responsible for RFID adoption in both the NHS and its commercial partners should seek out, disseminate, and call for more pilot projects to highlight the capabilities and benefits of RFID technology used in healthcare settings. RFID technology adoption can also be aided by establishing Healthcare Technology Adoption (HTA) committees whom sole task is drive the adoption of technological innovations. These committees then, can consider technological, organisational and social concerns together.

Upon this baseline of the identification of the drivers and inhibitors of RFID adoption and their implications for practice, the conceptual foresight model developed three scenarios using an internally consistent, systematic process and a technology roadmap inclusive of flex points. The scenarios created presented three visions of 2030 of what the NHS may look like, inclusive of the implications in each scenario for RFID adoption. The process of developing these scenarios is not only useful to the HUG as an organisational learning exercise (Van der Heijden, 2005 p.162) but provides a platform for strategic planning. This is due to the steps related to strategy development in the intuitive logics school of scenario planning being replaced with a technology roadmapping exercise. As the scenarios were used to develop a technology roadmap in the new conceptual foresight model, the weaknesses of both techniques are addressed. The overall implication for the HUG members is a technology roadmap for RFID adoption in the English NHS, which recommends activities in the spheres of internal business strategy, products/services/systems, technology and resources. These activities range from the short-term through to the long-term whilst concurrently taking into consideration the long-term macro environment provided by the scenarios ‘thinking’ phases that has been a major weakness of technology roadmapping.

Foresight practitioners have been provided with a proof of a new conceptual model that addresses the major inherent weaknesses of two of foresight’s most popular techniques, as well as capitalizing on their individual, inherent strengths. Foresight practitioners can use the new conceptual foresight model in areas where there is a requirement to develop internal, short, and medium-term activities as well as understanding the longer-term macro environment. Previously, the intuitive logics scenario planning technique could provide understanding of the longer-term macro environment but did not provide a robust platform for strategy development due to a lack of evidence and guidance of how to use the scenarios. The conceptual foresight model embraces ‘scenario thinking’ in that the strategy development stages are removed completely but replaced with technology roadmapping. Technology roadmapping allows for the development of strategies for internal business, products/services/systems, technology and resources range from the short-term through to the long-term. Previously the long-term qualities of technology roadmapping were questioned due to the production of one vision of the future and the lack of integration of understanding of long-term uncertainties. The conceptual foresight model integrates the strengths of scenario planning in its capability to integrate an understanding of long-term uncertainties in the macro environment to alleviate those weaknesses of technology roadmapping. The benefit of using the model is that once the scenarios are produced, there is a clear ‘next step’ in the process. Employing technology roadmapping at this stage then allows for development of strategies for internal business, products/services/systems, technology and resources range from the short term through to the long term whilst using the knowledge created through producing scenarios. Foresight practitioners are invited to use this model in other complex settings to further test the model. Foresight practitioners are also invited to embark on creating other combinations of foresight models to alleviate the weaknesses of individual models used in isolation.

5. Limitations of this study

The first limitation of this study was in how the workshops were organised for the scenario-planning phase of the conceptual foresight model. The workshops were organised over a period of almost a year. Ideally, the workshops would have been conducted over a shorter period. For example, two workshops of 5/6 hours each for the scenario-planning phase would have allowed data to be collected more quickly. In addition, the participants would not have to be reminded of where in the scenario planning process each workshop was placed, reminded of previous results and what the plan is for the current workshop. For the scenario planning exercise, one workshop with all participants was recorded and transcribed, nine separate workshops with two participants each and a final workshop to gain feedback on the scenarios developed, were conducted. The workshops were conducted in this way to fit in with the participants availability and having to deal with a number of issues as set out in Table 10. The way that workshops were organised in this study may not be in accordance to the ideal steps in a scenario planning process but did not have a significant effect on the results. The way in which each workshop was conducted allowed for each pair of participants to clarify any questions they had. This allowed the capability to work with each pair in a closer way to ensure understanding and the desired outputs of each task. Looking forward, facilitators should consider conducting the scenario planning workshops with smaller groups in multiple workshops or with a second facilitator to ensure clarity and understanding of the various tasks involved.

The second limitation of this study is how the technology roadmapping phase was conducted. The technology roadmapping phase of the conceptual foresight model was conducted through interviews via Skype. Technology roadmapping is commonly conducted in workshops. Interviews were conducted using Skype for various reasons including those listed in Table 10. The HUG was going through major structural/personnel changes and although attempts were made to organise workshops where all participants could be present it was not possible to agrees a time or place. However, conducting the technology roadmapping phase via one-to -one interviews using the framework presented in Chapter 3, allowed each participant to give their views without influence of the other HUG members. This created multiple roadmaps, presented as Appendix 3, which were then amalgamated into one roadmap. The desired outcome of a technology roadmap being a fully completed framework with input from all participants was achieved despite using individual interviews. The case could be made that the framework was populated without the presence of group dynamics and power relationships. In the future, technology roadmapping facilitators could conduct the workshops on a one to one basis. If using the conceptual model designed and deployed in this present research, the time needed to conduct the technology roadmapping phase would be lessened, as some of the framework would already have been completed through creating the scenarios.

A third limitation to be considered is the participants of this study were relatively few in numbers. As an advantage, this allowed for trust and rapport to be built with the participants, which was invaluable during the subsequent workshops. Trust and rapport was achieved by regular and in depth contact and communication with participants. The dependence on HUG members as the participants of this research can be in the first instance considered an asset. This is because there is a strong alignment between the HUG's interests and with the required setting to test the conceptual foresight model developed by this present research. The HUG are interested in, but not responsible for, the future of RFID adoption at the system level. Working with this group allowed for a richness and depth of insight from subject matter experts, which was key in obtaining a proof of concept of the new conceptual foresight model developed by this study. This group also allowed for depth in investigating the drivers and inhibitors of RFID adoption at the system level.

However, Interviews and workshops could have been conducted with those involved with the current pilot studies in the NHS allowing for localised, isolated viewpoints to be obtained also. This would have given this thesis input from a wider range of stakeholders who are related/interested/responsible for RFID adoption in the English NHS. To widen the net of stakeholders involved, interviews and workshops could have been conducted with patients or non-technical care givers/employees of the NHS. This could have widened the perspectives gained for this present study. Due to the focus on RFID, including non-technical stakeholders may have required extra steps to ensure participants understood the technology in question. Also, the HUG has a certain number of participants, selected for their expertise and knowledge of RFID and healthcare related technology and to invite other participants in would have been difficult. Moving forward, researchers could conduct studies investigating and collating the viewpoints of drivers and inhibitors of RFID of practitioners conducting pilot studies to contrast the investigation conducted thus far by this study.

6. Recommendations for future research

There are a number of recommendations for future research that can be made moving forward from this study:

6.1. **Local viewpoints of the drivers and inhibitors of RFID adoption.**

This study has investigated the drivers and inhibitors of RFID in the English NHS at the system level. Researchers could investigate the drivers and inhibitors of RFID adoption from the perspective of local practitioners. For example, hospitals inventory managers, surgical nursing staff and those responsible for operational efficiency in hospital settings.

6.2. **Exploring when to introduce consistency checking to the intuitive logics scenario planning process.**

During Workshop 2, each pair is asked to choose two sets of two uncertainties to place on a matrix, producing 20 initial scenarios. Each scenario is then briefly outlined. This took a significant amount of time during Workshop 2..

This leads to the consideration of when the consistency check grid should be introduced in the overall process. The checking of the consistency of the relationships between uncertainties could be conducted before the pairing of uncertainties during Stage 4:

Choosing themes and developing scenarios. Checking the consistency of the relationships between uncertainties, if conducted before the pairing of uncertainties during Stage 4 could save time during the scenario planning process. This could allow for the participants to select uncertainties for pairing that they knew already to have strong relationships due to conducting the consistency check grid beforehand. This would mean that instead of labelling this step as ‘checking the internal consistency of the scenarios’, it should be labelled as ‘checking the strength of relationships between uncertainties’. Internal consistency of the scenarios can only be checked once they are written.

However, to introduce the only internal consistency check this early in the process could be detrimental to the final output by not having a further check conducted once the final scenarios have been written in full. This question of when and how often to introduce consistency checking mechanisms to the scenario planning process, especially in time constrained settings could be an important topic for future research. Technology Roadmapping has had its “Fast Start” (Phaal et al., 2000) movement of streamlining the technology roadmapping process for time constrained settings and perhaps scenario planning would benefit from time saving efforts too.

6.3. **Different combinations of scenario planning and technology roadmapping to address their weaknesses**

This thesis presented one way of combining scenario planning and technology roadmapping. Other ways of combining the two techniques should be explored in order to identify other possible paths to alleviating their weaknesses.

6.4. **Deployment of the conceptual foresight model in other settings**

The technology foresight model developed and deployed in this study is not only limited to RFID adoption in the English NHS. The conceptual foresight model can be deployed in other settings where there is a requirement to develop short term planning activities in the areas of internal business strategies, products/services, technologies and resources and to gain long term understanding of the macro environment. Deployment in these settings could provide further proof of the concept, identify strengths of the model and indicate areas for further development.

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Appendix

1. Consistency Check Grid

Pair 1

Uncertainty	Level of rationed healthcare	Level of 'capital' budget to adopt new technologies for NHS hospitals	Health of the population in terms of obesity, mental health, aging issues	Level of availability of Energy resources	Level of quality online Patient records	Level of privatization of healthcare services	Migration of people from different parts of the world	Level of global technology regulations	Level of care expected	Cyber attacks	Global adoption of the same data standards across healthcare	Fluctuations in technology regulation
Level of rationed healthcare	X	M	S	W	S	S	M	M	W	VW	W	W
Level of 'capital' budget to adopt new technologies for NHS hospitals	X	X	VS	S	S	M	W	W	VW	M	M	M
Health of the population in terms of obesity, mental health, aging issues	X	X	X	VW	S	W	W	VW	S	VW	W	VW
Level of availability of Energy resources	X	X	X	X	VW	VW	W	M	W	W	W	W
Level of quality online Patient records	X	X	X	X	X	S	W	S	S	S	S	S
Level of privatization of healthcare services	X	X	X	X	X	X	M	W	VS	W	S	W
Migration of people from different parts of the world	X	X	X	X	X	X	X	W	S	VW	S	W
Level of global technology regulations	X	X	X	X	X	X	X	X	W	S	S	S
Level of care expected	X	X	X	X	X	X	X	X	X	W	S	M
Cyber attacks	X	X	X	X	X	X	X	X	X	X	S	S
Global adoption of the same data standards across healthcare	X	X	X	X	X	X	X	X	X	X	X	VS
Fluctuations in technology regulation	X	X	X	X	X	X	X	X	X	X	X	X

Pair 2

Uncertainty	Level of rationed healthcare	Level of 'capital' budget to adopt new technologies for NHS hospitals	Health of the population in terms of obesity, mental health, aging issues	Level of availability of Energy resources	Level of quality online Patient records	Level of privatization of healthcare services	Migration of people from different parts of the world	Level of global technology regulations	Level of care expected	Cyber attacks	Global adoption of the same data standards across healthcare	Fluctuations in technology regulation
Level of rationed healthcare	X	W	S	VW	VW	VW	W	VW	M	VW	VW	VW
Level of 'capital' budget to adopt new technologies for NHS hospitals	X	X	W	VW	S	VW	VW	M	M	VW	M	W
Health of the population in terms of obesity, mental health, aging issues	X	X	X	W	Take the "online" out? W	W	M	VW	S	VW	VW	VW
Level of availability of Energy resources	X	X	X	X	VW	VW	VW	VW	VW	VW	VW	VW
Level of quality online Patient records	X	X	X	X	X	VW	VW	VW	VW	VW	VW	VW
Level of privatization of healthcare services	X	X	X	X	X	X	S	VW	M	VW	VW	VW
Migration of people from different parts of the world	X	X	X	X	X	X	X	VW	M	VW	VW	VW
Level of global technology regulations	X	X	X	X	X	X	X	X	VW	W	M	M
Level of care expected	X	X	X	X	X	X	X	X	X	VW	VW	VW
Cyber attacks	X	X	X	X	X	X	X	X	X	X	VW	W
Global adoption of the same data standards across healthcare	X	X	X	X	X	X	X	X	X	X	X	M
Fluctuations in technology regulation	X	X	X	X	X	X	X	X	X	X	X	X

Pair 3

Uncertainty	Level of rationed healthcare	Level of 'capital' budget to adopt new technologies for NHS hospitals	Health of the population in terms of obesity, mental health, aging issues	Level of availability of Energy resources	Level of quality online Patient records	Level of privatization of healthcare services	Migration of people from different parts of the world	Level of global technology regulations	Level of care expected	Cyber attacks	Global adoption of the same data standards across healthcare	Fluctuations in technology regulation
Level of rationed healthcare	X	VS	VS	VW	W	S	M	W	S	VW	W	W
Level of 'capital' budget to adopt new technologies for NHS hospitals	X	X	VS	VW	S	S	M	S	M	W	S	M
Health of the population in terms of obesity, mental health, aging issues	X	X	X	M	S	M	S	W	VS	W	S	M
Level of availability of Energy resources	X	X	X	X	VW	VW	VW	VW	W	VW	VW	VW
Level of quality online Patient records	X	X	X	X	X	M	VS	S	S	W	VS	S
Level of privatization of healthcare services	X	X	X	X	X	X	W	S	S	W	M	M
Migration of people from different parts of the world	X	X	X	X	X	X	X	S	S	W	VS	S
Level of global technology regulations	X	X	X	X	X	X	X	X	S	W	S	VS
Level of care expected	X	X	X	X	X	X	X	X	X	VW	S	M
Cyber attacks	X	X	X	X	X	X	X	X	X	X	W	W
Global adoption of the same data standards across healthcare	X	X	X	X	X	X	X	X	X	X	X	VS
Fluctuations in technology regulation	X	X	X	X	X	X	X	X	X	X	X	X

2. Informed Consent Form

INFORMED CONSENT FORM

INFORMATION AND PURPOSE

The interview you are being asked to participate in is a part of a research study that is focused on examining the adoption of AIDC in the English Healthcare System. The purpose of this study is to gain a better understanding of barriers/enablers.

YOUR PARTICIPATION

Your participation in this study will consist of an interview lasting approximately one hour. You may pass on any question that makes you feel uncomfortable. At any time you may notify the researcher that you would like to stop the interview and your participation in the study. There is no penalty for discontinuing participation.

CONFIDENTIALITY

The interview will be digitally recorded; however, your name will not be recorded on the tape. Your name and identifying information will not be associated with any part of the written report of the research. All of your information and interview responses will be kept confidential. The researcher will not share your individual responses with anyone other than the research supervisor.

DISSEMINATION OF RESULTS

There are a number of ways results will be available to interviewees. Copies of the final research report will be available, both hard and electronic. Each interviewee will be given an executive summary from the final report. If requested, meeting individually to discuss results and recommendations. If you have any questions or concerns, please contact the researcher:

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By signing below I acknowledge that I have read and understand the above information.

I am aware that I can discontinue my participation in the study at any time.

Signature____ Date_______________

Interviewee 7. Notes of transcript and to see publication pre submission.

3. Technology roadmapping Frameworks.

Interviewee 1.					
	Past	Year 1	Year 3	Year 10	Vision
External					
Internal Business Strategy		DoH / NHS England gains mandating rights and takes the lead	Health Assessment and Screening programs to be a priority for the NHS agenda	Rationing/Sharing a budget for each person of healthcare costs	
Products/Services/Systems			Pre-emptive screening for major diseases Delicate balance in Broad brush/highly targeted screening	Pre-emptive screening for major diseases	
Technology			Home monitoring	Home monitoring	- Home monitoring - Visibility to the general public of episodes of care i.e. audit tools
Resources			Industry led tech project but with health service collaboration	Industry led tech But with health service collaboration	Industry led tech but with health service collaboration

Technology Roadmapping Framework 1

Interviewee 2.					
	Past	Year 1	Year 3	Year 10	Vision
External					
Internal Business Strategy		Working with large, successful customer information organisations (i.e. IBM) Define what the NHS is actually responsible for? I.e. public health, physiotherapy. Satellite public health issues.	Qualified persons making decisions	Centralisation enabled on decisions of all aspects of the healthcare system. Local requests can be assessed by DoH	A singular decision making process
Products/Services/Systems		Relevant stakeholders informed of centralized system change. Roadmaps produced to bring clarity for the path to Centralisation	Central Systems available with multiple interfaces depending on type of person/organisations using the system	Centrally governed systems. Migration systems for paper	Getting away from any paper processing
Technology			Further papers for stakeholders of specifics of technology. Central Systems available with multiple interfaces depending on type of person/organisations using the system		
Resources		Subject matter expertise, not clinical leads dealing with other aspects such as information standards	Contracts with multi purpose interface system providers. Working level staff involved with the design of the system. Decision making staff decide which staff members require access to which		

			interface. What each staff profession is actually responsible for. I.e. clearer scope of what each professional role		

Technology Roadmapping Framework 2

Interviewee 3.					
	Past	Year 1	Year 3	Year 10	Vision
External					
Internal Business Strategy		Policy level change	Planning for the healthcare system over a longer term than the current election cycle		
Products/Services/Systems				Policy level change implemented by systems	
Technology					
Resources					

Technology Roadmapping Framework 3

Interviewee 4.					
	Past	Year 1	Year 3	Year 10	Vision
External					
Internal Business Strategy					Mandated IT standards by DoH
Products/Services/Systems			Centrally developed database for identification of products and shared standards between proprietary systems	Working with stakeholders on technology and information standards	Product identification/ information management systems shared by the healthcare industry
Technology					Technology products and systems guided by the DoH (reactive development of systems)
Resources		Technology capability assessment projects Applied product development research	Joint R&D projects commissioned by DoH to work with industry		Working with similar stakeholders to today but with more user groups

Technology Roadmapping Framework 4