Northumbria Research Link

Privacy and Security of Electronic Patient Records – Tailoring Multimethodology to Explore the Socio-Political Problems Associated with Role Based Access Control Systems

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Abstract

Multimethodologies are now an established area of 'soft' operations research (OR). Adopting appropriate OR methods to tackle unstructured and complex problems is a promising field of inquiry and potential application. Research in the areas of energy and utilities, education, UK public services, and healthcare has demonstrated the success of applying multimethodologies to practice. This research focused on the socio-political and socio-cultural issues associated with the specification and design of a Role Based Access Control (RBAC) system as a precursor to the adoption of an electronic health and patient record system in an English National Health Service (NHS) hospital Trust. Although being a local hospital Trust initiative, there were many complex requirements and constraints from UK NHS policies, strategies and standards, as well as from government contracted IT company vendors, consultancy companies and software consortia (termed Local Service Providers). This research develops a multimethodology, using SSM in combination with process modelling and technology management (referred to as TM^{SSMXL}), in order to tailor problem structuring methods to a healthcare hospital context. The research concludes that by adopting methods that are compatible with an organization's culture, stakeholder perspectives and professional working, a suitable mix of OR methods may be combined and deployed that can enable, and enhance, stakeholders' knowledge and learning about the unforeseen organizational consequences of complex technology introduction. It is argued that this leads to more effective technology systems requirements definition and greater project implementation success.

Keywords: **Problem Structuring; Multimethodologies; Role Based Access Control; Soft Operational Research; Electronic Health Records.**

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1. Introduction

The provision of an efficient, high quality, sustainable and cost effective healthcare service is now seen as one of the grand challenges for both developed and developing economies (OECD, 2011; 2015). The rising demographic related to worldwide ageing populations is giving governments major concerns over how economies and societies will be able to meet growing healthcare demand (Bloom *et al.*, 2010). Challenges arise based on population needs, growing shortages of qualified healthcare professionals, and the cost of investing in new healthcare technologies and innovations, as well as imposed austerity measures (Brailsford and Vissers, 2011; OECD, 2011; Lodge and Hood, 2012; Hicks *et al.*, 2015; OECD, 2015). With the rise of new technologies comes the security concern in securing and restricting access to patient records to individuals who require such access. How technologies are designed and configured plays a key role in how access can be controlled. Due to the multidisciplinary nature of the healthcare sector and the stakeholders involved, identifying the best technological design creating a technology that meets multiple government and industry standards, and implementing such a technology, is a challenging problem (Edwards *et al.*, 2005; Leonard *et al.*, 2005; Gunasekaran *et al.*, 2006; Brailsford and Vissers, 2011; Ciani *et al.*, 2016). Multimethodology is one approach that can be used to explore and tackle such multifaceted socio-political, socio-cultural, and technical problems.

The development of multimethodologies, especially those incorporating problem structuring methods (PSM), are a maturing field of 'soft' operations research (OR) (Ackermann, 2012; Midgley *et al.*, 2013). Adopting appropriate OR methods has become a key research area for management practitioners and operational researchers alike, as well as academics from other disciplines (Ferreira, 2012). Problem structuring methods (PSM) are a group of problem handling techniques whose primary purpose is to assist with learning about, and potentially help solve, complex problems (Rosenhead, 1996); whilst multimethodology is a way to draw on a number of different perspectives and combine them to create a joint understanding and interpretation of different perceived realities (Lane and Oliva, 1998; Mingers, 2001). Multimethodology is easily explained as using "*more than one method or methodology…in tackling some real-world problem*" (Mingers, 2001, p. 289). Multimethodologies could be argued to provide a framework that encompasses methods that are tailored to a problem situation under investigation (Watson, 2012; Midgley *et al.*, 2013). This tailoring will depend on the user(s) identification of what is suitable (workable solutions taking into account the constraints of a situation) for a problem context (Watson, 2012; Henao and Franco, 2016). It could be argued, therefore, that PSM could lead to the application of a multimethodology either through formal planning prior to entering the problem

situation (e.g., Jackson and Keys, 1984; Midgley, 1997; Lane and Oliva, 1998; Rouwette *et al.*, 2009; von Winterfeldt and Fasolo, 2009), or as the problem situation emerges over the problem lifecycle (e.g., Bennett, 1985; Ormerod, 2008; Franco and Lord, 2011; Small and Wainwright, 2014) – as identified by Mingers and White (2010).

The first section of the paper provides a review of multimethodology in action where multimethodology combinations have been used to structure and provide solutions for complex problems from different sectors and from around the world. The paper then goes on to present multimethodologies encountered in healthcare organizations before seeking, defining, and explaining why role based access control (RBAC) may be perceived as a complex problem that requires a more socio-politically informed (especially with regards to professional healthcare working and information governance and security policies) approach to technology justification, selection and implementation. The second section provides an account of the research project and methodology adopted in this research. The third section presents the findings from the research with appropriate examples of how the multimethodology was devised and used in practice. The fourth section focusses on the evaluation, findings, and discussion of the outcomes. The fifth and final section concludes the paper.

2. Multimethodology in Action

Multimethodologies, although initially developed and promulgated in Europe, are now increasingly used in OR practice worldwide. For example, multimethodologies have been applied in: the Netherlands (Vos and Akkermans, 1996); Sweden (Sorensen *et al.*, 2004); USA (von Winterfeldt and Fasolo, 2009); Australia (Pollack, 2009); Pakistan (Thunhurst, 2003); Peru (Paucar-Caceres and Rodriguez-Ulloa, 2007); Colombia (Henao and Franco, 2016); and South Africa (Pauley and Ormerod, 1998; Petkov *et al.*, 2008; Siriram, 2012). Research has demonstrated the many sectors that multimethodologies have been applied to. For example, energy and utilities (Ormerod, 1999; White, 2009); education (Casu *et al.*, 2005; Paucar-Caceres, 2009); UK public services (Eden and Ackermann, 2004; Greasley, 2005; Brown *et al.*, 2006; Kinloch *et al.*, 2009); and healthcare (Kotiadis and Mingers, 2006; Boyd *et al.*, 2007; Tako and Kotiadis, 2015). These studies evidence that the balance of debate has now moved in favour of the extended application of OR methods across a range of problem structuring contexts (Rosenhead, 1996; Mingers and Rosenhead, 2004; Eden and Ackermann, 2006; Mingers, 2015). In addition, the choice and sequence of candidate methodologies relative to a problem context can often be critical. For example, Pollack (2009) examined how hard and soft OR methodologies can be combined both in series and

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parallel, where the application of a multimethodology in series is seen as the most straightforward and popular approach.

Multimethodology, used in parallel, is seen as providing enhanced potential for solving 'wicked' and more complex socio-political problems associated with information systems strategic planning and systems implementations. Pollack (2009) reported on the use of SSM (soft) in combination with project planning (hard) methods in the Australian public sector, focusing on the 'embedding' of soft and hard methods rather than 'grafting' two methods in series. Pollack (2009, p. 158) stated that: "*a soft methodology, such as SSM, is used to continuously explore and learn about the problem situation, while a hard methodology is used to facilitate implementation or product delivery*" and that: "*parallel multimethodology allows a collaborative and facilitative approach to be sustained throughout the whole project, emphasizing continuous learning and adaptation to change, while a hard approach is used to analyse specific aspects of the situation, develop conclusions or deliver project products...where this approach could be used to continuously refine project objectives and explore alternatives while potential solutions were being developed*".

Reviews of the development and application of problem structuring methods (PSM), 'soft' OR methodologies and techniques, and in particular multimethodology theory and development (Munro and Mingers, 2002; Petkov *et al.*, 2008; Mingers, 2011; Ackermann, 2012; Midgley *et al.*, 2013), highlighted the popularity of using Soft Systems Methodology (Checkland, 1981) as a preferred PSM 'front end' for multimethodologies, which is then combined with one or several complementary methodologies, methods or techniques. The combination of SSM with harder approaches has now started to be used in practice (for example, Holm *et al.*, 2013). This paper builds on the work of Small and Wainwright (2014) who combined SSM with technology management (Soft Systems Methodology eXpanded for Learning incorporating Technology Management – abbreviated to SSM^{XLTM}) to specify, design and implement a quality control system in a manufacturing company, and an exploration of the use of multimethodology in practice. This paper applies multimethodology in order to define multiple stakeholder requirements involved in exploring the current and proposed 'new system' of issuing of smart cards, which are associated with role based access control systems in a healthcare context. Healthcare is a more diverse and complex sector than manufacturing. The suitability of applying multimethodologies to this sector, which is still dominated by a positivistic and scientific paradigm, may be open to question – especially within institutional cultures that are focused on material and physical

outcomes that are historically driven by hard scientific or single paradigm hard OR methodologies and techniques such as simulation modelling (Mingers and Brocklesby, 1997). However, multi-paradigm multimethodologies have been applied within a healthcare context since the 1990's, and are just as relevant at tackling problems now as back then.

2.1 Multimethodology use in healthcare OR problems

The use of multimethodology in the healthcare sector has been applied to a number of different themes, including: strategy; policy; care in the community; information systems use; and improving hospital wards, to name a few. A selection of studies and the multimethodology adopted are presented here. Thunhurst and Barker (1999) drew on the problem structuring method of problem trees to help create more effective strategic plans in the Pakistan healthcare sector. The adoption of the problem structuring methods varied by province depending primarily on the skill level of the individual planning offices. The methods were not presented as a 'one size fits all' approach but were drawn on as required at each stage of the process. Thunhurst and Barker (1999) concluded that the problem trees were useful and were being used frequently in the planning process, but the take up of the more sophisticated ranking methods were less popular. Connell (2001) deployed Soft Systems Methodology (SSM) to take account of a number of different stakeholders in order to design an information system to support users who provided care in the community. Connell (2001) pondered how successful the outcome of the project actually was. Connell's (2001) concerns focused around the suitability of SSM to that particular problem domain, and whether the methodology had been applied correctly. However, the project was deemed successful at a time when the National Health Service was facing severe stress.

In terms of health policy and strategy, Fahey *et al.* (2004) developed a multimethodology that was applied to public health in order to evaluate the demand for information and communication technologies (ICTs) to be incorporated into the public health network. The authors adopted Soft Systems Methodology (SSM) and complemented its use by developing input/output models and evaluation trees as a way to model the networks. The use of a cybernetic model was also adopted in order to summarise the current network under investigation before an input/output model was developed, which created the evaluation plan (Fahey *et al.*, 2004). The authors concluded that adopting their multimethodology helped them understand the core elements of the public health network and its interconnected causal relationships – and along with the use of SSM, allowed the creation of an action plan that was used to evaluate the network.

In 2005, the Journal of the Operational Research Society (JORS) published a special issue on meeting the challenges faced in the healthcare sector with OR (Davies and Bensley, 2005). The special issue published eleven papers from an eclectic area of healthcare settings. These included: "*the staffing of an intensive care unit (ITU), the location of dental services, residential and nursing care for the elderly, planning walk-in centres, the provision of muscular-skeletal services, organization of hospice care, information technology (IT) provision for emergency services, the provision of services for the mentally ill, the transmission of variant Creutzfeldt-Jakob disease (vCJD), the comparative cost- effectiveness of drugs for osteoporosis and the vertical transmission of HIV*" (Davies and Bensley, 2005, pp. 123-124). The approaches these papers drew on included 'Soft OR', simulations (spread sheet simulations, discrete event simulations), and knowledge management (Davies and Bensley, 2005). It is not practical to provide a full review of the eleven papers but readers are pointed towards this special issue.

Kotiadis and Mingers (2006) (a further special issue of JORS on problem structuring methods) combined SSM and Discrete Event Simulation (DES) to Intermediate Care for the elderly. They applied SSM and DES at the same time allowing outcomes from one approach to feed into the other. The authors found that this application improved the results of the other methodology. Like many applications of multimethodology, the application was not without its challenges, but the outcome of the work achieved more than expected and allowed new services to be introduced into the region (Kotiadis and Mingers, 2006). With regards to ICT adoption by health organizations, Westbrook et al. (2007) designed a multimethodology to evaluate the impact of a computerised order entry system in a medical centre in Sydney, Australia. The authors extended socio-technical theory to include a complexity dimension in order to incorporate the professional cultures that characterise healthcare work. The multimethodology was conceptualised around three key areas, namely: work and communication patterns; organizational culture; and safety and quality (Westbrook et al., 2007). The authors concluded that their approach was beneficial in taking a systems perspective to the evaluation through drawing on the different dimensions of process and outcome. The multimethodology provided flexibility in terms of its use at pre as well as post-implementation phases of IT systems, and facilitated communication between the specialisms that make up healthcare (Westbrook et al., 2007).

The development of new causal and simulation models, used in various combinations with SSM, for increasing the efficiency and effectiveness of healthcare operational systems have been an area of

recent focus. Holm et al. (2013) combined Soft Systems Methodology (SSM) with Discrete Event Simulation (DES) and used both methodologies in parallel. The multimethodology was applied to investigate how increasing patient numbers could be managed for a surgical unit in a hospital in Norway. The multimethodology proved useful to the participants involved with a number of the outcomes identified already being implemented, however, what was more of value was the identification of the importance of team behaviour and softer skills required in surgery (Holm et al., 2013). Research by Tako and Kotiadis (2015) also combined Discrete Event Simulation (DES) with Soft Systems Methodology (SSM) to create PartiSim. PartiSim has been designed to support modellers who are experts in DES with stakeholders who are experts in the problem domain. Tako and Kotiadis (2015) have used PartiSim on two cases in the National Health Service UK, so far, and the multimethodology was found to work well in bringing about agreement in taking action to improve the problem situation. Similarly, Pessôa et al. (2015) used cognitive and causal mapping as a problem structuring method to enable health professionals to understand how DES could be used to model scenarios to demonstrate how surgical throughput can be increased in hospitals.

The use of multimethodology in the healthcare sector raises important questions in terms of which particular combinations work well, to what effect, and in which problem types and contexts? Of particular interest are those combinations which use a 'soft' OR front end as a method to learn about and structure a problem situation, which may then have the potential to complement the use of 'harder' OR methodologies and techniques (Brown *et al.*, 2006). This may then be used for the design of solutions for complex organizational problems that can typically involve IT requirements determination, developments, or implementation and process redesign. This is especially important as any multimethodology may have to be commensurable with other project management approaches healthcare providers may (need to) adopt. For example, the UK National Health Service requires all Information Technology projects to utilise the PRINCE2 project management methodology.

Our research builds on these studies and the lessons learnt through applying multimethodology in healthcare by investigating a complex introduction of Role Based Access Control (RBAC) to a National Health Service (NHS) hospital Trust in North East England, UK, in order to allow employees to access Electronic Health Records both locally and nationally. This was part of the UK government's £6.2bn (€9.2bn, $11.1bn) National Programme for IT (NPfIT) healthcare transformation project (Humber, 2004) (later rebranded 'Connecting for Health' with costs rising to £13 + billion). Although being a local

initiative for the hospital Trust, there were many complex requirements and constraints from NPfIT government policies, strategies and standards, as well as from the NHS government contracted IT companies and technology vendors, large management consultancy firms and software consortia (called local service providers).

2.2 Problem Context: Electronic Health Records and Role Based Access Control

It is increasingly perceived that digital health technologies, such as the design and adoption of electronic health/medical/patient records (EHRs, EMRs, EPRs), and more recently personal health records (PHRs), will provide new opportunities for more effective integration of health and care services. Such technologies could lead to gains in efficiency and make more effective use of shrinking resources (World Health Organization, 2006). A growing barrier to the effective adoption of these new technologies that are based on the large scale acquisition, storage, and use of sensitive human individual patient data, are issues related to information sharing, privacy and security (Pagliari *et al.*, 2007). The access to patient information, particularly in the new era of 'Big Data', is a complex and growing area of concern where patients are not the only stakeholders (Detmer *et al.*, 2008). Other stakeholders include: hospital personnel, both generalist and specialist clinicians; family members; laboratory workers and biomedical staff; health organizations; pharmacies; ancillary medical staff; insurance companies; governments; and community agents. These community agents can include: the police; ambulance; social housing providers; social and care service providers; and scientists and researchers. Privacy can relate to identity protection, preservation of anonymity and access control and authorization models and systems (Peleg *et al.*, 2008).

The complexity of moving from paper based records to EHRs is compounded by the need to adopt highly sophisticated, secure and rigorous forms of access controls, processes and procedures. This involves not only secure computer and software applications access, but also physical access to buildings, wards, rooms and use of physical artefacts, inventory and infrastructure. This is especially important where these systems will involve decisions over investments, in both new technology combined with the adoption of new working practices, new privacy and security strategies, and the adoption of a new culture of secure working (Shortliffe, 2005). Organizations such as hospitals and other types of large scale healthcare providers have to make detailed business cases to justify the requisite investment in new technologies that must then be tailored to local requirements and initiatives (Tzeng *et al.*, 2008).

Role Based Access Control (RBAC) systems were first conceived and introduced in the 1990s (Ferraiolo and Kuhn, 1992; Sandhu *et al.*, 1996) leading to an American Standards Institute (ANSI) standard in 2004 with a life-cycle based on three phases. These phases include: customization involving planning, software modification and role engineering. The role engineering phase consists of setting up user's needs, access policies and assigning roles to permissions, and finally daily operations often called role management determining the role structures and keeping the assignations up-to-date. RBAC was seen to lead to positive returns on investments as it had key strengths such as: efficient management of large scale user's permissions; enforcement of need to know access controls; simplified auditing for regulatory compliance; and scalability – as access is controlled by profiles based on responsibilities, duties, job functions and qualifications where authorities are based on organizational structures (Franqueira and Wieringa, 2012). Identifiable limitations, however, are related to: unanticipated role explosions; technical (and political) interoperability issues; and rigidity to change associated with organizational, strategic and policy dynamics. As well as these issues related to technology management (Wu *et al.*, 2009) and organizational factors (Orlikowski, 2000), other limitations include funding (Hendy *et al.*, 2005) and attitudes (Chau and Hu, 2001) – but a major barrier to adoption of EHRs are the security and privacy concerns that relate to holding patient health data in electronic formats (Fernández-Alemán *et al.*, 2013). This problem is more complex than it appears on the surface, as it involves not only new forms of technology innovation, but also the redesign of business and organizational processes involving sophisticated administrative bureaucracies, professional needs, and compliance with national and international legal requirements (Anthony and Stablein, 2016). Such new working practices may create political tensions within existing clinical and medical professions as well as challenge custom, practice and autonomy (Currie *et al.*, 2012).

This literature review both reveals and highlights a number of research questions that need addressing. One question is, 'how might soft and hard methods be combined as an effective multimethodology that will be understandable and usable for both the technology focused project management sponsors and key professional stakeholders?' Secondly, can this particular multimethodology be used as a legitimate means to interrupt and refocus projects that are too narrowly technically and organizationally defined working within project management and mandatory (UK NHS determined) Prince2 (https://www.prince2.com/uk) constraints? Finally, 'can the multimethodology help reshape and complement traditional IT technical requirements and planning approaches to take greater account of, and enhance learning, to address complex organizational, socio-political and sociocultural needs?'

3. Research Methodology

3.1 Problem Overview: The Smart Card Project at Angel Hospital Trust

The organization where the multimethodology was applied consists of a set of 3 major acute NHS hospital providers, which are referred to collectively as 'Angel Hospital Trust' (not the organizations real name). Angel Hospital Trust is one of the largest NHS trusts in the UK, with over 1,800 beds offering a wider range of specialist services to over 1.72 million patient 'contacts' every year. Angel Hospital Trust prides itself on providing innovative, high standard healthcare, including community services and primary care.

The Information Management and Technology (IM&T) committee had tasked senior management to investigate and implement a 'smart card' system in response to a National Programme for Information Technology (NPfIT) (later rebranded 'Connecting for Health') requirement for managing patient records electronically, across the three hospital sites offering different services and specialties (labelled as Hospital F; Hospital R and Hospital G). The purpose of the Information Management and Technology (IM&T) Committee is to support and drive the broader agenda to deliver information technology solutions that supports clinical and operational services within the appropriate technical, operational and legal frameworks. Two priorities for the committee relate to project delivery and identifying and managing risks; relating to information governance and health informatics and developing communication between services for the benefit of patients. With a particular focus on information systems/information technology projects, the committee: promote technologies to enhance the quality of patient services; approve strategies in order to ensure consistency with both national and local strategies; and adopt a consistent project assurance mechanism for technology investment and apply rigour to applications for information technology investment, change, specification, procurement and implementation. Finally, IM&T apply priority to projects within the scope of trust and national programmes as this raises issues over future inter-operability, integration and compatibility with nationally defined systems and standards.

Access to such electronic health records needed to be strictly controlled in terms of both location/place and IT application. In order to meet governmental and local hospital requirements, users of the patient records system would be registered by the hospital Trust where the staff member/user was primarily based. Upon starting to investigate this problem, senior managers felt the problem was very complex

and presented numerous challenges. These challenges were more socio-political and socio-cultural, than technical. The researchers, comprising 2 academics from local universities, working within a small healthcare information research group, were asked if they could help untangle some of the problems by drawing on suitable academic methodologies, frameworks and techniques. The researchers introduced systems thinking concepts, using this as a suitable opportunity to further develop and apply a multimethodology to the problem domain.

Angel Hospital Trust required each member of staff to provide proof of their identity and have a photograph taken prior to production of a unique 'smart card'. The information system, therefore, would allow all individuals that make up Angel Hospital Trust, in addition to new starters joining the organization, to be issued with this Role Based Access Control smart card. The 'smart card' ultimately would allow the individual to access site locations as well as IT systems containing the appropriate records, workflow processes and documentation associated with their role. A two-way conflict emerged between the government top-down led NPfIT and Local IT Service Provider organizations and Angel Hospital Trust management team as to the functionality, use requirements, and aesthetics of the smart card. NPfIT wanted Angel Hospital Trust to adopt a smart card to access national (standardised summary) healthcare records stored on the NHS 'N3 spine' that was plain in design with only an NHS logo depicted on the front. This meant the smart card could not double-up as an identification badge for local hospital use as well as a smart card for role based access control. Further to this stipulation, NPfIT wanted Angel Hospital Trust to use a smart card that could only have one set of IT security/network authentication certificates stored in the chip, whist Angel Hospital Trust wanted two sets of certificates (the NPfIT certificates for national N3 network access and Angel Hospital Trust's own certificates for Trust healthcare ICT and building location access). Secondly, at the hospital Trust level, there were disagreements around who would do the issuing of smart cards, especially if this function was extended to incorporate RBAC. How to resolve these two issues was a problem for the Trust. As a consequence, the multimethodology used needed to take account of this increasingly tense and political issue.

3.2 The Application of Multimethodology
The multimethodology adopted an appropriate combination of a 'soft' OR methodology (SSM expanded for learning, SSM^{XL}) together with what might be viewed as a 'hard'/functional OR process modelling technique using the IDEF0 notation, all encapsulated within a technology management methodology (Figure 1). This extension, however, is focused more on using both methodologies (SSM^{XL} and

Technology Management) in a parallel combination as the multimethodology in order to clarify stakeholder understanding of complex healthcare technology introduction. Angel Hospital Trust wanted to conduct the research by using the researchers on site as expert facilitators. The Trust were familiar with employing management consultants for major IT projects. In this case, one of the researchers would undertake the RBAC investigation on behalf of Angel Hospital Trust. As a consequence, the multimethodology had to initially be used in 'mode 2' as the multimethodology was "*acted out in the process of work and daily problem structuring, described as 'doing work using SSM'" (Checkland and Scholes, 1990, p. 280).* Two immediate problems then occurred. Firstly, this contradicts the co-research production model and participative philosophy under which SSM^{XLTM} was developed. Secondly, the original SSM^{XLTM} (Small and Wainwright, 2014) multimethodology would need to be 'reversed', or SSM^{XL} used in a parallel as opposed to a sequential mode, as the technology management methodology would be the starting point, and the Trust had already identified an electronic smart card as a mechanism to enable RBAC.
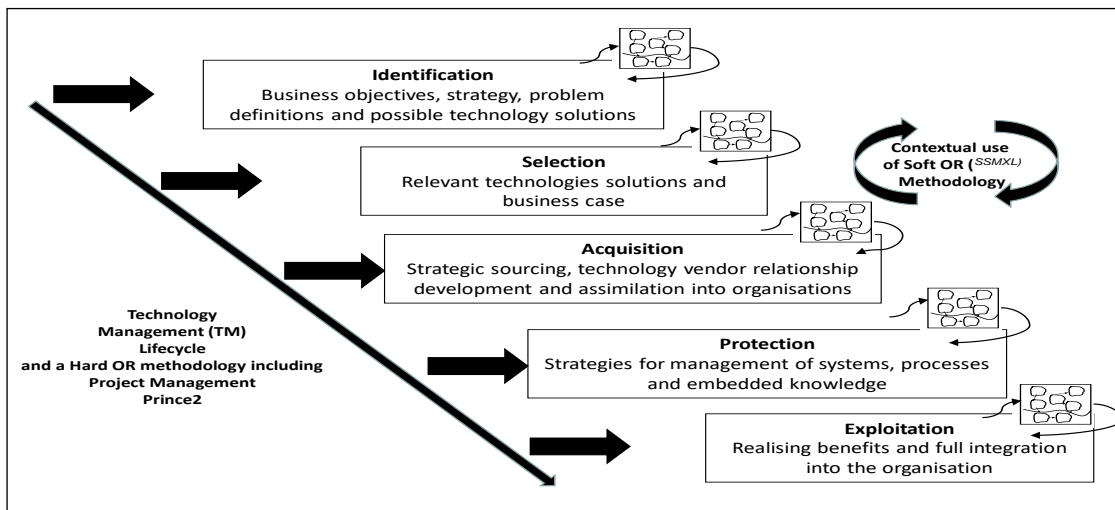
Figure 1. TM^{SSMXL} Multimethodology Applied to Angel Hospital Trust

In essence, a Role Based Access Control system solution had already been 'identified', along with some possible candidate technologies, but how this organizational design process should be undertaken, and by whom, was not clear and this now needed to be identified. The project was less about the technical complexities of role based access control and more on the socio-technical aspects the implementation of role based access control would have on the Trust and its employees in offering healthcare.

Due to the recursive nature of the selected multimethodology, and its underpinning problem structuring techniques, the SSM^{XL} element would be required to facilitate revisiting the initial selection and acquisition of the technology, as shown in Figure 1. This reversal of SSM^{XLTM} multimethodology (Soft preceding a Hard methodology in sequence) to create a Technology Management multimethodology incorporating SSM^{XL} now termed (TM^{SSMXL}) (Hard preceding Soft methodologies or both used in parallel) needed to be investigated in terms of the research questions identified.

In order to begin structuring the problem from the beginning of the RBAC process, an investigation into how staff employees currently obtain their identification badges needed to be undertaken. This would allow a cross validation (Miles, 1979) to be performed on whether the most suitable technology had been identified as well as investigate which technology could actually be selected in order to satisfy the problem situation. The Trust perceived that RBAC systems would be centred around and fully integrated into a new staff smart card. Therefore, all existing employees would need to be issued with a replacement card, whilst all new employees would be required to obtain a smart card prior to attending their place of work (otherwise they would not have access to particular IT systems, locations and key records). Employees leaving their job would need to surrender their card before exiting the organization. Angel Hospital Trust did not have a formal documented standard operating procedure for starters and leavers, or processes involved in obtaining and surrendering identification badges. Finally, it needed to be understood which department(s) would be best suited to issue the smart card as they would have a key responsibility in assigning role based access rights to employees.

3.3 Research Methods

Interviews were conducted with 11 key stakeholders of the project, including: Information Manager for IT (Project Leader), Workforce Planning Manager, Human Resource Employee, IT Manager, Security Manager, Medical Staffing Employee, IT Security Officer, Senior Staff Nurse, Personnel Director, IT Project Manager, and IT Security Employee. Some interviewees were interviewed more than once. In total, 18 interviews were conducted. In addition, 3 follow-up interviews with senior managers were performed post-hoc, to verify our analysis and interpretation of events with respect to the final decisions made and the RBAC solution adopted.

Interviews averaged 50 minutes, were fully transcribed and were analysed using the ATLAS.ti qualitative analysis software. Thematic coding (Miles and Huberman, 1994; Miller and Crabtree, 1999; Fereday and

Muir-Cochrane, 2008) was used to categorise and classify the data in order to identify key issues and problem areas. On average, the transcription of each interview took three hours. Transcription was performed by one of the researchers. This provided a mechanism to compare the voice recordings with the detailed notes taken during the interviews and the interview summary sheets used to help record initial interview outcomes (see Miles and Huberman, 1994). Any ambiguities or clarifications were followed-up with the interviewee. This approach also provided participants with the opportunity to review the interview transcript and add or request specific parts of the interview to be removed (in line with the ethics of research). Ethics procedures were fully adhered to, and permissions obtained. A detailed researcher diary was recoded throughout the research. The analysis of the data took eight months to complete.

4. Applying TM[SSMXL]

4.1 The Problem Situation Unstructured

An informal meeting was conducted with the Information Manager for IT (project leader) in order to form an initial understanding on how an individual staff member could enter and leave the Trust. The process for new starters as envisioned is depicted in Figure 2.
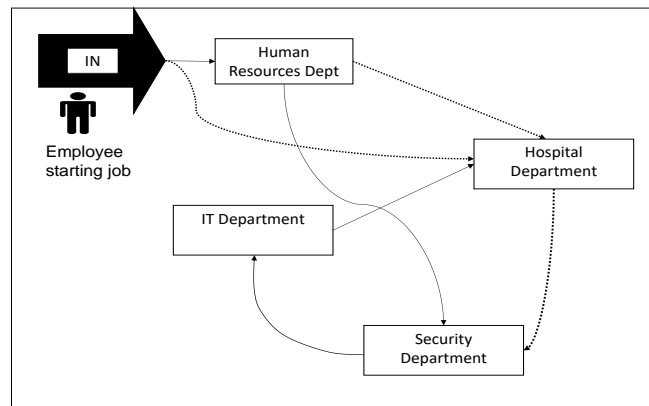
Figure 2. The Process of Individual Staff Smart Card Registration with the Hospital as originally envisioned

When individuals enter the Trust and start work, it is believed they do so through firstly contacting the Human Resources department. New employees, however, may turn up at their home department first – before going to Human Resources (the dotted lines in Figure 2 show where the process may be circumnavigated). Individuals have to attend Human Resources on their first day to sign their contract

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officially, allow payment for employment to be made, and to collect an ID badge authorisation form. Individual's needed to provide proof of identity (e.g., a passport, driving licence etc.) and proof of address (e.g., bank statement, utility bill etc.) in order to sign their contract. On collection and completion of the ID badge authorisation form, employees could then attend ID badge sessions administered by the security department. The ID badge sessions would be run three times a week. Individuals just needed to provide proof of employment (issued by the HR department) in order for security to take a photograph of the individual and create the ID badge. Once an ID badge was obtained, employees could contact the IT department to arrange for an IT account to be set-up. All that the IT department required, was an ID badge from the employee as proof of employment. The leaving process for Trust staff was similarly envisioned to be as depicted in Figure 3.
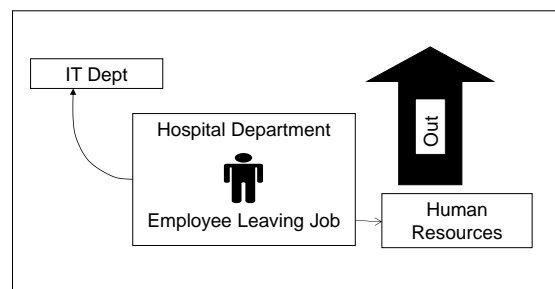

Figure 3. The Process of Individual Staff Leaving the Department/Angel Hospital Trust

On leaving the Trust, it was envisioned that employees will inform their department before contacting Human Resources. Following this, the IT department are then informed, but it was unknown precisely how this would happen. Whilst both Figure 2 and Figure 3 presented ideas about the envisioned process, it was unknown which particular (or combination of) stakeholders held these ideas. This gave a problem, firstly, to the researchers, and secondly, to the project leader who wanted to test the validity of this mental model. Without a clear process determining how individuals enter employment, register their ID, and conversely leave Angel Hospital Trust, no decision could be taken on which department or individuals, should be responsible for: firstly, undertaking the issuing of smart cards, secondly, determining the training requirements such a technology requires, and thirdly, specifying the type of RBAC technology and infrastructure that could effectively be deployed and used.

4.2 Structuring the Problem Situation

Appropriate stakeholders associated with the RBAC project were identified and interviewed in order to gain a clearer understanding of the envisioned RBAC process and proposed technology requirements

and infrastructure. The key learning outcomes of the interviews are presented in Appendix 1. Key

stakeholders were 'shadowed' to observe how they undertake their role and the types of processes that

were currently in use. From the interviews undertaken and the observations of workflow and

administrative processes conducted, SSM rich pictures were used to communicate these findings back to

the project team. This would enable the project team to learn about the hidden complexity of the

current and proposed system. This moved the mode of TM^{SSMXL} from mode 2 to mode 1 (i.e., following a

more prescribed sequence of activities for problem structuring and identifying proposed solution

alternatives). The complete rich picture is shown in Figure 4.
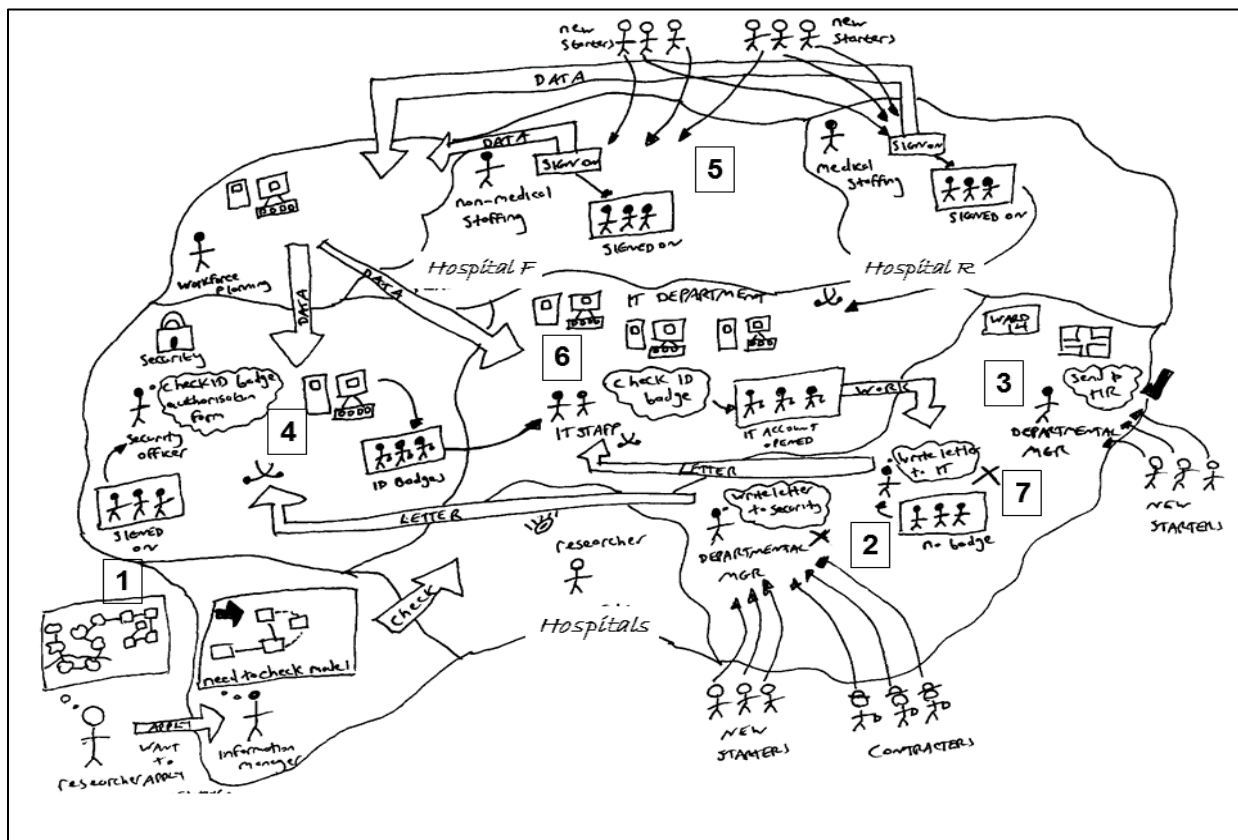
Figure 4. A Rich Picture of the RBAC and Smart Card Problem Situation at Angel Hospital Trust

Figure 4 is complex to describe but was constructed for the research and demonstrates the researcher in

Angel Hospital Trust looking at the starter/leaver process by applying the multimethodology (shown in

'1'). The key issues identified in Figure 4, and derived from the interviews and observations, include the

informal methods used to obtain ID badges and open IT accounts. This is shown as number '2' in Figure

4. The picture depicts a departmental manager writing a formal letter that a new starter or a temporary

contractor will produce to security in an attempt to get an ID badge. This is not the formal process as new starters and contractors are required to produce their official documentation to the Human Resource department first where they will receive an ID badge authorisation form (as shown by number '3').

Once employees have signed their formal documentation or turned up with a letter, the security officer checks this documentation and produces the ID badge (shown in '4'). One of the reasons why departmental managers may resort to writing the letter, as opposed to getting the employee to go through the official HR process, relates to the limited sessions held each week where employees can obtain ID badges. Therefore, there is a time pressure to obtain the ID badge at the next available session. There are differences in processes between the three Angel Hospital Trust sites (geographically separate locations, termed Hospital F, Hospital R and Hospital G) in terms of whether a new starter first goes to their department of work, or straight to the HR department. For example, there are no ID badge sessions held at 'Hospital G', so employees have to go to either 'Hospital F' or 'Hospital R' on the appropriate time and day.

There were two separate processes for recruitment, one for medical and the other for non-medical staff as shown by '5'. The medical staffing process is more organised as the new intake of starters is always known in advance. In order to assist with the medical staffing process, the medical staffing office moves between Hospital F and Hospital R.

Once employees (both non-medical staffing and medical staffing) have obtained their ID badge can they go to the IT department and open an IT account (shown in '6'). IT just need to check the ID badge and the account can be opened. However, depending on the employees role, if they do not have an ID badge (for example, they have missed a relevant ID badge session), but need IT access, the departmental manager may write a letter to the IT department to try and get the employees IT account activated (shown in '7'). Other useful information identified was that information on staff leaving Angel Hospital Trust is only provided to security once a month and a voluminous amount of data held on the current ID badge database is out-of-date (this is shown as the data arrows in Figure 4).

On revealing the rich picture to the project team, there was a lot of discourse around what the picture depicted. There was more focused questioning around what particular elements of the picture actually

communicate and how this information was uncovered. Upon further review, the project team focused the conversation down to more detailed issues in terms of why processes were configured in this way. The researcher, therefore, had to accommodate these requests and now had to re-model the outcomes in order to present the findings back to the project team. This presentation needed to be in a language that was more commensurate to formal technology management discourse and the 'hard' Prince2 project management methodology under mandated use by NPfIT, their Local IT Service Providers, and the Hospital RBAC project team in order to try and further generate a useful dialogue.

4.3 Developing the Models

In terms of the systems theory aspect of the multimethodology, a decision had to be taken on how the modelling process and models themselves should be presented. Project participants and especially senior management stakeholders seemed unwilling to make the time to learn the techniques of TM^{SSMXL}. The issue of developing a CATWOE (Customer, Actor, Transformation process, World view, Owner, Environmental constraints)(see Checkland and Scholes, 1999) and revealing this, along with developing further rich pictures, to participants to co-produce and model may be a disadvantage, as participants may be put off by the unfamiliarity of such techniques. However, the opportunity, due to the wishes of the research project sponsor based in the hospital, was never tested. The key learning points related to the modelling techniques concern issues of limited time and low participation, therefore, a number of root definitions, CATWOE's, were created by the researchers in order to model the outcomes. The researchers would then act as expert facilitators and type of advisory management consultants, before feeding back the findings to the project team using dialogue and discourse that was more familiar to them. This could be compared with what Lewis (1994) undertook in removing the language of SSM, or as West undertakes through using the Appreciative Inquiry Method (West *et al.*, 1994; West, 1995). This switched the mode of TM^{SSMXL} back to mode 2.

Developing SSM root definitions posed a problem. This aspect of soft systems promotes modelling different 'systems' based on perceived different viewpoints that could then be incorporated. This project, however, had a more structured element to it, in the sense that 'smart cards' were already a pre-determined technological solution to allow role based access permissions to be set. In theory, however, the systems modelling aspect should temporarily suspend accounts of processes in the 'real world', and require systems to be modelled that would ideally improve the problem situation. Being pragmatic (adhering to the principle of cultural feasibility as the technology solution was already being

mandated by NPfIT and their Local Service Provider IT project team), and based on the fact finding interviews, meetings and observations, the first root definition was formulated as:

RD1: A National Programme for Information Technology (NPFIT) owned and Hospital Trust run system to issue employees with smart cards in line with the government legislation guidelines.

This root definition (RD1) is very general, but at the same time useful, as it incorporates the legislative perspective that NPfIT states as a mandatory requirement for the Trust. A further two root definitions were then formulated incorporating perspectives deemed more relevant to the participants of Angel Hospital Trust. These perspectives try to take action to improve the situation relating to which department should issue smart cards. Whilst these definitions have been developed, it has to be remembered they are from the perspective of the researchers based on the data collected from the participants. This is important, as other project team members may have focused on other issues. These two further root definitions are:

RD2: "A National Programme for Information Technology (NPFIT) owned and Hospital Trust run system for Security to issue employees with smart cards in line with government legislation guidelines".
RD3: "A National Programme for Information Technology (NPFIT) owned and Hospital Trust run system for Human Resources to issue employees with smart cards in line with government legislation guidelines".

The first root definition (RD1) is stated as the main priority of the project to make sure all employees with a smart card comply with nationally defined data protection and other security protocols. How this is undertaken locally was not a concern for NPfIT. The second root definition (RD2) takes the perspective of designing a 'system' that retains the status quo within Angel Hospital Trust, with the Security department taking responsibility for issuing smart cards. The third and final root definition (RD3) draws on the work undertaken during investigating and structuring the problem situation. From this work, the duplication of effort undertaken by Human Resources was highlighted on the medical and non-medical staffing side to sign up an employee, and for the same employee to obtain a new smart card when they are inducted into the organization. By having a number of root definitions comprising different 'systems', different perspectives, and learning can be achieved through the development of further SSM CATWOE's, conceptual models (see Appendix 2) and any other models developed.

4.4 Comparing the Modelling with the Structured Problem Situation

Ideally, the participants who constructed the models should undertake this comparison so that a debate about purposeful action can be taken. As the participants did not co-create the models, relying on the expert facilitator/researcher, this did not happen at this stage. Formal questioning as set out by Checkland (1981) was adopted in order to allow issues associated with the cultural stream of SSM (Checkland and Scholes, 1990) and TM^{SSMXL} to be taken into account before presenting any data back to the project team. As a number of processes had to be included in the 'system', not every activity was identified or included in any tables or matrices (cf. Checkland and Scholes, 1990) that could be used to compare the models. Focus was placed upon the activities that were highlighted within the discussions, namely: (1) whoever issues the smart cards requires training; (2) the role of the Human Resources and Security departments in the process; (3) the issue of the staff sponsor signing the registration authority form or accompanying the employee to get their smart card; (4) the duplication of effort (5) the use of resources; and (6) obtaining an IT account. These six points can be seen and compared with each conceptual model (see Appendix 2) through Table 1.

Point	Conceptual Model One	Conceptual Model Two	Conceptual Model Three
1 (training)	Senior individuals need to discuss this issue, as it is unknown.	Security manager needs to address this issue with his staff and senior individuals.	Human Resources manager needs to address this issue with his staff and senior individuals.
2 (the role of HR and Security)	As long as the process meets nationally mandated software stipulated by the government on registering smart cards – any department can issue smart cards.	Process is similar to current identification badge process (but uses nationally mandated software to issue the smart card). Security manager states any help would be a benefit to his department, due to the requirement to issue cards full time.	Security not involved. Unknown what issues the Human Resource department currently has (but has to use nationally mandated software to issue the smart card).
3 (staff sponsor)	Sponsor meets employee at smart card issuing department.	Sponsor signs registration authority form when employee turns up to work within the department.	Sponsor meets employee at Human Resource department.
4 (duplication of effort)	None. Signing on process not taken into account.	Lots. Identification required at both Human Resources and Security in issuing smart cards. Issues Human Resources and Security need to discuss.	None, Human Resources controls all processes.

5 (the use of resources)	Additional resources may be required.	Additional resources may be required.	Additional resources may be required.
6 (obtaining an IT account)	Same as current system.	Same as current system.	Same as current system.

Table 1. A Matrix Designed to Identify the Issues Coming out of the Three Conceptual Models comparison with the Real World

As explained by the IT manager and the project leader, the culture of Angel Hospital Trust was not particularly conversant with, or sympathetic to, SSM style 'soft' research methodologies. A preferred approach, therefore, was that the research project findings would be communicated back to stakeholders using familiar language, terminology and processes, such as block and data flow diagrams, or techniques that are contained within the Prince2 project management methodology. Communication problems such as these can come up in other organizations undertaking what are perceived to be hard technology projects. If TM^{SSMXL} is to be of use in open organizational dialogue and for creating a shared language through the models and techniques presented, other more familiar and accepted IT project management processes/techniques may be required to be undertaken as part of the modelling exercises. For this reason, the IDEF0 process software was identified as a suitable modelling tool. This was due to IDEF0's similarity to a flow diagram but also its usefulness as a recursive modelling tool that decomposes each element of the model to create as much detail as the modeller requires. As a consequence, it allowed TM^{SSMXL} to move back to a mode 1 operation. This approach adopts a second process that Checkland (1981) advocates by using the conceptual models to model the real world. An example of an IDEF0 technique derived from this study can be seen in Figure 5.
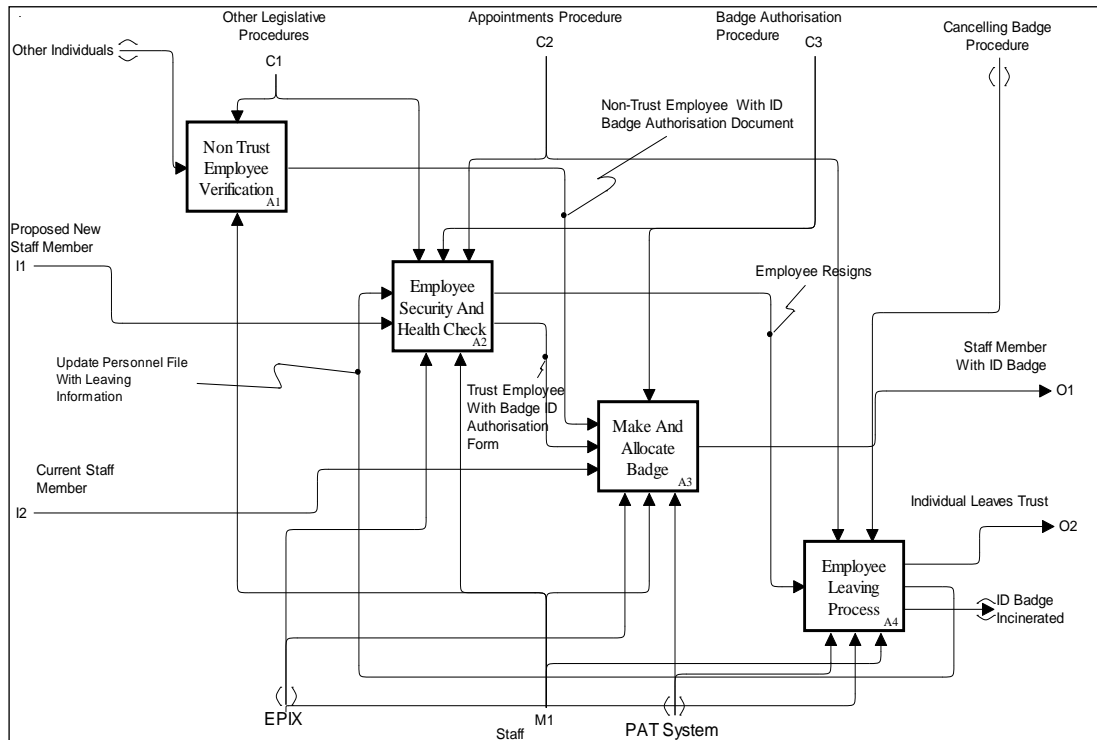
Figure 5. The Use of an IDEF0 Tool to Present Models Back to the Participants in an acceptable format and language

Figure 5 demonstrates how the data collected and the issues highlighted were eventually presented back to key stakeholders. IDEF0 process models require a set of rules to be used. Using Figure 5, these rules take the form of inputs that are converted through the process (in this case the starter/leaver process and the allocation of ID badges) to an output. This is similar to the CATWOE, but IDEF0 requires mechanisms (in the example staff) and controls (badge authorisation procedure, appointments procedure, and other legislative procedures). Any omission of these four rules has to be taken rationally and justified for a model to be declared as valid. As part of the 'selection' of the technology management stage, different software was being piloted in order to examine the RBAC and Smart Card technologies feasibility. The technology was being piloted on a ward at Angel Hospital Trust at Hospital F. Seeing how the technology works, and the data that the software can collect, firstly, allowed more context around which technologies could meet the requirements outlined in the 'identification' stage. Secondly, the pilot allowed mental models to be tested around which department should implement the smart card. Observations were made on how the data was input into the software with staff having to enter a password and a pin-number (two factor authentication). This aspect of the security is so that the

individual is the only person who can use the card. The process, however, can be time consuming. In the two hours of observing the registration process, only four cards were issued (Researchers Diary).

4.5 Taking Action

A report of the progress to date was presented back to the project team. It was agreed that the project team would further review the report, models, and compare what data was collected. The project team synthesised the data and presented the findings to the Information Management and Technology (IM&T) committee. On being presented with a bigger picture of the issues at play, the IM&T committee decided that the best decision was to wait until a set of smart cards could be procured that could hold both Angel Hospital Trust and government NPfIT security IT network access certificates and create a smart card that will also serve as an identification badge. This was important as the IM&T committee also decided that the perceived 'smart card' would dove tail into the current building programme that was moving away from using mechanical keypads to card readers for access to buildings and other estate facilities. Finally, the IM&T committee recommended that the Human Resources department would be best served issuing the smart cards and assigning RBAC role definitions and security access privileges based on the outcomes of the research.

5. Discussion

Role Based Access Control (RBAC) on the surface would seem a rather simple technological and mainly IT driven problem, but as the research demonstrated, RBAC is a complex minefield of socio-technical and political issues set within organizational and professional boundaries and constraints. This research focuses on complex IT adoption needs where stakeholders hold diverse views, where government policy for technology solutions may be in conflict with local wishes and autonomy, and barriers to change also exist due to strong and embedded professional working cultures. How these challenges were tackled needs to be reviewed as well as evaluating the techniques adopted in this research (White, 2006; Ackermann, 2012).

5.1 Retrofitting Soft OR methods onto Hard Technology Management methods

The first research question asked *how might soft and hard methods be combined as an effective multimethodology that will be understandable and usable for both the technology focused project management sponsors and key professional stakeholders?* The fully developed TM^{SSMXL} framework was designed to be used by participants to investigate the smart card problem situation. It is argued that

applying multimethodology in practice in the healthcare sector in order to define complex socio-political and socio-technical requirements for RBAC Systems in Hospitals has proved to be a useful approach. Whilst the original configuration of the multimethodology was sequential, with soft methodologies preceding hard, as detailed in SSM^{XLTM} (Small and Wainwright, 2014), this research had to reverse the framework where the soft methodology would follow and complement the hard methodology, in what we now call TM^{SSMXL} (Technology Management incorporating Soft Systems Methodology eXpanded for Learning) and primarily apply it in a 'mode 2' approach, both recursively and subsequently in parallel. This can be seen by using TM^{SSMXL} as a way to think about the problem situation, compared to actually using the multimethodology in sequence with the participants in more of a 'mode 1' perspective (following a normative framework). This enabled the researchers to retrofit SSM to the existing Prince2 and TM methodologies in order to rethink and redefine the problem situation, as depicted in Figure 1.

Prior to the research, the HR/personnel director, workforce planning manager, and IT project manager perceived that individuals within the IT department both owned and were responsible for undertaking the project. As a direct result and outcome of the research project and report, the Workforce planning manager stated that more key individuals from Human Resources/Personnel had now been included in the project. This may imply that as a result of the more inclusive multimethodology, a broader set of socio-political, socio-cultural, organizational and technical issues have now been highlighted and that individual stakeholders' traditional perceptions are being challenged. The IT and the Information department would usually carry out these projects, so how these individuals see sharing ownership and incorporating other participants and their perspectives is of importance.

There may be a gap to be addressed, however, between the benefits of undertaking the enhancement of learning capabilities that a 'mode 1' perspective may allow, especially if soft OR methodologies are used as a pre-requisite for hard methodologies such as technology management or in the case of project management, Prince2. This was compared in this case with using the multimethodology in 'mode 2' where precedence was not a concern and soft OR methodologies could be used alongside, or 'retro-fitted' with harder methodologies to meet the particular context. By tailoring the problem structuring methods to the context, that is, by adopting techniques and tools that are compatible with Angel Hospital Trust's cultural system, it has enabled a suitable multimethodology to be deployed in 'mode 2' (contingent use of methods and embedded in project according to actual situation and context) role to enhance 'social learning' (Bandura, 1977). This is summarised in Figure 6.
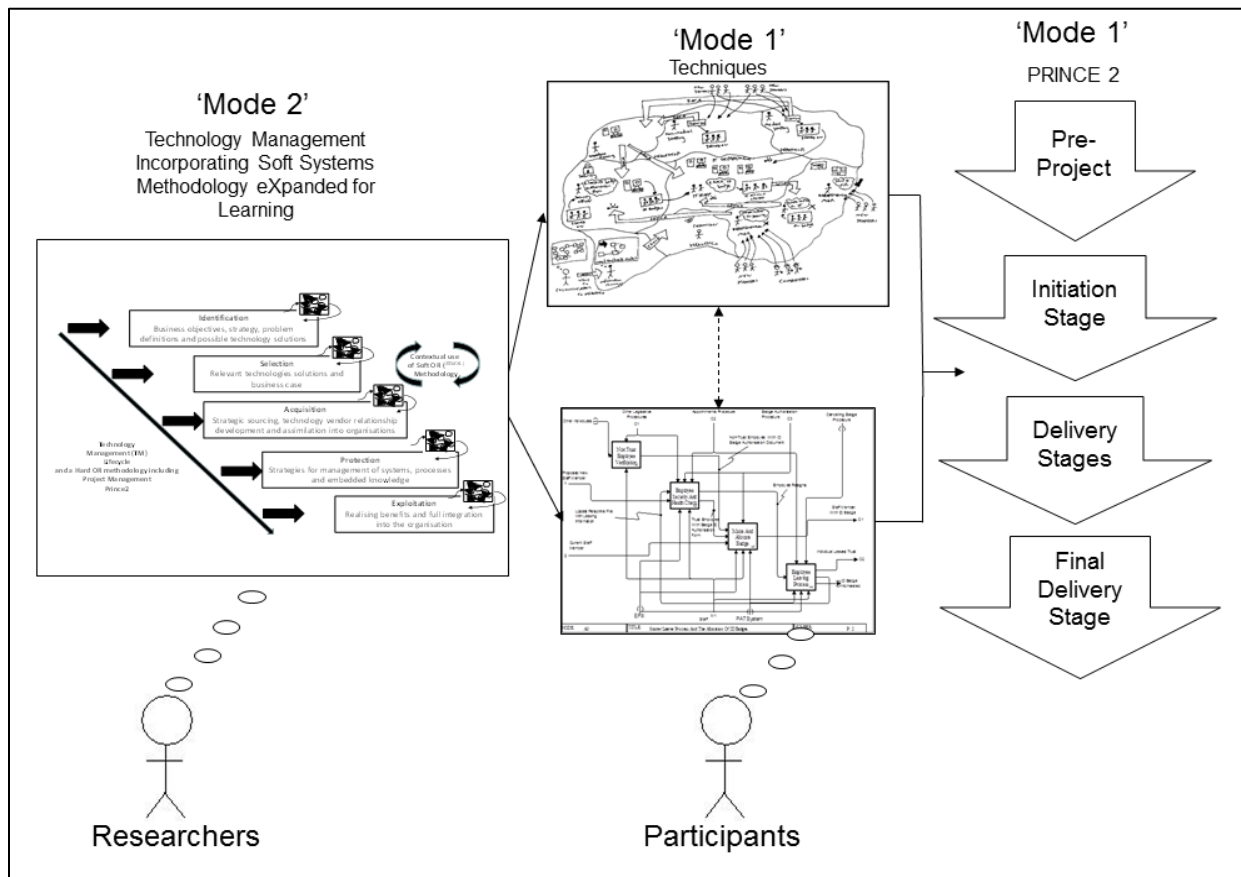
Figure 6. Tailoring Problem Structuring Methods to Angel Hospital Trust Context

5.2 Communicating and sharing common OR techniques and TM language

It was very important that models were fed back to RBAC project participants using an understandable common language (bridging OR techniques and NHS IT project and Prince2 management practice). This could be viewed as the litmus test in how successful the techniques were as the full SSM^{XL} was not used. Ackermann (2012) stressed the importance of problem structuring methods (PSMs) in fostering an understanding and enabling a shared language to be developed. The HR/personnel director, the workforce planning manager, the IT project manager and IT security manager stated that the particular conceptual and process models used by the researchers were very suitable for communicating the findings. The IT security employee also agreed, "*yes, the flow models were good*" (Interview with the IT Security Employee). Whilst all interviewees agreed that the presented models were good, whether they could be able to undertake a similar process themselves in future projects, needed to be explored. This could then allow the shared language to be further developed. The personnel director, workforce planning manager, and IT security manager, agreed that they could undertake a similar process as that

laid out by this research. The IT project manager stated, "*yes, we would do exactly the same as you*" (Interview with the IT Project Manager). The IT security employee also agreed when he stated, "*yeah, I'd like to think so*" but added, "*finding the time I suppose, but yeah*" (Interview with the IT Security Employee). These responses could be argued to imply that the exploration and modelling techniques could be undertaken in further projects. It cannot be stated that the multimethodology could be used in exactly the same manner, without formally revealing the Technology and SSM^{XL} methodology, and receiving the participants' feedback – however, the particular problem structuring methods deployed seemed to have helped. By adopting a mix of 'soft' (rich pictures) and 'functional' (IDEF0) techniques that are commensurable with the social, personal and material factors that are intertwined throughout the organization, has enabled better communication between stakeholders (Mingers and Brocklesby, 1997).

5.3 Cultural Issues and resistance to technological innovation

The second research question asked *can this particular multimethodology be used as a legitimate means to interrupt and refocus projects that are too narrowly technically and organizationally defined working within project management and mandatory Prince2 (https://www.prince2.com/uk) constraints?* The cultural aspect of any organization needs to be better appreciated by key stakeholders in complex IT projects. With larger technology projects, more resistance is encountered due to individuals being able to compare what they have now with what is perceived to be required (Interview with the IT Manager). To accompany this problem, individuals do not want to change to a new way of working (Interview with the IT Security Employee). The IT security manager echoed the resistance that is encountered. The IT security manager stated that due to the high profile national programme (NPfIT) failing to deliver suitable technologies and realise the claimed benefits, individuals are cynical about such projects. The personnel director and the workforce planning manager observed technology projects as having their critics but stated that individuals perceive technologies positively overall if they deliver what is promised. They continued by discussing the technologies that their department have to use and argued that due to the technologies usefulness, compared to working manually, the technologies are perceived with a positive attitude. They added that individuals that were positive about the project tended to be the same individuals who were involved, which might be why it was perceived positively (Interview with the Personnel Director and the Workforce Planning Manager).

The limitation of participants only willing to use processes and techniques they are familiar with could be problematical and result in creating a project that is too narrowly defined. Traditional project management has its foundations embedded in systems engineering/analysis and the use of 'hard' techniques such as program evaluation and review technique (PERT) and the critical path method (CPM), which is based on the assumption that goals are clearly and objectively defined. An emphasis is then on the most efficient delivery of a product defined in terms of costs, time and quality. This is strongly linked to both positivist and realist paradigms. Whilst an officially certified project management methodology, Prince2 is superficial in terms of problem structuring methods and begins by assuming participants understand Prince2 and what the project is aiming to do. By drawing on other OR methodologies, techniques and tools, it may be possible to allow further insights and questioning to be drawn out. Therefore, the multimethodology can act as a precursor, or be enacted in parallel, to the project management methodology. Whilst this approach may allow a project to be refocused and redefined, the limitations relating to time, and participants having nobody to ask questions of, or seek guidance from in using the TM^{SSMXL} multimethodology still remains. Reliance may be required on an expert consultant or researchers until such issues are fully understood and embedded within an organization's social structures (Greenhalgh and Stones, 2010).

The use of the IDEF0 functional modelling technique and modelling software tool was an attempt to take a systems perspective to a problem situation, which participants could reuse in other projects. The participants of Angel Hospital Trust case stated they could undertake a similar process in the future, and the technique could be added to the tool box of techniques and modelling processes, which could be used to try and explore problems in systems terms. For this project, IDEF0 was used to model 'as is' as well as 'could be' scenarios. This perhaps creates a stronger link between the softer rich pictures and the more structured PRINCE2 approaches as a form of a 'joining or bridging techniques'. These approaches could be added to the approaches that TM^{SSMXL} can utilise in drawing out and structuring problem situations, in addition to trying to develop learning activities. If these processes are undertaken, it should enable a more focused approach to implementing technologies – if this is the path that a project team want to take.

5.4 Inculcating learning within the TM lifecycle
The third research question asked *can the multimethodology help reshape and complement traditional IT technical requirements and planning approaches to take greater account of, and enhance learning, to*

address complex organizational, political and sociocultural needs? The purpose of combining Technology Management (TM) and SSM^{XL} was to try and generate and embed further learning conditions across the TM lifecycle. Whilst the multimethodology was primarily operationalised by the researchers in mode 2, it was hoped the research produced from deploying both hard and soft OR techniques would draw out different stakeholder perceptions and thinking within the organization. The IT security employee expressed that the techniques had allowed his thinking to change. This was put down to the conceptual and process modelling and formalised processes being communicated, which allowed project discussions to be undertaken. Previously, nobody could state explicitly that the process for starters and leavers worked in a particular manner except for medical staffing. The IT security manager acknowledged that his thinking had not changed, except in respect to the issues that Personnel have to deal with. The IT project manager echoed the thinking of the IT security manager by stating that the outcome did not affect his thinking personally, but having the process modelled had been helpful.

It is argued that when TM^{SSMXL} is further applied, the process has to be made explicit before any project is undertaken, so all participants can understand what the multimethodology is designed to do, and how TM^{SSMXL} could be used. A form of workshop may be required, where participants of a project can attend and discuss the proposed mix of methodologies, techniques, sequence and general strategy. Undertaking such a workshop may leave participants perceiving the approach as complex, or too time consuming. This was already a concern drawn out from the participants in the case. This limitation may not be solved by this or any other multimethodology. This is also similar to teaching participants how to construct root definitions, CATWOE, and conceptual models if participants are not familiar with using them. Therefore, it does not matter how good or useful a methodology or technique is perceived, it has to be used if it is to become effective for participants.

5.5 Increasing smart card project participation

It is envisioned participation can be increased if the technology management and SSM^{XL} methodology is used, even though a RBAC system has already been identified as the solution, and smart cards have been selected as the technology to deploy as mandated by NPfIT using the Prince2 project management methodology. Whilst the project is to a degree already pre-defined and structured, as this research has emphasised, there is still a need for wider participation and drawing out different perspectives around processes and outcomes in order to structure a technological solution that is fit for purpose. Participation was increased by revisiting the problem exploration phases, as the issue of who should be

responsible for issuing smart cards needed to be explored in far more detail. Secondly, the increased participation through using TM^{SSMXL} was encouraged as this made how the smart cards should be acquired and exploited more explicit (e.g., making the chosen departments jobs easier through the RBAC system).

5.6 Multimethodology tailoring

One of the advantages of adopting a multimethodology is the flexibility in tailoring the methodology to the problem situation. The Information Manager for IT elaborated that the TM^{SSMXL} techniques, and the way they were presented, had allowed further discussions about the project to develop that he had not expected. He went on to explain that the models and outcomes presented through TM^{SSMXL} were perceived to be better than the specification and reporting requirements produced by the formal PRINCE2 methodology. This was because a PRINCE2 approach would only document and capture the evolutionary development of what individuals perceive as the technology requirements, new workflow requirements and RBAC strategy are to be. The actual iterations towards these aims are not historically documented or the reasons why (Interview with Information Manager for IT). The Information Manager for IT concluded that when individuals experience the outcome of a project they argue that it is not what they thought the technology would look like or how it would perform. This is because a formal methodology like PRINCE2 does not capture what people actually say. The TM^{SSMXL} techniques presented were deemed to be more informative and elegant and promoted more discussion around the area of concern than just a Prince2 standard report. In order to conceptualise TM^{SSMXL} we have adapted the taxonomy set out by Mingers and Brocklesby (1997) in order to map this (multi) methodology. The mapping is shown in Table 2 below.

	Appreciation of	Analysis of	Assessment of	Action to
Social	Social practices and power relations (SSM)	Socio-political issues and organization culture, Rich Pictures, CATWOE + Root Definitions (SSM)		Achieve accommodation and consensus, Rich Pictures + CATWOE (SSM)
Personal	Individual beliefs, meanings, emotions (SSM)	Individual perceptions and Weltanschauung (CATWOE + Root Definitions + Conceptual Models) (SSM)		Identify and influence organizational key stakeholders (SSM interviews + Rich pictures)

Material	Organization structure and formal communication channels (SSM)	Alternative physical and structural arrangements (IDEF0) Alternative RBAC technology devices and systems (Technology Management)	RBAC Legislative requirements, Rich Pictures (SSM) and (Technology Management) for data standards	Formulate technology strategy and RBAC policy, Workflow Modeller (Software Tool) and Business Process Modelling + IDEF0 (Technique) and (Technology Management)

Table 2. A Framework for Mapping TM^{SSMXL}
Adapted from: Mingers and Brocklesby (1997)

Whilst the framework may be viewed as 'complete', that is, can be used in the same format in another setting, it can be criticised as implying that the TM^{SSMXL} multimethodology encompasses everything required to design, implement, manage technologies, and explore the socio-technical and socio-cultural issues, as Ackermann (2012) argued, providing a single right answer. As can be seen in Table 2, the methodologies, techniques and tools adapted in this multi-paradigm multimethodology does not cover all of the different multi-dimensions. It also needs to be highlighted that as Mingers and Brocklesby (1997) stated, these mappings can be debated. What can be stated is that multimethodologies have to depict a problem solving approach that engages participants more fully than a consultancy driven model. Only by enhancing engagement in the problem situation through a 'community of practice' (Lave and Wenger, 1991) – or as Mingers (2001) demonstrates as moving through Habermas' (1984) three worlds (social, personal and material), can the methodologies and techniques used allow any form of reshaping of requirements. The participants of the problem situation are best suited to understand their political and socio-cultural needs. Legal issues and compliance with other regulatory bodies may also pose problems. In this case, Angel hospital Trust had to comply with legislation stipulated around accessing Electronic Health Records stored on the national IT network infrastructure spine. The Trust also had its own legislative requirements around how its own employees access health records related to the Trust. The third structural requirement comes from complying with standards relating to Role Base Access Control (RBAC) itself. Therefore, the multimethodology has to be a vital supporting mechanism in drawing such issues out.

6. Conclusions

This paper has contributed to the important body of knowledge on designing and using multimethodologies in practice. Previous research has demonstrated the increasing use of multimethodologies in a number of different countries and varying sectors including: energy and utilities; education; and UK public services. This research contributes to the work of using multimethodologies for IT projects in healthcare. This research specifically investigated the use of multimethodology in exploring socio-cultural and socio-technical issues in order to allow complex requirements for Role Based Access Control (RBAC) Systems in a National Health Service (NHS) Trust in the UK to be better understood. In this case, the multimethodology was constructed and used in more of a 'mode 2' approach and enabled a complementary set of OR techniques to be deployed alongside the mandated Prince2 and technology management methodologies. There may be a gap between the successes resulting from undertaking the enhancement of learning capabilities that a 'mode 1' perspective may allow but by tailoring the problem structuring methods to the context, and adopting techniques and tools that are compatible with an organizations cultural system can enable a suitable mix of OR methodologies to be deployed in a mode 2 role to enhance 'social learning'.

It does not matter how effective, or useful a methodology or technique is theoretically perceived to be. It has to be used if it is to become effective for participants. It is not until the problem situation is encountered that it will be possible to identify which methodologies and techniques to combine and how. The limitation of participants only using processes they are familiar with using could be one problematic element of initially defining a project that is narrowly defined. Drawing on other methodologies, techniques, and tools may allow further insights and questioning to be drawn out. The multimethodology can act as a precursor to, or be used alongside, the project management methodology such as Prince2, especially where the stakeholders/participants of the problem situation are the ones best suited to understand complex issues associated with their socio-political and cultural environments. Methodologies do not need to be combined sequentially, the emphasis has to be on communication with any multimethodology providing a structure that considers different paradigms, the methodologies, and the actual techniques. A researcher or consultant could create any manner of multimethodology and state a valid case for its purposeful use. Our research has demonstrated that you do not have to do everything in a prescribed manner, which is set up in advance of the problem situation. Once the problem situation is encountered you have to be flexible to adapt (tailor) the

methodologies and techniques to the problem situation encountered in order to enable adjustments on the model design as the problem situation evolves over time.

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