Towards a systems-based framework for understanding the diffusion of technology: A case study of a modest technological innovation in the multi-agency context of policing

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Abstract

Technological innovation in policing is being given greater emphasis. In public discourse about technology and policing, there is often a focus on large-scale projects that are known to fail, sometimes at significant cost (National Audit Office, 2012). The implementation of smaller innovations are often overlooked. This thesis examines practice of innovation and adoption in the context of multi-agency working.

The literature review in this thesis reveals that little is known about contexts where decision making does not rest with the police and exposes potential limitations in the use of diffusion and adoption frameworks/models. The research question is: In the context of multi-agency diffusion and adoption of a technology to enhance policing, can systems thinking techniques enhance, or even replace, existing frameworks and models?

This empirical research study looks at the adoption of a relatively simple technology that scans identification documents. However, the decision to adopt and implement an ID scanner takes place within a complex setting. Tracking an adoption decision requires understanding of the various actors and their roles. The research includes 48 semi-structured interviews with police officers, premises owners and managers and other stakeholders involved in the decision to adopt an ID scanner. Their perceptions of the history leading to an adoption decision, their own role and that of other key actors is examined.

Initial analysis takes place using spray diagrams and further analysis is made through the lenses of existing diffusion and adoption frameworks/models. Subsequently systems thinking techniques are deployed and the additional insights they provide are highlighted. This research finds that systems thinking can extend understanding of multi-agency diffusion and adoption decisions when compared with solely utilising existing frameworks/models. Finally, the research proposes a systems-based framework for collaborative diffusion and adoption analysis.

Acknowledgements

Contents

List of tables

List of figures

Chapter One: Introduction

1.1   Introduction to Chapter 1

This thesis provides a report on an investigation into the diffusion and adoption of a relatively simple technology in a complicated multi-agency policing context. The investigation looks at whether systems thinking can enhance or replace existing diffusion and adoption frameworks and models.

As the literature review will show, innovation is a widely-, though not always consistently-used term to describe how something novel is generated, developed and/or used. Schumpeter pioneered the notion of innovation. He set out examples of innovation such as:

> …the development of new products (or new variants of such), the introduction of new types or qualities of raw materials or intermediary products, the creation or exploitation of new markets and new ways to organize business.

> (Schumpeter, 1934, 1943, in Fagerberg, 2003, p. 6).

In this study innovation means the 'idea, practice or object that is perceived as new by an individual or other unit of adoption' (after Rogers, 2003, p. 12). Adoption is taken to be the installation and use of an innovation by an organisation or a group of organisations. Rogers explains diffusion as 'the process by which an innovation is communicated through certain channels over time among the members of a social system' (after Rogers, 2003, p. 35). Diffusion is thus a process that, in effect, increases the number of adopters. It is these definitions that will be used in this study.

This introductory chapter presents the rationale for the study and then provides a synopsis of the thesis. Next, the organisation of the thesis is set out and a summary of the chapter is provided.

1.2   Rationale for the study

Frequently, multi-agency working involves complex problems, contains unpredictable variables and involves a multifaceted web of relationships where those connections or interactions have

influence over one another. Each agency will have its own purpose, interest, perspectives and priorities but at the same time will, at least in part, share an interest in adoption. This is almost certainly the case where a number of stakeholders come together to achieve adoption of a new technology but not all of them can be regarded as the actual adopters. This is a growing occurrence in policing where adoptions of technologies require the police to work collaboratively with a wide range of stakeholders in a multi-organisational way (Wastell et al., 2004; Farrell, 2022). In many cases the diffusion of those adoptions requires police to influence, and receive benefit from, the methods and technologies adopted by agencies that have different aims but share some mutual interests. Examining a situation where there are multiple perspectives and different interests means there is a usually high level of uncertainty and complexity that requires unpicking. One example is the well-known technology closed circuit television (CCTV) video surveillance system. The police do not necessarily own and operate the technology themselves; sometimes they encourage, prompt or work with others and encourage adoption. Subsequently the police draw upon the data from that innovation to assist in their investigations. Sometimes the police lead the adoption, development or utilisation of new methods or technologies such as the introduction of laptops for use by the police (Colvin and Goh, 2005).

In other circumstances, the police work in partnership with organisations with very similar goals. For instance, through the use of traffic cameras and Automatic Number Plate Recognition (ANPR) for scanning vehicle number plate data. ANPR is used and operated by a variety of organisations and by the police for the purposes of law enforcement. The challenge to diffusion and adoption of innovations is that it is not just the police who need to successfully adopt an innovation but also the broader stakeholders.

As a greater and greater emphasis is placed on technological innovation in policing and in the wider public sector, innovation is often seen as the answer to increasing efficiency and reducing costs. Indeed, innovation is seen as an essential component to meeting the demanding needs of a changing society (OECD, 2017). The police represent a significant public sector organisation

through which innovation, diffusion and adoption can be investigated. As society locally and nationally changes, so do the methods and technologies the police deploy.

There are 43 territorial police forces in England and Wales and one force each in Scotland and Northern Ireland. In addition, a small number of 'special' organisations exist including the British Transport Police, the Civil Nuclear Constabulary and the National Crime Agency. The College of Policing (the professional body for policing in England and Wales) promote the importance of conducting and using policing research.

An evidence-base developed through research can inform policing strategies that contribute to achieving police forces' aims to prevent and combat crime. Work in policing is challenging due to impacts such as the economic climate of austerity. The National Audit Office (2018) reported the UK police budget was a sizable £12.3bn and in 2019, police workforce numbers were over 200,000 (The Home Office, 2019a). However there remains a need to reduce cost and increase efficiency in policing as the police are required to do more for less. This backdrop confirms that innovation in policing is given prominence.

Policing in the UK has been subject to significant changes throughout its history. Some of those changes have been organisational but many have been associated with the diffusion and adoption of technological innovations. Technology has played an increasingly important role in society and, in policing, various innovative technologies have been seen as a solution to some of the problems they face. Historically, significant crime events have emphasised the need for the police to develop its use of technology (e.g., the Whitechapel murders in the 1800s helped lay the foundation for modern day forensics). From the early 1900s, advances in technologies such as the telephone and wireless radio communications led to the police becoming more mobile, improving the flexibility of the service they offered. Even in those times, however, the police were required to work collaboratively with suppliers and other bodies to successfully adopt innovation and often, there were problems in the diffusion process.

In more recent times, the pace of technological change is accelerating more than ever because of a need to tackle violent, high harm and digital crime (The Home Office UK, 2018; The Home Office UK, 2019b). Professional reports show that large scale technology adoption in policing had been sometimes found to fail, sometimes at a cost of millions of pounds (See National Audit Office, 2012; Davidson, 2017; BBC, 2020; Private Eye, 2022). The Mobile Police Programme (National Audit Office, 2012), for instance, aimed to increase officer visibility, increase the efficiency and effectiveness of police forces and reduce bureaucracy by equipping frontline officers with mobile technologies. However, several significant failings were reported (House of Commons Committee of Public Accounts, 2012). These included: a focus on devices rather than benefits; some forces spending extra time in the police station as a result of using the devices; and only one force in five effectively improving their operational processes. There was also variation in the number of devices different forces received. For example, the Metropolitan Police Service received 3,500 devices whilst its neighbouring much smaller force, Essex, received 3,000 devices. Other forces reported receiving few or no devices. Possible reasons for the problems were a lack of planning for resource and knowledge needed to implement change and process improvement (p. Ev 14). Further discussion on the state of Information Technology (IT) in the police, one committee member said 'I am still agog that 43 police forces can come up with 2,000 different systems, which is 46.5 systems per force.' (p. Ev 3). This general failure by the police service to implement mobile technology highlights the very substantial extent to which adoption did not occur. In another report by the London Assembly (2013), the Metropolitan Police were instructed:

> [they] …cannot afford to get its new ICT strategy wrong.

(London Assembly, 2013, p. 6)

And:

> The force must think carefully as it seeks to use new technologies: it must consider changing working practices; proper training will be essential; and new technologies must be implemented with great care, or they risk being ineffective.

(London Assembly, 2013, pp. 6-7)

These reports present a disappointing picture of the state of new technology diffusion and adoption in policing.

There is a tendency for research to concentrate on large-scale projects but there are a myriad of smaller technological initiatives that are less revolutionary but together make a big contribution. Learning about the introduction of these modest innovations is frequently overlooked. Innovations such as the implementation of mobile fingerprint devices (Faúndez-Zanuy, 2004) adopted by one force have the possibility to be scaled up across the country becoming a more significant investment. Much more needs to be known about the diffusion and adoption of such innovations. One of these smaller innovations is a digital device used in the night-time economy by the police. The device, an ID scanner, is a relatively simple technology that scans, checks and stores identification from documents such as driving licences or passports. ID scanners carry out identification scanning as a condition of entry to premises that operate late at night.

Typically, there are a variety of strategic and tactical reasons for deciding whether to take up an innovation like an ID scanner and each stakeholder or agency would have their own view and experiences. Therefore a complicated picture of diffusion emerges once the different aims, objectives and roles of the many different stakeholders are considered. Research on the different objectives and experiences of stakeholders could shed light on technological innovations that are adopted, identify how any conflicts might be mitigated and how to improve diffusion. In the Strategic Policing Requirement (The Home Office, 2012), the expectations of the Home Secretary were set out and a section on connectivity stated '…policing capabilities should be able to connect effectively with key partners…' (The Home Office, 2012, p. 13).

The intention for policing to have capability that allowed access to intelligence mechanisms, and to collect and share data with other forces and agencies for the prevention and detection of crime, was conveyed (The Home Office, 2012, p. 13). In addition, it was not just stakeholders who had different views but the media also added to a wider public debate about police technologies. For example, some drawing on concerns of the introduction of ID technology (Urban, 2013) or others highlighting the benefits of adopting an ID scanner (Nelson, 2022). While other reports

added to debate on the police use of the technology when they pointed to potential future extension of functionality, such as the inclusion of facial recognition (Dodd, 2022).

Other countries' police organisations faced similar issues in the introduction of innovation too (Pennington, 2020). All faced problems in managing the implementation and potentially suffered shortcomings at different stages of diffusion and adoption. Furthermore, the police would not be the only organisation facing these similar challenges. Undoubtedly, the success of technological innovation and its diffusion and adoption in a multi-agency setting requires further investigation.

Societal changes, including pandemics, austerity and sustainability, are all drivers of innovation but bring challenges to innovation, diffusion and adoption. In 2020 the coronavirus pandemic brought about a period of uncertainty and rapid change all over the world. In many public service sectors, a range of technologies were introduced at short or no notice to move services online. With healthcare, for instance, General Practitioner appointments moved from face-to-face to digital delivery using software such as Skype, Microsoft Teams and Zoom. In retail, online shopping, home deliveries and robot deliveries came to the fore. UK policing faced new and unprecedented operational and organisational challenges including, for example, resourcing impacted by the coronavirus, fast-paced changes to legislation and the accelerated use of technology for remote working (His Majesty's Inspectorate of Constabulary and Fire and Rescue Services, 2021). As recovery following the pandemic takes place, the police service and wider public sector will be entering into a long period of inquiry, debriefing and taking account of lessons learned. A key element of the recovery phase is enabling forces, the National Police Chiefs' Council (NPCC) and the College of Policing to learn lessons from their experiences and understand whether alternative technologies employed during the coronavirus pandemic may remain useful. It is important that police forces are well supported in this endeavour. New knowledge on technological innovation has the potential to support policing and other organisations in that recovery and for longer term resilience.

In multi-agency adoption, it is the diffusion process that becomes particularly complex and an innovation is more difficult to adopt. Generating greater understanding of the complexities in multi-agency working is one compelling reason for conducting this research.

There was a perceived gap where existing diffusion and adoption frameworks/models may not usefully take account of the uncertainty and complexity in a situation and there might be more to learn by taking a different or new approach that could enhance or improve innovation, diffusion and adoption. Existing frameworks/models largely overlook the notion of collaboration as an element of diffusion, they tend to focus on pre-defined aspects or features of adoption such as a particular phase of implementation, the acceptance decision, or adoption involving just one organisation. The frameworks/models may prove restrictive when it comes to researching the multitude of factors involved. As such, they were not always suitable to help understand the full complexity surrounding diffusion and adoption. This may have led to important aspects of the process by which an innovation is communicated to achieve diffusion being overlooked.

The frameworks/models selected for this research were representative because of having broad application and providing some understanding of why and how an innovation is successfully adopted or not. They are the ones most closely aligned to shedding light on the diffusion and adoption process. From the review of current literature, a selection of existing frameworks/models that were identified as most applicable to multi-agency diffusion and adoption are, therefore, examined in-depth. Using multiple frameworks/models in this way also allows new insights to be developed into whether they are helpful in a multi-agency setting.

However, understanding complexity from the beginnings of the idea of an innovation to its implementation, is also needed. There was an opportunity for a research study to explore whether existing frameworks/models could be enhanced by looking at the diffusion and adoption in a different way. Taking a holistic view is where systems thinking could enhance understanding and provide new knowledge ultimately supporting innovation in practice. It was thought that using systems thinking may be a way to enhance understanding and improve the process of innovation or, indeed, be a replacement for existing frameworks/models. Systems thinking has a

robust academic background drawn from many disciplines including the sciences, engineering and psychology and can be applied to a wide range of complex challenges (Jenkins, 1969; Churchman, 1971; Checkland, 1981). Systems thinking is known to allow complexity to be explored and the dynamics of a system understood in an organised way. A systems thinking approach could provide a distinct advantage to an exploration into technology innovation.

Complexity is not just a case of there being many different factors and interactions to look at, it is also the uncertainty surrounding the situation and the multitude of perspectives within the area of interest. The degree of involvement of those in a situation and the interpretations and constructions that could be placed on the factors and interactions concerning the system and its environment is what leads to complexity.   Existing frameworks/models are known for specifying factors and variables rather than exploring all those involved in a situation. Furthermore, the term 'system' is a word with multiple meanings. Systems are regularly referred to in everyday language for example 'IT systems', a method or procedure or in terms of a health care system, an information system or a political system but a system can also be conceptual or perceived and not exist in reality and can be 'constructed'. Systems thinking is 'a notion applied to a situation by an individual, often with the aim of understanding the situation or explaining it more easily' (Fortune and Peters, 2005, p. 47). Another important point for the purposes of this research is to distinguish system from the term systematic which relates to a plan or method and is 'organised and following a pattern' (Fortune and Peters, 2005, p. 56). A key characteristic of systems thinking in this research is to use the approach in an innovative way to try and generate new understanding.

Using systems thinking in this way could lead to a new and rich representation of innovation, diffusion and adoption through a whole system approach that could then be used for problem solving or improvement.

This section supplied the rationale for a research study to look at technological innovation, diffusion and adoption in policing in a complex multi-agency setting. Several challenges for the

police have been highlighted including operational challenges arising due to uncoordinated technological introductions resulting in unsuccessful adoption. This compounded by tighter budgets due to economic austerity. Therefore, there is a need to look at not only large national projects (which had often been found to fail) but also those at local, and regional level, especially ones where the police were not always the primary adopter but working collaboratively with a wide range of agencies. This research will consider existing frameworks/models claimed to help diffusion and adoption and will apply systems thinking as a novel approach to investigate the variety of different perspectives or influences on the diffusion and adoption of an ID scanner in the night-time economy. The next section provides the synopsis of the research.

1.3   Synopsis of this research

The overall setting for this research is policing as a public service. This research study explores how participants diffusing and adopting an ID scanner engage with the activity, with each other and how such engagement produces adoption or non-adoption of the ID scanner.

Researching this topic requires in-depth exploration of many interactions between the agencies involved. An approach would be designed to understand the complexity of issues related to innovation, diffusion and adoption. Specifically, this thesis will answer the following question:

> In the context of multi-agency diffusion and adoption of a technology to enhance policing, can systems thinking techniques enhance, or even replace, existing frameworks and models?

The following questions are covered by the research and contribute to answering the overall research question. These are:

1. How does systems thinking improve the approach to learning about diffusion and adoption in a multi-agency situation?

2. How does systems thinking improve the recognition and understanding of the factors and variables affecting successful diffusion and adoption in a multi-agency situation?

3. Does systems thinking lead to a better framing of adoption decisions for decision makers within a multi-agency situation?

4. How does the addition of a systems thinking perspective to existing diffusion and

   adoption frameworks/models improve the ability to describe, explain or even predict the

   outcome of diffusion and adoption initiatives in multi-agency situations?

The methodology is found later in the thesis.

1.4   Organisation of the thesis

Chapter 2 examines innovation and policing and sets out the development of technology in

policing and events that have led to technological change. It also highlights practical issues

relating to diffusion and adoption. Chapter 3 presents the research setting. This research uses

the ID scanner as the technological innovation being diffused and adopted in a collaborative

multi-agency setting. ID scanners are an attempt to have mandatory digital identification

scanning as a condition of entry to venues that hold a premises licence. The ID scanner is a

technology used in the night-time economy sought as one solution to help the police to address

alcohol-related violence and disorder late at night. It is also a technology which requires multiple

agencies to work together. This research studies the adoption of the ID scanner through the

lenses of stakeholders such as the police, the local authority and premises owners and managers.

Chapter 4 outlines the academic literature underpinning this research. The literature on

frameworks/models of diffusion and adoption and in the context of policing will be reviewed and

a selection of existing frameworks/models identified for further examination in this study.

Chapter 5 sets out the methodology for the study and the means for acquiring new knowledge. A

framework is designed that will be used later in the thesis to examine the extent to which systems

thinking has been found to enhance or replace existing frameworks/models. Chapter 6

introduces systems thinking. The historical origins of systems thinking is traced back in time and

the fundamental elements of systems theory using its academic rigour are described through the

concepts and tools for thought used in this research. In Chapters 7, 8 and 9 an extensive field

study is described and the selected existing diffusion and adoption frameworks/models are tested

in this context. The study is designed to yield insights into existing diffusion and adoption

frameworks/models and systems thinking through exploring the take up, or not, of the ID

scanner. Chapter 7 presents the pre-analysis. Chapter 8 reports on the selected existing

frameworks/models in relation to the data in this study. Systems thinking is applied in Chapter 9 and the findings are discussed in Chapter 10. Chapter 10 draws together the findings from applying the existing diffusion and adoption frameworks/models and systems thinking. Finally, Chapter 11 summarises the whole thesis and concludes this thesis with implications for future research and the closing remarks.

1.5   Summary of chapter

This chapter explained the rationale for this research. It first described the importance of technological innovation in policing and the requirement for the police as a public service to learn more about its innovation, diffusion and adoption practices. The need for research on modest innovations and to unravel complexity due to multiple perspectives in diffusion and adoption were important observations made. There was also a need to overcome issues in the diffusion process including understanding more about multi-agency working and the factors and variables involved in adoption. Next was an explanation of the reasons for the choice of context in this study and how the perceived gap could be tested through an extensive investigation of practice. The introduction highlighted why looking at innovation, diffusion and adoption using systems thinking could be an important and novel stance to unravel some of the complexity in a multi-agency research context. Additionally, distinguishing whether enhancements can be made by using a different approach could provide an important tool for policing and practitioners that are expected to support and implement such innovations. Then the research questions were presented followed by an overview of the thesis structure.

The aim of this research is to investigate technological diffusion and adoption in policing by looking at existing diffusion and adoption frameworks/models and to apply systems thinking to conclude whether systems thinking can indeed extend or replace the existing frameworks/models. This research will not only shed light on the application of a particular technology such as the ID scanner but also contribute to wider conversations on systems thinking and its contribution to innovation, diffusion and adoption in a multi-agency setting. The next

chapter examines innovation and policing and sets out the development of technology in policing

and events that have led to technological change.

Chapter Two: Innovation and policing

2.1   Introduction to Chapter 2

This chapter gives an overview of historical developments with regard to technological innovation in policing, with particular emphasis on diffusion and adoption, and notes the growing involvement of agencies external to the police in those changes. The chapter first sets out the development of technology in policing and identifies events that have led to technological innovation in the past. Then modern policing is discussed in the context of information and communication systems and digital technologies. Failures in technology diffusion and adoption are also explored. The chapter highlights practical issues in diffusion and adoption in the development of technology in policing. Finally, a summary of the chapter is provided.

2.2   The 'new' police: the development of technology for policing

Before looking at the modern police force, this section examines how technology has become involved in policing in the past. The section discusses very early policing and events that led to alterations in the way police manage and adopt technological innovations.

In the 1700s, pre-industrialisation saw forms of 'old' policing as unofficial collections of people, notably the 'Watches' and 'Thief-takers', who came together to try to solve crimes. However, it was the body that became known as the Bow Street Runners, established in 1748 by Henry Fielding (Cox, 2010) which was the first officially established and paid detective service. As socio-economic development and industrialisation took place, an increase in the number of reported crimes, particularly in London, led to growing political interest in crime and policing but law enforcement in Great Britain lacked organisation until 1839. In 1839 with Sir Robert Peel as Home Secretary, parliament passed the Metropolitan Police Act (The National Archives, 1829) and the Metropolitan Police was established as the first organised and full-time force offering paid employment. This was the start of the 'new' police, a model of policing later to be adopted nationally and internationally. This 'new' police effectively became a formal institution with

direct responsibility to the Home Office and the 'Peelian principles' (UK Government, 2012) were introduced as a constant set of principles for the police which still form the basis of policing today.

Alongside structural changes in policing, significant crime events emphasised the need for the police to innovate, particularly in relation to the adoption of new technologies. The most notable examples in the late 1800s was the unsolved crimes of 'Jack the Ripper', known as the Whitechapel murders, which were carried out in the East End of London between 1888 and 1891. These unsuccessful murder investigations spanned two police forces but the extent to which the two forces collaborated is not known to have been documented. Technology available at the time included early developments in photographic equipment and innovation in documentation methods such as crime scene sketches though the extent to which they were used appropriately is hotly debated. Even at this early stage of policing, collection and processing of data and communication of information were important.

The early 1900s brought a key turning point in the use of technology in policing in the form of new communication systems. Telecommunication systems such as the telephone and the wireless radio (introduced in the Metropolitan Police in 1910) were adopted as well as two-way radio. All of these innovations led to the police becoming more mobile and improved the flexibility of the service they offered. However, as Williams (2014) points out, there were problems relating to the diffusion process. The police initially experienced problems with the technology:

> The telephone was not as immediately attractive to the police as the telegraph, because it was difficult to get a durable record of the messages passed through it. As late as the 1930s, communication within Scotland Yard by written notes through its pneumatic tube system was recommended in preference to the telephone, to minimise errors.
>
> (Williams, 2014, p. 127)

Williams then describes the adoption of the telephone through three phases:

1. Indoor use (first introduced at police command levels).

2. Outdoor use in the form of telephone boxes.

3. The telephone becoming more dominant for informal tasks internal to the police force.

The diffusion process appeared to take a systematic approach starting as a small project in one force before being communicated to others and, over time, becoming widely recognised as a beneficial innovation in policing. Many aspects of the diffusion process are not reported but there is evidence of communication between local police forces that encouraged adoption. Nevertheless, Williams still concludes the adoption of the telephone was uneven at best (p. 135).

Williams also explained that adoption began to involve third party technology suppliers around this time. Williams said 'Through the 1920s the media and enthusiasts within the police were keen to play up the performance of mobile radio as well as its potential.' (p. 147). The need to work with third parties to adopt technological innovations is common in present day policing. It was 1928 when police boxes were first trialled by the Metropolitan Police as a means of providing a point of coordination and emergency communications. In the 1930s, new technologies such as the early telex machines were introduced though there was some reluctance to adopt them due to overlap with current systems and compatibility issues. Fingerprinting is another noteworthy technological development that has had great impact on policing since the early 20th century. It was introduced by the Metropolitan Police in 1901 following the findings of a government committee, appointed by the Home Secretary under the chairmanship of Lord Belper, to explore methods of the 'Identification of Criminals by Measurement and Fingerprints'. The Fingerprint Branch at New Scotland Yard was established in July 1901. Today, important facilities on fingerprinting still remain at Scotland Yard and fingerprint data is held in national databases such as the Police National Computer.

After World War Two, further developments in the use of police technology took place. For example, Williams (2014) described how the use of closed circuit television (CCTV) technologies became available. The Metropolitan police first experimented with CCTV in 1963 but found the cost of implementation outweighed the possible benefits. It was not until much later, once trialled for policing large events and the technology evolved, did the police use CCTV more widely. Once other sectors began to adopt the technology for applications such as the control of traffic in London, did the police become more interested in CCTV and often, not as the primary adopter but

as a stakeholder with high interest and influence. The diffusion process almost certainly included mechanisms for increasing awareness of CCTV in the police and with agencies such as local authorities and suppliers.

As the number of recorded crimes continued to increase through the 1960s, the need to improve communication technologies increased. Some forces, such as Lancashire Constabulary[1], had invested in technology development themselves. They developed their own VHF (Very High Frequency) personal radio but there were problems getting it into production (Williams, 2014, p. 159). Multi-agency working was required between the police and private sector bodies as well as government (the Home Office as the primary funder). It took until 1975 until every UK police officer had a personal radio (Williams, 2014, p. 160).

Also in the 1970s, organisations' use of mainframe computers was becoming more widespread but UK police forces were not amongst early adopters. However, in 1974, the Police National Computer (PNC) came into operation, managed directly by the Home Office. Its purpose was record keeping with stolen vehicles the topic of its first database. Over time, the number of PNC applications increased and its use expanded to the investigation of crime and gathering of intelligence. However, the introduction of this computer technology was fraught with problems. The Home Office had expectations that the number of staff would be reduced as a result of its introduction but there were many difficulties with the adoption. One example was the failure of the Modus Operandi index project. The index had been proposed as a way of computerising the classification and filing of crime reports to enable patterns to be detected easily. However, crime data was constructed on tacit and narrative information which was difficult to classify in a way that it could be interrogated using an IT system and ultimately the index was deprioritised and then dropped from the plans for computerisation. It is possible that using academic frameworks/models early in the adoption process could have helped the police gain an

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[1] The Police Act of 1964 (The National Archives, 1964) led to significant changes in police forces' management and accountability structures. The Act set clear lines of responsibility from government to Police Authorities and, by delegation to Chief Constables, police forces were aligned to the geographical boundaries that we are familiar with today.

understanding of requirements for the IT system and identified potential issues in the diffusion process. One example of a theory that had potential to improve such practice is Rogers (2003) Diffusion of Innovations:

> …early knowers' (p. 94) and individuals' knowledge about an innovation would raise questions at an early stage: 'An innovation typically comes with such questions as 'What is the innovation? 'How does it work?' and 'Why does it work?'
>
> (Rogers, 2003, p. 172)

The extent to which practitioners would have been aware of, and been able to apply, such frameworks/models is an interesting question in the context of this study.

Even though the PNC had come into operation in 1974, the case of the 'Yorkshire Ripper' in the second half of the 1970s brought continuing problems with data storage, organisation and retrieval to the fore. At that time, there was little standardisation across forces so the fact that the Ripper's crimes spanned force boundaries was one of the factors that led to delays in capturing him and thus to more deaths. Manual card systems were still in use and in the face of very large volumes of paperwork there were difficulties in cross-referencing intelligence data. The Ripper case was part of the background that led to the development of the Home Office Large Major Enquiry System (HOLMES) that was launched in 1984. HOLMES was put in place in all UK mainland police forces but it is noteworthy that each force sourced and implemented its own version of the system.

2.3   Modern policing

Moving on to more recent times, in the 21st century, use of technology by police forces continues to lead to change, sometimes in response to a critical event and sometimes through incremental development of technology. Very often, however, changes are driven by the need to reduce costs and increase efficiency. The variation of structure of policing (See Appendix F) could be important when considering the impact and influence on technology diffusion and adoption.

A report (Independent Police Commission, 2013) argued the case for driving efficiency and effectiveness through use of technologies in the police service but emphasised the negative

consequences of the complex structure of ICTs used in policing. Though the number of functions and devices available to the police is accelerating, and that may be a positive benefit, it does mean that the management of technology needs even more consideration. Technology has the potential to improve services and practice such as providing front line officers with more discretion and increased mobility, but the ongoing strategic and operational management of technology needs to be considered.

Modern policing also has other significant new challenges to contend with such as increased threats from terrorism and cybercrime. The vast majority of technologies seen as solutions to all these needs are information and communication technologies. Technology has been identified as playing a vital role in delivering more for less. A wide range of technologies from criminal databases to speed cameras and CCTV are seen as ways of increasing effectiveness and reducing costs. Other benefits of introducing technology in policing that are cited include reducing crime, decreasing offences against officers and improving accountability but there is also a need for technology adoption to work for back-office functions. (A report by Her Majesty's Inspectorate of Constabulary (2011) entitled *Demanding Times* found that just under 40 per cent of the police force was involved in middle/back-office functions). Additionally, and to put the need to deliver more for less into context, in 2012, the Association of Chief Police Officers (ACPO) stated that savings equating to around 20 per cent of the entire police service budget will need to be made. They stated that forces plan to create as many opportunities for cost savings as possible through collaboration; around a sixth of policing will be delivered through collaboration. The National Police Chiefs' Council (NPCC) replaced ACPO in 2015 as the new body. Working collaboratively with PCCs and other bodies, the Policing Vision 2025 provided a renewed look at the futures for digital policing. Innovative digital solutions were required to improve collaborative working with the criminal justice system around topics such as contact with the police, intelligence and evidence (National Police Chiefs' Council, 2016). This growing need for innovation and multi-agency working requires investigation into what is required in the diffusion process if it is to lead to successful adoption.

Police forces already share the Police National Database (PND) which was officially launched in 2011. The now defunct National Police Improvement Agency (NPIA) which put it in place intended it to represent a strategic change in policing and serve as an example of the benefits of collaborative working across forces. The PND was one of the many extensions to the Police National Computer (PNC) mentioned earlier and was a direct result of the Bichard inquiry's recommendations in 2004 (Bichard, 2004). The Bichard inquiry was in response to another high-profile case, this time in relation to child protection and the murders of Holly Wells and Jessica Chapman. The enquiry reported on the need to connect the disparate databases and to share intelligence across force boundaries. In a PhD Thesis looking at modelling the implementation and acceptance of the PND, Lambri (2014) said:

> Delivering the PND is not simply about the delivery of IT. Delivering the PND is about business change enabled by IT and is a complex process, ensuring not just the right IT capabilities and functionality are delivered, but also that the data are prepared and the necessary supporting business change elements are in place. This requires time and careful planning if the Police Service is to realise the benefits from the PND.

(Lambri, 2014, p. 259)

Many of the changes suggested by Lambri relate to aspects of the diffusion process. Whether the nature of the factors involved, how they interact together in a process of diffusion and impact adoption is difficult to understand without exploring the whole situation.

Mobility has become an increasingly important aspect of policing so police officers across the UK are now equipped with a variety of technologies providing access to a range of systems for use in offices and on patrol. For instance, in 2008 Northamptonshire Police, officers were issued with smart phones with PNC, incident management and intelligence capability (BBC, 2008). Lancashire Constabulary is one of the forces who adopted an application called 'Pronto' and were one of the first, working collaboratively with the private sector, to integrate the use of Body-Worn Cameras (Motorola Solutions, 2021). However, the mechanisms by which these new adoptions are diffused in, and between, police forces are not reported.

2.4   Failures in technology adoption in policing

As elsewhere, failures in technology adoption in policing range from the catastrophic and the very expensive to more pedestrian problems leading to delays, suboptimal applications and failure to realise the potential benefits available. Slowness to embrace digital ICTs is demonstrated in the following Blog post by a serving officer:

> The take up of technology by the police has been woefully slow. I joined my current force in 2005. On arrival, nobody, NOBODY, had access to the internet! When I mentioned it I was met with much teeth sucking and shaking of heads like a plumber providing an estimate. A colleague I worked with had transferred to a Scottish force at the same time as me. I sent him an email, based on the standard format of police emails, to see how he was getting on. The emails bounced. I later made contact by other methods and established that email hadn't even been rolled out in his new force. In 2006!
>
> (Dewson-Smyth, 2015)

This very slow rate of take up indicates there were problems in the diffusion process which are interesting in the context of this study. Some of the problems are strategic:

> The last ICT audit of the MPS recorded a portfolio of approximately 750 systems; these range from simple macro-enabled spreadsheets, through to complex investigation management applications. Policing relies on these systems to be available and effective, whilst keeping alignment with changing legal and organisational imperatives. Analysis shows that over 80 per cent of our investment in technology supports existing legacy systems, whilst less than 20 per cent is invested in new, modern and agile solutions. The audit noted that there were over 400 projects either in progress or waiting to be progressed. This demand reflects the desire of the various MPS business groups to make best use of ICT to meet their specific business objectives.
>
> (Metropolitan Police Service (MPS), 2014, p. 4)

Other reports make similar points. For example, the London Assembly (2013) commenting on the Metropolitan Police, said: 'Forces tend to go straight to a technology solution before working out

the problem that they are trying to solve. And rather than exploiting the ICT capabilities they already have first, police forces tend to buy new technologies and incorporate them with their existing systems – sometimes unsuccessfully' (p. 8). The lack of understanding of barriers to diffusion is of interest in the context of this study.

A very costly failure in policing technology adoption was the Mobile Information Programme which ran between 2008 and 2010. Significant central government funding was distributed via the now defunct National Policing Improvement Agency (NPIA) under a programme to enable police forces to buy new mobile devices for front line staff. The programme was intended to increase the visibility of officers and improve the efficiency and effectiveness of police forces as well as reducing bureaucracy (National Audit Office, 2012, p. 3). The problems were highlighted in the report by National Audit Office (2012) who provided detailed scrutiny of the outcomes of the programme. Few forces were found to have benefitted from the programme and considerable variation in implementation was found. The report referred to a variety of failings including: a focus on providing mobile devices rather than the benefits they could deliver; the distribution of devices was inconsistent between forces and roles (some forces had no devices, other forces had distributed to officers and staff); only one fifth of forces used the technology to make efficiency improvements such as reducing paperwork; and there were procurement issues with forces sourcing their own suppliers. (pp. 5-6). The report noted some suppliers had greater influence on the police than others.

As described earlier, and as the literature review will show, diffusion and adoption frameworks/models may identify and explain some of the reasons for failure but the influences involved in multi-agency adoption are likely to require deeper understanding than those existing frameworks/models might generate.

2.5   Summary of chapter

The first part of this chapter looked at historical technology development in policing where high-profile crime events have led to technological change and where drives to improve efficiency and effectiveness have changed technology in policing. Innovations in technologies such as fingerprinting, CCTV and information technology has made a significant and lasting impact on the service. Some of these provided early indications of police collaboration with third parties and acting in a multi-agency way and highlighted very practical issues in the diffusion process. The second part of this chapter described the structure and events that have shaped the diffusion and adoption of technology in modern policing sometimes in response to critical events. It also outlined problematic failures highlighting there is complexity and uncertainty in diffusion and adoption. It is clear that steps to improve diffusion and adoption are needed and more knowledge and understanding of the factors and variables that contribute to or are affected by adoption and diffusion, are also required. The way this research will address the gap is to look at one of the modest innovations introduced in the night-time economy. Existing diffusion and adoption framework/models are explored later in this thesis in the literature review (Chapter 4). The research setting for this study is described in the next chapter.

Chapter Three: The research setting

3.1   Introduction to Chapter 3

This chapter provides the context for the research on adoption of ID Scanners in policing. It first

describes the overall characteristics for the research setting then outlines a range of contextual

features including the night-time economy and crime, within which diffusion and adoption of an

ID scanner takes place. This chapter then looks at governance and regulation through licensing of

premises, describes some of the challenges inherent in keeping the night-time economy a safe

place and considers multi-agency working. Next, the origin and capabilities of the ID Scanner as a

technological innovation is presented followed by the final section, a summary of the chapter.

3.2   Overall characteristics of the research setting

The context for this research was obtained to represent a technological innovation that involved

the police as a public sector organisation and where there was involvement from several other

key parties thus ensuring a suitably complex situation. In summary, the criteria for choice of

setting was that:

1) The technological innovation should be original or novel but an 'everyday' innovation with

   scalable potential.

2) The project did not need to start or finish at any particular time and could be subject to

   varying degrees of decision or implementation. The wider the differences would mean

   there would be more complexity to explore as it would be possible for those who had not

   yet adopted an innovation, and those that had or had the innovation for a longer

   timeframe, could report on the situation as it was.

3) The situation involved the police and other multi-agency collaborations thus displaying a

   variety of purposes, interests, perspectives and considerations.

4) There was potential for more than one geographical location, a concentrated area for the

   main research and a wider boundary perhaps where the purpose of the innovation had

   similar or contrasting affect.

The next sections describe the chosen context in more detail starting with the night-time economy.

3.3   The night-time economy

The night-time economy comprises a range of hospitality or retail premises such as pubs, nightclubs, restaurants and often, a selection of fast-food outlets. Though no single definition exists, the night-time economy is normally taken to cover the late evening period and the night-time between 6pm one day and 6am the next day. Pubs and clubs primarily sell alcohol and some late-night operating premises offer a place to dance and socialise. This period of time is important to the backdrop of a town or city as it contributes to the reputation of the location. It requires careful management by the bodies responsible for governance so the area is kept clean and safe. Disorder in the night-time economy can often dominate the news and incur cost for stakeholders such as the police and the National Health Service (NHS) who respond to incidents. Despite issues of crime and criminal behaviour at night, the term 'economy' demonstrates there are financial benefits to be realised and the night life can be an opportunity for growth. One way police seek to keep crime at bay and maintain or improve the reputation of the area is through the introduction of new technologies. For example, the technology considered in this research is the adoption of ID scanners that are thought to help prevent crime as well as being an investigative tool.

3.4   Crime

According to official public statistics, crime overall in England and Wales has been reducing over time and is at its lowest levels since the 1980s (Office for National Statistics - Crime Survey for England and Wales, 2022). Figure 3.1 shows the Crime Survey for England and Wales (CSEW) estimates.

Figure 3.1: Crime in England and Wales: year ending September 2022 (Source: Office for National Statistics - Crime Survey for England and Wales, 2022)
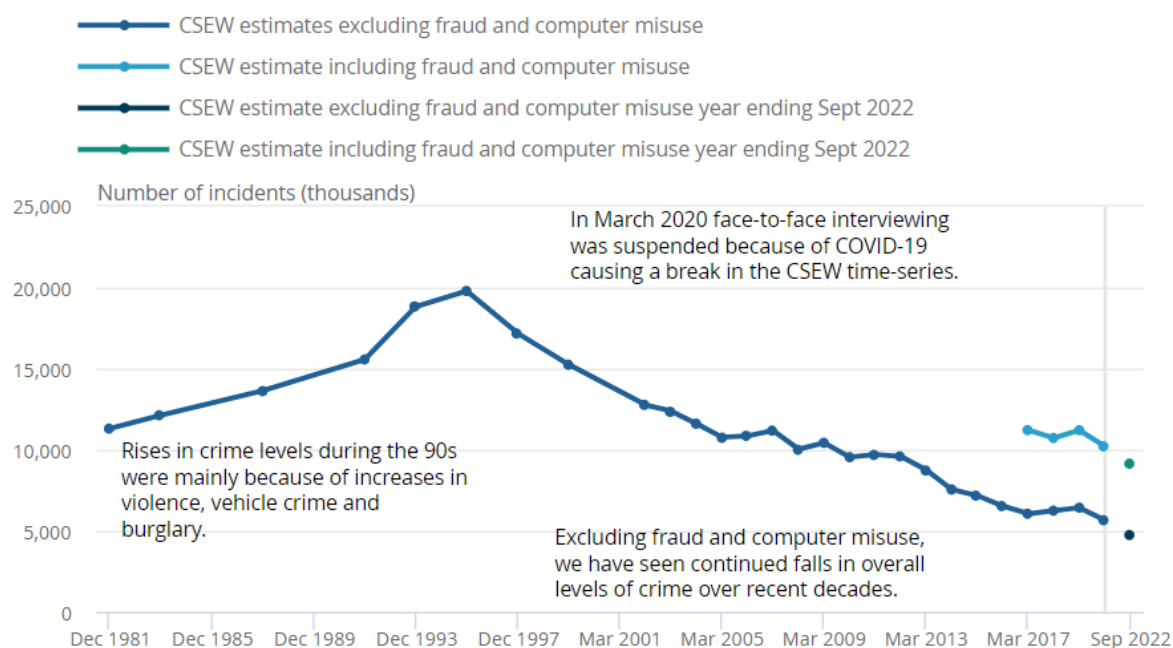
There appears to be a general trend of falling crime since 1996 in the survey. The Crime Survey data is based on victim crime where a victim is identifiable, and can therefore be surveyed, but excludes crime such as fraud, cybercrime and drug possession. The Crime Survey is intended to indicate trends for the type of crime in the population it serves. In addition, police recorded data is reported on but this data set does not account for all offences as some wrongdoings go unrecorded because the police do not raise an incident report. Some variation is expected between the two sets of data because they use different categories of crime.

Some crime rates such as those for burglary have been decreasing in the long-term whilst others, for instance violent crime[2], increased. The police suggest burglary reduction has occurred because technological devices found in the home, such as DVD players and simple audio equipment, are not attractive for burglars to steal due to their low value in the market. Sutton (2008) examined a local stolen goods market operation by prolific thieves for Nottinghamshire Constabulary and pointed out that:

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[2] Violent crime 'covers a range of offence types from minor assaults - such as pushing and shoving that result in no physical harm - to murder.' It also includes 'offences where the victim was threatened with violence whether or not there is any injury. wounding and assault (for both complete and attempted)' (Office for National Statistics, 2022).

> Since most prolific burglars steal from strangers because they want money, top of their list is cash, followed by items that can be easily sold for relatively high prices such as jewellery and hi-technology home entertainment equipment that is in demand.

(Sutton, 2008, p. 7)

He went on to say:

> Arguably the most valid predictor of what burglars choose to steal is whether or not they believe an item can be sold easily for a good price. This means knowing who wants to buy what and knowing how much they will pay. While weight and portability of items will be considered by thieves, this will only happen if they believe the goods to be saleable once removed.

(Sutton, 2008, p. 8)

Mobile phone theft is of particular interest here. The police argue that devices found outside the home provide a higher return for offenders and contribute to an increase in theft against the general trend of falling crime. Mobile phones have become more sophisticated and therefore more valuable whilst phone ownership has risen gradually over the past decade. For example, a high cost device, and a main target for thieves, is the latest version of the Apple iPhone. The Home Office (2014) recommended mobile phone manufacturers 'design out' theft (p. 2) and it is the case that manufacturers have done more to make phones less attractive to thieves by providing features such as tracking, and applications that enable data to be wiped remotely. Nevertheless, young people and women remain particular targets for theft from a person and 60 per cent of incidents were reported to take place at night. Introducing technology such as ID identification systems does not necessarily counter rises in burglary directly but it is thought to have an impact on crime in the night-time economy (Palmer et al., 2013). A high number of criminal activities that take place at night involve incidents that are more serious. The police are often under pressure from the public and their superiors to reduce the crime rates for violence so although burglary and theft remain a concern for the police, tackling public disorder and violent crime has become a priority.

Many of the problems that exist late at night are related to the consumption of alcohol and a wide range of literature looks at the link between alcohol and violence (See, for example, Murdoch and Ross, 1990; Plant et al., 2002; Lipsey et al., 2002). The Crime Survey for England and Wales indicates that up to 50 per cent of all violent incidents are alcohol-related (Walker et al., 2009; Alcohol Change UK, 2021). As social drinking styles have changed, people often obtain cheaper alcohol from supermarkets and drink at home before going 'out on the town'. This is known as 'pre-loading' and often results in people being 'drunk' for more of their time spent in the night-time economy and also results in fewer purchases of alcohol in premises. The increase in university tuition fees in 2012 has also had an influence, especially in geographical areas where there is reliance on the student population to provide customers. Certainly, students (and others) have been found to purchase only one drink each from a premises during an entire night out. This drinking culture is not just confined to the younger population but extends to those in their 30s and older too.

3.5   Governance in the night-time economy

Licensing is one of the tools used to address or suppress problems in the night-time economy. The 2003 Licensing Act (The Stationery Office, 2003) which was intended to bring a European culture of drinking style to the UK, became effective in 2005[3]. The Act meant that local authorities across England and Wales took responsibility for regulating and issuing licences and carrying out other functions in accordance with the Act by becoming a licensing authority. Everyone involved in the licensing process must abide by four overarching licensing objectives:

1. The prevention of crime and disorder

2. Public safety

3. The prevention of public nuisance

4. The protection of children from harm

(PopplestonAllen, 2021, p. 6)

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[3] This research focuses on England but it is noteworthy to mention that the night-time economy in Scotland is subject to the Licensing (Scotland) Act 2005.

Separate licences for the person (the manager or owner of a premises) and for the premises or place are issued by the relevant authority. The definition of 'premises' in this context is a broad one. Not only do licences exist for clubs and pubs the definition can also include fields and gardens or movable venues such as boats. Essentially, licences cover the supply or retail sale of alcohol, where regulated entertainment and/or where regulated late night refreshment is provided.

Licence holders are required by law not to sell alcohol to anybody under the age of 18 years of age. However, a range of practices exists. Some sellers ask for ID from someone who looks under-21 or under-25 and in some cases a 'Think 30' policy is in place. These policies are not just limited to the night-time but cover alcohol sales at other times of the day in a range of retail premises. In a report by the Manifesto Club, an organisation that campaigns for freedom in everyday life, Cummings (2010) called for age verification practices to be reviewed arguing they resulted in confused application of the policies. They also suggested that on-the-spot fines for those serving under-age drinkers 'unfairly victimised bar staff…who can ill-afford the fines, and lead them to take an overly cautious approach to age checking.' (p. 4). The police and/or Trading Standards Officers undertake 'test purchases' or 'sting' operations to check if alcohol is being sold to under-18s.

The Act introduced flexibility in opening hours for premises. Because of this possibility for more widespread opening times, in practice, this change in the Act has led to an increase in potential for public order issues. Instead of pubs closing at a regular time and people moving into the later opening premises, pubs and clubs could choose to open for longer. The Act intended to improve issues in public order by discouraging binge drinking and by not having single closing times resulting in people vacating premises at one time. Additionally, the economic downturn and resulting austerity mean many people choose to drink at home because supermarkets and specialist stores sell alcohol at a much-reduced cost.

The Act brought new challenges for the police who became the 'responsible authority'. This role requires police to report issues with premises or licensed persons to the local authority who can then take appropriate action against them. From time to time, the Home Office issues a guide on interpreting the Licensing Act (The Home Office, 2015) to support implementation of the licensing objectives and the guide confirms the police are the primary enforcer of the Act. Reported consequences of the Act were almost always negative. The Act was found to be difficult to interpret, often leading to ambiguous conditions added to a licence (PopplestonAllen, 2016). An evaluation study by the Department for Media Culture and Sport (2008) pulled together findings from a programme of projects that reviewed the implementation and impact of the 2003 Act. The evaluation found that, although there had been only limited changes to opening hours, there had been no improvement in crime as the volume of incidents had remained static. They did identify trends they described as positive notably improved partnership working between local authorities, the police and other responsible authorities and licensees. They drew conclusions that enforcement is only part of the strategy for combating problems associated with alcohol. Those managing the night-time economy should continue to tackle underage sales and to protect children from harm. Strategies need to cover improving social responsibility amongst retailers and require earlier intervention with problem and harmful drinkers.

3.6   Premises licence

Although in 2016, the UK's night and evening economy was estimated to be worth £60 billion (The Association of Town and City Management, 2016), the nightclub sector as a whole has been declining since 2005. Indeed, it has been estimated that the number of UK clubs halved in the decade since 2005 (Anderson, 2015). Several factors are contributing to the decline in the night-time economy including the change in legislation and the introduction of the Licensing Act described earlier, the decline of the economy in general and changing social habits. Nightclubs are independently run or owned by a nightclub chain or a group that also runs pubs and restaurants.

Some chains have found financial sustainability very challenging leading to liquidation or changes in ownership. Social factors have also influenced the decline. It may also be the case that the smoking ban that came into force in 2007 affected the sector too.

A premises licence plays a role in contributing to safer operating as specific conditions can be attached to a licence. For example, the capacity of a premises may be specified on a licence on the grounds that the fuller it is, the more likely trouble is to occur. Premises operating within the night-time economy must also have door supervisors who are Security Industry Authority (SIA) licence holders and a ratio of staff to patrons often features on a licence. The SIA is an independent UK-wide body that reports to the Home Office and is responsible for helping to ensure the night-time economy is a safe environment. It was established in 2003 and is responsible for the regulation and licensing of door staff through their Approved Contractor Scheme. The requirement for door supervisors to be licensed was introduced soon after the SIA was set up. There is a general impression amongst stakeholders such as the police and the local authority that the licensing of door supervisors has been a positive move. Door supervisors, often referred to as 'bouncers', are usually contracted to the premises sometimes through a third party though managers or the premise's owners are responsible for choosing and building their security team.

Door supervisors are responsible for checking the suitability of people entering a premises. They are usually the first point of contact and form an important rapport with the customers. They also have responsibility for the safety of the customers in the premises and need to be able to handle a range of situations, calming the more difficult customers where conflict has occurred following refusal to allow entry. To do so requires good people skills as their job role includes being a preventative measure to addressing crime. Door supervisors can be subject to abuse and violence. In a research study by Reform Think Tank (2012) looking at the reduction of violence against security staff, survey respondents suggested ID scanning technology was a suitable measure for dealing with violence. The research surveyed 823 security staff and almost half in

that study were in favour of ID scanning though the research did not seek to identify the reasons for this support. Palmer et al. (2013) suggests that ID scanning is a deterrent to violent behaviour because those with a history of violence or criminality will be prevented from entering the premises. There are tasks where door supervisors need to make a judgement before allowing a person to enter a premises including assessing someone's ID or assessing whether the person is too intoxicated.

Other measures of addressing issues in premises exist. Club Angels and Street Pastors are Christian organisations that work in collaboration with the police and other organisations. The Club Angels initiative (Club Angels, 2015) arranges for volunteers to work in clubs to look out for the general wellbeing of the public. The benefit to the club of having a Club Angels presence is that they have support close at hand for their customers and, in effect, that support operates as unpaid staff. The Street Pastors initiative is becoming well-known in cities across the UK and internationally (Street Pastors, 2016). Street pastors are volunteers who usually work outdoors between 10pm and 4am to provide support to potentially vulnerable people. The extent to which each of these initiatives, or technology, plays a part in preventing crime and improving the night-time economy has not been established although many news articles report on its contribution to creating a safer night life (See for example, Metcalfe, 2014; Gelder, 2015). These organisations are additional ones operating alongside policing and to which relationships between them and the police may be built.

3.7   Multi-agency working

Industry groups and networks also play a part in supporting implementation of the licensing objectives. Partnership mechanisms such as the trade led National Pubwatch, which is a national network, and local crime partnerships (e.g., Radiolink, Pub and Club Watch and local alcohol partnerships) have been established. There are also a range of other groups in operation in different locations including Business Improvement Groups, the Night Time Industries Association and recognition associations such as the Purple Flag accreditation scheme. Although Pubwatch is a national network, locally it is usual for a Board of premises owners and managers to govern this

non-profit making organisation, run by members for its members. One role the Board has is to make a collective agreement on which specific individuals will be banned from members' premises. The partnership offers tools to support crime reduction in the area and brings issues to the attention of the police and other members of the partnership. Varying levels of membership are offered from a basic sharing of photos of priority offenders right through to subscriptions for two-way radio devices. In 2016 Pubwatch charged an annual fee of £75 per establishment while full membership, allowing sharing of images, could cost as much as £300. (The latter charge varies depending on the number of employees). Options to rent radio link devices also exist and cost between £309 and £586 depending on the type of radio issued. In some areas, the partnership provides training on statement writing, loss prevention, first aid and lectures on the use of force and the act of theft. Members are also charged a fee for receiving individual reports prepared by the network on incidents. These multiple bodies also operating in the night-time economy all with differing interests demonstrates there is complexity in the environment and the police will be required to work in a multi-agency way.

3.8   Technology

Not surprisingly, the police and other stakeholders are interested in technological solutions to counter issues in cities and towns at night. Closed circuit television (CCTV) is well known and has been widely used for some time. Indeed, it features on almost every premises' licence. Stakeholders often collaborate in the use of CCTV. In Oxford city centre, a police-run CCTV control room has oversight of the city centre and members of a local partnership can be in direct contact with CCTV operators. In non-emergency cases where the member needs the police to attend, contact with the police is made through the usual channels such as the police non-emergency telephone number. In an emergency, the police control room instructs the police to act instead. Another technology that has been in common use by the police for many years as a means of sharing intelligence is the two-way radio device. Companies now provide digital radios and network infrastructure for hire to members of the Pubwatch network. The primary focus is on tackling theft and tracking banned persons.

Members of the network with a radio obtained through this scheme can contact the police directly as communications are routed through the local police control room.

As discussed earlier, misuse of alcohol is a cause of some of the criminal behaviour that occurs at night. The breathalyser, a familiar technology in the context of drink driving has now been developed for use at entrances to nightclubs and, in some areas, it has been trialled for use by door staff at the request of the police. Other technologies such as Body Worn Video (BWV) are also being trialled with door supervisors.

Identification and scanning technologies were invented in the mid-2000s. The first scanning technologies were devised from early facsimile-type technologies that had existed since the late 1800s and the first image scan was made in 1957 (Woodward, 2013). The technology has continued to evolve since then and a range of different scanning equipment now exists from bar code scanners used in most retail premises and in supply chain control in different sectors, to biological scanners and to newly developing iris scanners, not to mention 3D printing scanners. The ID scanner featured in this research was developed and brought to market by Tamlyn Thomson in 2005. After a failed attempt to secure investment through a television series (Dragons Den) where entrepreneurs seek financial support for new innovations (Dragons Den, 2016), he went on to establish a company called ID Scan. ID Scan is presently the only provider of this technology and other similar technologies have not yet come close to challenging the capability of ID Scans' device, although some alternative ideas are beginning to emerge that make use of mobile phone applications. It should be noted that there are issues concerning the robustness of some of those products. The ID scanning device observed in this study is usually offered as a freestanding or desktop machine. The freestanding option has wheels for manoeuvrability and therefore has flexibility in its positioning. It can be kept in storage and brought out for use when needed. Desktop devices are often used in locations that have limited space. They consist of a screen, keyboard and scanner and are usually fixed in place near the entrance to a premises. (A photo of an ID scanner is provided in Appendix G). Using an inbuilt infrared light, and with appropriate software, it scans documents presented in front of it and

'reads' detail and codes on the document. Using the scanning function enables data (including images) to be gathered from a wide range of ID documents such as driving licences and passports. The data the scanner has captured is presented on a screen that can then be reviewed by the door supervisor and checked against the appearance of the person who presented the ID. (An example of a displayed result of an ID scan is also shown in Appendix G). The data is stored electronically for later use. The ID scanner has the capacity to identify thousands of different types of ID from all over the world. It detects and alerts the user of the machine to counterfeit documents and/or duplicate ID (it is a criminal offence to possess forged identification documents with improper intent).

The scanner also calculates the age of the person in the document presented and verifies that the ID has not expired. In some circumstances where the individual presenting the ID has previously been recorded as subject to a ban, the ID Scanner will also highlight that earlier ban to the door supervisor.

In relation to the use of identification documents, in 2012 the Home Office published guidelines on handling false ID which was aimed at door supervisors and other staff in premises (The Home Office, 2012). Annex E of their guidelines provides a positive case of the use of the ID Scanner by the Metropolitan Police. However, the Home Office and the police have some concerns about potential passport theft. The UK Passport Office are said to prefer to deter people from carrying passports late at night. Despite such concerns about carrying passports, there is no widely accepted alternative ID for people to carry instead. In 2010, proposed plans for a UK-wide ID card were scrapped due to cost and concerns about the protection of personal data (Travis, 2010).

Government departments use a form of ID scanning and issue a set of publicly available guidelines on use of such machines but advice on the use of ID scanners in general is more difficult to find. The Information Commissioner's Office (ICO) (2009) provides overarching suggestions for managing the use of ID devices. The ICO requires premises to collect only relevant information and display signs to inform customers why the scanner is there and advise customers whether

data is shared with other schemes. Premises should also have robust management for access, storage and security of the scanning equipment and data. It is true to say that use of the ID scanner does raise data protection and privacy concerns for some. For example, an uncertainty surrounding the data captured by an ID scanner is that it may not be clear who is responsible for requests to amend or delete data. There are also considerations relating to future development of the technology. The ID Scanner has already incorporated some capability for future advances in facial recognition and use of fingerprints and the device already has some capability for scanning these different types of input.

News reports have highlighted the benefits of the ID scanner and a number of articles promote the use of the ID Scanner by the police (See for example, Drummond-Smith, 2014; Russell, 2015). One example reported on an incident in Romford in Essex (Gelder, 2015) and showed a successful conviction took place due to the introduction of a scanner because police were able to access data to aid their investigation into the incident. Other incidents have taken place where it appears an ID scanner may have benefited the police investigation (See for example, Pidd, 2022; BBC, 2023).

3.9   Summary of chapter

This chapter has provided the context for the research on adoption of ID Scanners. The overall characteristics for the choice of context were explained first. Then the night-time economy was described including crime, governance, the premises licence, groups operating in the night-time economy and finally the technology. It is clear that management of the night-time economy is complex. Local authorities, police and other organisations active in the night-time economy have responsibility for tackling issues that happen late at night in a town or city often in a multi-agency way. Following the introduction of the Licensing Act in 2003 (The Stationery Office, 2003), there has been uncertainty regarding ways to tackle rising violent crime and theft which are problems often caused by overuse of alcohol. However, many of the stakeholders involved in the night-time economy work together in an attempt to improve the situation. One of the ways they do this is through the adoption of technology. Some technology is already well integrated, such as

the use of CCTV in nightclubs, and new technologies such as the ID scanner are under

consideration as both a deterrent and as an investigative tool and a valuable one to be looked at

in this research. The next chapter examines the academic literature relating to this research.

Chapter Four: Literature review

4.1   Introduction to Chapter 4

The overall aim of this research is to investigate whether systems thinking can enhance, or indeed be a replacement for, existing diffusion and adoption frameworks/models in a multi-agency partnership context. This chapter reviews the literature underpinning an understanding of the approaches used to explain diffusion and adoption of innovations. Chapter 6 describes systems thinking. The review will evaluate the strengths and limitations of those frameworks/models in relation to diffusion and adoption and comment on the extent of applicability to multi-agency working.

The search for authoritative academic texts on the topics of innovation, diffusion and adoption spanned several disciplines including information and computer sciences, crime and justice and technology management. To conduct the review thoroughly terms including 'innovation', 'technology adoption', 'technology in policing', 'multi-agency adoption' and 'diffusion of innovations' were used and relevant phrases and text were searched for. Abstracts and keywords were used to search databases including Emerald Insight, Google Scholar, IEEE Xplore, JSTOR, ScienceDirect, Wiley Online Library. These routes provided access to a wide variety of journals and types of literature. In some cases, the SCONUL facility was used to access literature held in other libraries. Using multiple sources in this way ensured the literature review would cover the topic in the most thorough way. Throughout the review of literature, commonalities were identified and further literature pursued using citations and references and the search terms were further refined.

This chapter is organised as follows. First, it introduces the concept of innovation generally, and then it discusses the more specific topics of diffusion and adoption alongside the various relevant frameworks/models. Then, literature relating to policing practice is also explored to uncover how innovation, diffusion and adoption took place in a police setting. Next, literature is reviewed on

multi-agency partnership. The field of collaboration and partnership is vast so the section focuses on literature where there are similarities in the mechanism for multi-agency working. Figure 4.1 illustrates the areas of literature covered in this review. Finally, the chapter summarises the gaps identified in the literature and a selection of frameworks/models is made for further analysis in this research.

Figure 4.1: Areas of literature covered in this review
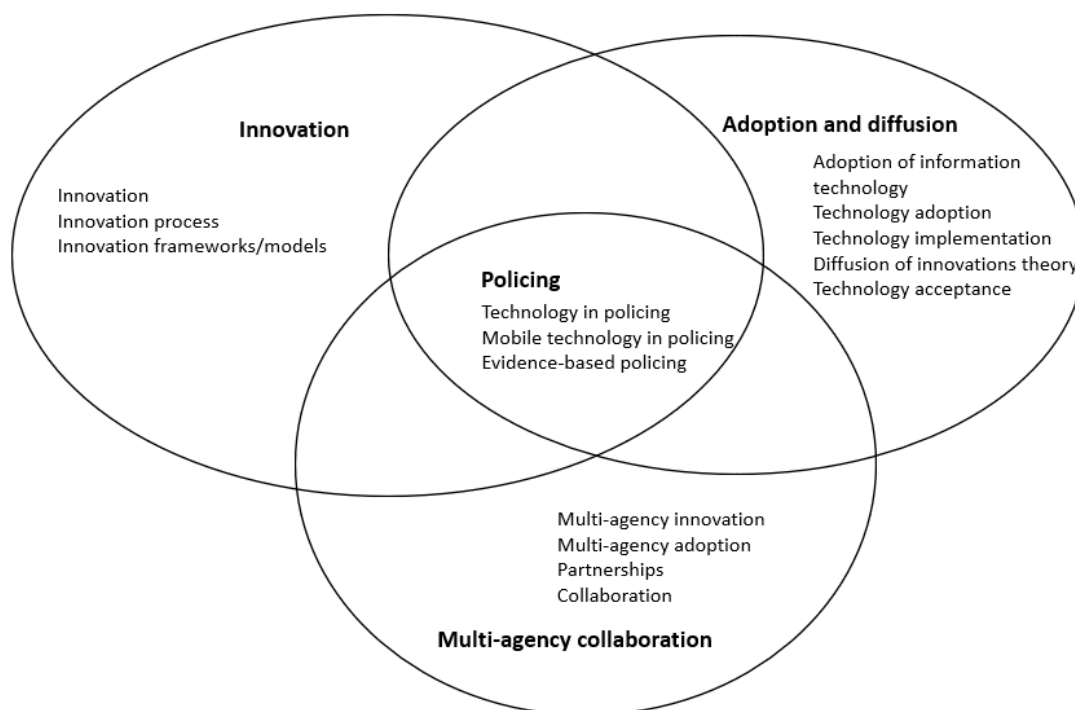
The next section introduces the concept of innovation.

4.2 Innovation

Innovation is now a widely used term to describe how something novel is generated, developed or used. The notion of innovation has been explored in a variety of disciplines in academic literature and is defined in Chapter 1 to describe something new: an idea; practice or; object.

4.2.1 Innovation processes

One key author attributed with pioneering the notion of innovation was Schumpeter (Fagerberg, 2003). Though Schumpeter is said not to have closely studied the factors and conditions that led to innovation or how innovations came about (Fagerberg, 2003), indicating that more needs to be known about innovation as a process and how to manage diffusion and adoption. Indeed this is

particularly true in technological innovation which requires careful management. Goffin and

Pfeiffer (2002) point to five key areas they say would benefit from measuring performance. The

areas are:

> Innovation management requires performance in five areas: innovation strategy;
>
> creativity and ideas management; portfolio management; project management; and
>
> human resource management.

(Goffin and Pfeiffer, 2002, p. 143)

Referencing to a study that collected data from around 200 companies on innovation

performance by the Cranfield School of Management and the Export-Akademie Baden-

Württemberg, Goffin and Pfeiffer identify three key issues in managing innovation:

'misunderstanding the role of innovation, too many development projects and perceiving

innovation as a single discipline' (Goffin and Pfeiffer, 2002, p. 143).

Literature featuring innovation as a result of a process includes that by Hartley (2005). Hartley

(2005) located governance innovations as one of several categories of innovation within a

typology of innovations. Hartley suggested the categories of innovation were:

- Product: new products (for example new instrumentation in hospitals).

- Service innovation: new ways in which services are provided to users (for example on-line

  tax forms).

- Process innovation: new ways in which organizational processes are designed (for

  example administrative reorganization into front- and back-office processes; process

  mapping leading to new approaches).

- Position innovation: new contexts or users (for example the Connexions service for young

  people).

- Strategic innovation: new goals or purposes of the organization (for example community

  policing; foundation hospitals).

- Governance innovation: new forms of citizen engagement, and democratic institutions (for example area forums; devolved government).

- Rhetorical innovation: new language and new concepts (for example the concept of congestion charging for London, or a carbon tax).

(Hartley, 2005, p. 27)

Hartley's typology shows that innovation is not limited to manufacturing of physical goods but is also present in other areas including the innovation of services which is a key focus for this research. She argues that there are 'important lessons for policy, practice and research…to develop an understanding of innovation which is not over-reliant on the private sector manufacturing literature but reflects the distinctive contexts and purposes of the public sector' (p. 27). Innovation can be complex involving a variety of perspectives and interests arising from relationships involved in service delivery and impacting on the innovation and its diffusion and adoption. Hartley reflects that context plays a part and that complexity and uncertainty 'has an impact, both directly on innovation determinants, processes and outcomes and indirectly through organizational features such as the amount of organizational resources and organizational strategy' (p. 33). These insights point to a need to know more about the choices made when diffusing and adopting an innovation when it has not come about from just one organisational strategy. Yet innovation can also be known as a source of change. Joubert and Van Belle (2012) looked at success factors for product and service innovation. A study drawing on a wide range of literature, they aimed to classify critical success factors for innovation. Namely they identified strategic, organisation, market and development factors. They also distinguish between product and service innovation and note the intangible nature and complexities that surround service innovation being a primarily knowledge and process focussed activity. However they acknowledged that technological innovation happens when the change in use of technology leads to the development of new processes and services. Even so, they advise this in the context of the competitive nature for organisations and the nature of the police as a public service and the multi-agency context within which they operate may offer distinct differences.

They drew the conclusion that:

> Although plenty of literature exists on the critical success factors for product innovation
>
> and new product development, less can be found on the factors determining success in
>
> service innovation. Overall, it was clear that a clear gap exists in the current innovation
>
> literature: most researchers and innovation success models focus on only a few variables,
>
> and no overarching model exists that incorporates all or even a major subset of factors.

(Joubert and Van Belle, 2012, p. 16)

This variety of understandings suggests how innovation happens is confusing.

4.2.2   Generations of innovation models

In a much-cited paper (e.g., Fagerberg, 2018; Alam and Perry, 2002; Bigliardi et al., 2021; Füller et

al., 2022), Rothwell (1994) looked back over the development of innovation processes in a

manufacturing environment since the early 1950s. Primarily aimed at the manufacturing industry

to overcome adaptation required in innovation to respond to changing market conditions,

Rothwell conceptualised innovation processes in terms of five generations of models. He

identified the origin of the first generation as the growing commercialisation of firms in the 1950s

and saw it as a linear sequence of steps, from scientific discovery through to product

development. Rothwell called this the 'technology push' model. He classed the second

generation as a 'market pull' approach but one which still followed a sequence of steps: market

need; development; manufacturing; and sales. He saw the third generation as emerging in the

early to late 1970s as a more interactive model. He named this the 'coupling' model.

As can be seen in Figure 4.2, the coupling model comprises a sequence of steps that begin with

idea generation and conclude when the innovation reaches the marketplace but instead of being

entirely sequential the model also incorporates feedback loops.

Figure 4.2: The Coupling Model (Source: Rothwell, 1994, p. 10)
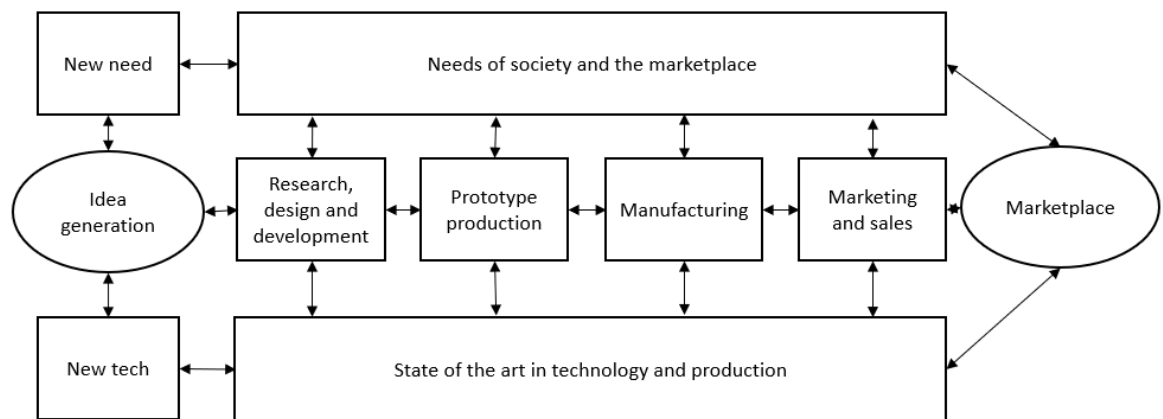
Alongside his discussion of the third generation model, Rothwell provides two groups of factors associated with best practice that he had assembled after examining 'the spate of innovation research projects undertaken during this period' (p. 10):

1. Project execution factors:

    - Good internal and external communication: accessing external know-how.

    - Treating innovation as a corporate wide task: effective inter-functional coordination: good balance of functions.

    - Implementing careful planning and project control procedures: high equality up-front analysis.

    - Efficiency in development work and high quality production.

    - Strong marketing orientation: emphasis on satisfying user needs: development emphasis on creating user value.

    - Providing a good technical and spares service to customers: effective user education.

    - Effective product champions and technological gatekeepers.

    - High quality, open-minded management: commitment to the development of human capital.

    - Attaining cross-project synergies and inter-project learning.

2.   Corporate level factors:

- Top management commitment and visible support for innovation.

- Long-term corporate strategy with associated technology strategy.

- Long-term commitment to major projects (patient money).

- Corporate flexibility and responsiveness to change.

- Top management acceptance of risk.

- Innovation-accepting, entrepreneurship-accommodating culture.

(Rothwell, 1994, pp. 10-11)

Rothwell goes on to say that:

… success or failure could rarely be explained in terms of one or two factors only; rather explanations were multi-factored. In other words, success was rarely associated with performing one or two tasks brilliantly, but with doing most tasks competently and in a balanced and well co-ordinated manner. At the very heart of the successful innovation process were "key individuals" of high quality and ability; people with entrepreneurial flair and a strong personal commitment to innovation.

(Rothwell, 1994, p. 11)

It is the case that, although Rothwell's Coupling model focuses on the introduction of a new product rather than a service or technology adoption, the inclusion of feedback loops into the process makes it interesting in this research context and often there will be iterations in the innovation process that require understanding but no multi-agency or collaborative working with external organisations were reported.

The fourth-generation model, identified by Rothwell as dating from the 1980s, builds on the previous generation but takes into account globalisation and an increasing emphasis on technology strategy. Rothwell reports a growing interest in networking between organisations to meet the speed of innovation required in the market place. Two of the key features in the fourth generation are integration, both internal and external (for instance, when supplier engagement takes place early in the product development process) and management of the innovation

process that allows different departments to work in parallel rather than consecutively. The evolution of these previous models demonstrates the complexity surrounding innovation and that frameworks/models develop as new knowledge is found. The development of the model continues when Rothwell concludes the paper by proposing a fifth generation model that he believed leading edge innovators were beginning to take on elements of.

The fifth general model regards innovation as 'a process of know-how accumulation, or learning process, involving elements of internal and external learning' (p. 26). Rothwell anticipates the model has a wider range of internal and external factors and he proposes to take account of external engagement with key suppliers, competitors, leading edge customers and alliances and strategic partnerships. There are 24 factors listed in the paper as 'being involved in increasing speed and efficiency' (p. 15). These include top management commitment and support, adequate preparation and mobilising support and resources, high quality initial product specification (resulting in fewer unexpected changes), close and early linkages with primary suppliers (p. 18) and accessing external know how (p. 19). Drawing on examples of Japanese innovators who were said to be adept at collaboration even integrating suppliers into the process, Rothwell completes his paper by suggesting those that can master this process of integrating internal and external feedback and making use of the 24 factors throughout the product development process will be successful innovators.

The concept of Open Innovation, and a contribution to the development of a sixth generation of innovation model, is introduced by Chesbrough (2003). In the context of managing innovation in the electronics industry, Chesbrough suggests Open Innovation is a model that considers external perspectives:

> Open Innovation is a paradigm that assumes that [organisations] can and should use external ideas as well as internal ideas, and internal and external paths to market, as the [organisations] look to advance their technology.

(Chesbrough, 2003, p. 24)

Chesbrough presents an argument that organisations do not take full advantage of others' ideas to import technology and knowledge and that potentially wastes innovative effort (p. 29). Referring to a study on the Xerox organisation (a well-known corporation and pioneer of office equipment), 'closed' innovation is explained as being bounded internally within an organisation. Even though innovations were developed by Xerox's own research centre, sometimes innovations were discarded because of a lack of relevance to their business. Instead, people left Xerox as an employer and set up 'spin-off' companies thus exporting both technology and knowledge. Chesbrough studied 35 of those break-away organisations and there were some successes reported. For example, some of the start-ups contributed to new developments in internet technologies. The research indicates that externality was a factor in successful innovation. Chesbrough reports an ability to commercialise knowledge in a process involving partnering or by, ultimately, acquiring organisations known as 'newcomers':

> These days, the former leading industrial enterprises are finding remarkably strong competition from many newer companies. These newcomers…conduct very little or no basic research on their own…they have been very innovative, these companies have innovated with the research discovery of others.

(Chesbrough, 2003, p. 18)

This transition is needed to take innovations from internal to external markets and it is said to happen best when projects find their value in the market. Although the development of technological innovation by importing and exporting technology and knowledge can be applied in different contexts and Chesbrough's work provides a useful framework for considering collaboration and innovation more broadly, it is often presented from the point of view of a single organisation. It is the relationships between several organisations contributing to diffusion and adoption of an innovation in an uncertain context that interesting in this study. There may be some reluctance by stakeholders that require influence by others or someway to overcome barriers to adoption.

Other points of relevance to this study is that Open Innovation makes an attempt to unravel some complexity by providing a more nuanced model of innovation that recognises there is non-linearity in innovation processes. In addition, and in the context of this research, it is not just about the technology itself but also complexity added through

policy, regulation, working practices and culture in the night-time economy.

Further literature on innovation through multi-agency working by Du Preez and Louw (2008) presents a framework for managing innovation. Developed from a review of literature, the framework draws multiple stakeholders into the process in a collaborative environment. Though the framework assumes that one organisation has the vision and strategy for innovation. Du Preez and Louw emphasise a shift in innovation literature from linear, more simple models, to increasing complexity (p. 2). They note the influences of the external environment have become more prevalent:

> …the innovation environment has changed through networking and collaboration from simple linear models to the more complex integrated network models. Open innovations call for a new logic, prescribing openness and collaboration at its centre.

> (Du Preez and Louw, 2008, p. 8)

This shift in innovation scholarship shows a need to consider externality in innovation with a realisation that organisations cannot be reliant just on their own but combining with the experience and skills of others. Often, innovations are introduced with an aim of getting to market first (See Du Preez and Louw, 2008 and Chesbrough, 2020). However diffusion and adoption in the context of a multi-agency setting requires further thought. Du Preez and Louw (2008) explain Open Innovation as a 'network' model of innovation that includes internal and external idea generation as well as internal and external paths to market (p. 6). However, there are assumptions made that an organisation wants to innovate and that the management process has a focus on innovation. Where several stakeholders have influence over diffusion and adoption for different ideas, purposes and perspectives, more complexity is found in the process

of diffusion and adoption. This notion that innovation is the product of a network of organisations is important to the diffusion and adoption process and is interesting in the context of this study. The ID scanner technology also requires collaboration to allow its adoption into the into the night-time economy. Individual stakeholders and agencies will contribute differently in the network by adopting specific roles and will also have to work collaboratively together.

Kotsemir and Meissner (2013) also looked at trends in innovation models and particularly at Rothwell as a major model in the field. They said that 'Over the last decades the understanding of innovation and the overall impact of innovation on national welfare has changed considerably' (p. 3) but 'nearly 20 years that have passed since the publication of Rothwell's article in 1994 there was no proposals on the sixth generation of innovation management models' (p. 10). They suggested this might be because of changes to innovation strategies such as networking, globalisation, and outsourcing which leads to flexible, interactive and interconnected processes alleviating the need for the development of a new model. This indicates a shift away from innovation only being understood as a product development process coupled with a lack of practical knowledge on how to diffuse and adopt an innovation to one that requires collaboration with external agencies.

The general trends in literature on innovation is useful in the context of this research and the shift from the traditional closed innovation model (where organisations relied upon internally developed innovation) to an open and collaborative approach that recognises the useful inclusion of external expertise and knowledge is important when examining diffusion and adoption in a multi-agency context.

Table 4.1 summarises the literature reviewed on innovation so far.

Author and year	Underpinning theory (where used)	Summary of literature	Summary comments
Füller et al. (2022)		In the context of new Artificial Intelligence (AI) technologies, refers to Rothwell (1994).	Examines a trajectory of innovation generational models including those by Rothwell (1994) and Chesbrough (2003).
Bigliardi et al. (2021)	Open Innovation	Refers to Rothwell (1994).	Discusses antecedents to Open Innovation such as Rothwell (1994).
Chesbrough (2020)	Open Innovation	Discusses Open Innovation in the context of medical science and the Coronavirus Pandemic.	Advises taking advantage of internal and external knowledge to speed up internal innovation processes.
Fagerberg (2018)		Refers to Rothwell (1994).	Discusses innovation policy development.
Kotsemir and Meissner (2013)		Explores trends in innovation models.	Refers to growing complexity in the environment including networking, globalisation and outsourcing.
Joubert and Van Belle (2012)		Examines success factors for product and service innovation.	Intangible and complexities surrounding service innovation is noted.
Du Preez and Louw (2008)	Open Innovation	Emphasises a shift in innovation literature from linear, more simple models to ones with increasing complexity.	Organisations are not just reliant on their own but combining with the experience and skills of others for successful innovation.
Hartley (2005)		Discusses innovation as a process and a typology of innovations is provided.	Innovation is not limited to physical goods but is also present in services.
Chesbrough (2003)	Open Innovation	Refers to Open Innovation as a paradigm that uses external ideas.	The relationships with external organisations are important to transitioning innovation to implementation.
Fagerberg (2003)		Explains Schumpeter as pioneering the notion of innovation.	Factors and conditions that led to innovation were not closely studied.
Alam and Perry (2002)		Refers to Rothwell (1994).	Focus on stages of new product development in the finance industry.
Goffin and Pfeiffer (2002)		Examines innovation management and suggest areas for measuring performance of innovation.	Helpful for awareness of management issues in innovation.
Rothwell (1994)	Fifth generation of innovation model	Conceptualises the innovation processes in terms of five generations of innovation models. Primarily aimed at the manufacturing industry to overcome adaptation required in innovation to respond to changing market conditions.	Reductionist with a focus on product development and not adoption overall. Consideration of external influences is missing.

Table 4.1: Summary of literature reviewed on innovation

To address some of the uncertainty surrounding innovation, the next sections provider firmer

grounding by reviewing some of the frameworks/models available to understand diffusion and

adoption within the innovation process.

4.3   Models of diffusion and adoption

The purpose of this section is to explore frameworks/models that are concerned with diffusion and adoption generally.

4.3.1   Diffusion of Innovations

This section explores theory and processes for explaining how an innovation is diffused. Rogers' very widely cited book entitled *Diffusion of Innovations* (e.g., Valente and Davis, 1999; Doyle et al., 2014; Dearing and Cox, 2018; García-Avilés, 2020) had five editions, the most recent being 2003. It seeks to explain generally why an innovation infiltrates a population or not and thus whether innovations become adopted successfully or not and provides frameworks/models for parts of the innovation process.

Rogers uses the following elements to explain diffusion:

1.   The innovation: the idea, programme, practice or object;

2.   Communication: the way messages are transmitted;

3.   Time: including the rate an innovation is adopted by members of a system and the innovation-decision process;

4.   The social system, which includes the role of individuals in the system and social networks.

Where the first of these elements is concerned, it is the characteristics of the innovation, as perceived by individuals, which contribute to the rate of adoption. Rogers identifies these characteristics as relative advantage, compatibility, complexity, trialability and observability. The first perceived characteristic affecting diffusion and adoption of an innovation is the degree of benefit or relative advantage of an innovation. Rogers suggest those innovations which are demonstrated to have high relative advantage will be adopted more quickly. He explains the diffusion of an innovation is an uncertainty reduction process. In the case of this research, the relative advantage may be the contribution of a technological innovation to crime reduction and, according to the theory, clarity in its advantage may reduce uncertainty amongst adopters.

Another way to reduce uncertainty in a situation is to use a systems thinking approach. Compatibility, another characteristic, is 'the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters.' (p. 240). Incompatibility can lead to non-adoption. The complexity characteristic refers to whether the innovation is perceived to be easy to understand and use. If difficult, adopters may become frustrated and unable to cope with the introduction of the innovation. Trialability and observability refer to the ability for potential adopters to try the innovation before committing and the degree to which the results are visible to others in the social system. A drawback of using this theory in practice is how these characteristics should be prioritised and how uncertainty in prioritisation may be managed. Another aspect of the innovation element in the work by Rogers is the concept of reinvention. Reinvention is the change or changes made by users once adopted. Rogers suggests that an innovation diffuses more rapidly when it is reinvented as it confirms adoption is made sustainable for the individual. The concept of reinvention gives some insight into adoption in practice.

In considering the communication element in diffusion theory, along with the influences of the social system, Rogers describes the roles of key individuals in adoption such as 'change agent' and 'opinion leader.' He explains a change agent as an individual who affects the innovation-decision and opinion leaders play a key role in diffusing an innovation through their networks. This role of key individuals supports the earlier claim in Rothwell (*Op. cit.*) that they are essential to the process. Although networks and communication are large themes in this work, an illustration of ideal communication structures in adoption is not provided in the literature.

In relation to the element of time, three features are particularly important in relation to this research. These are: the rate of adoption; categorisations of adopter innovativeness; and the innovation-decision process. The adoption of an innovation is usually found to follow a normal, bell-shaped distribution curve but this means the adoption of an innovation follows an S-shaped curve when the cumulative rate of adoption is plotted over time (See Fisher and Pry, 1971; Foster,

1985). These S-shaped curves are shown in Figure 4.3 for three examples of innovations with

different rates of adoption. Although some innovations may diffuse more slowly than others,

Rogers suggested that an individual curve takes off when 10-20 per cent adoption is reached. This

is called the critical mass, defined as 'the point after which further diffusion becomes self-

sustaining' (p. 343). Once communication and networks positively influence the adoption of an

innovation, this critical mass can be achieved and the rate of adoption gathers speed until around

half the population has adopted. The rate of adoption decreases when the final remaining

adopters take up the innovation.

Figure 4.3: Examples of innovations with different rates of adoption (Source: After Rogers, 2003, p. 11)
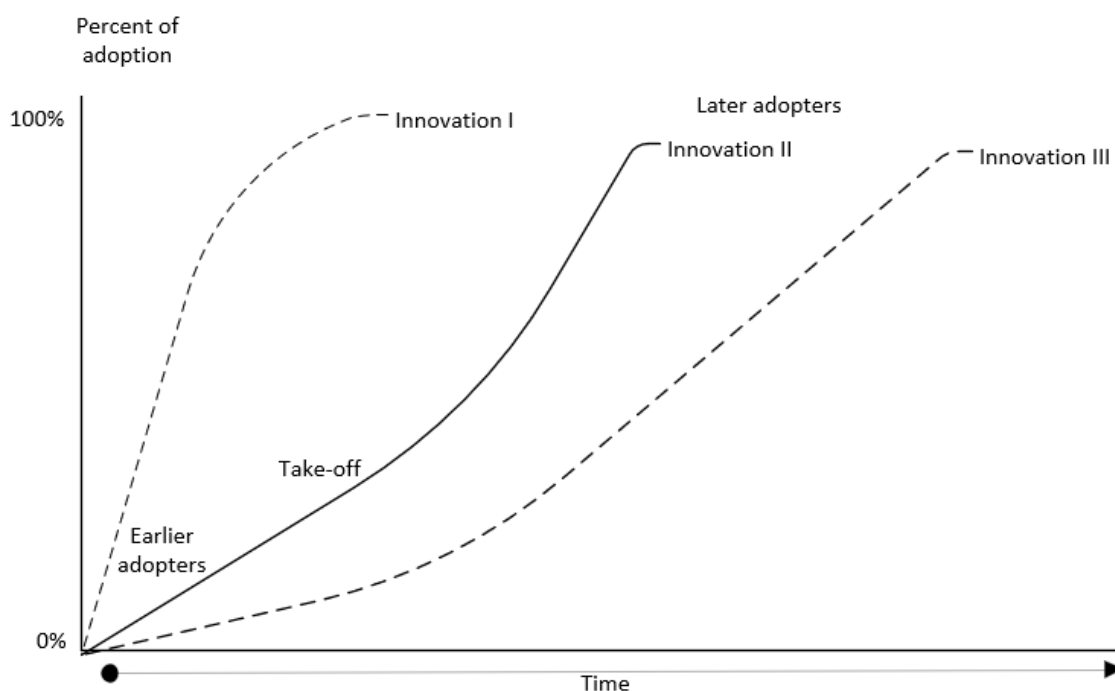
One important question that arises from this work is whether, beyond a certain point in the curve,

diffusion really is self-sustaining or if other activities need to take place to ensure continued

adoption. It is also interesting that Rogers refers to adoption by members of a system but it is

unclear what is meant by a system.

Rogers's work is widely recognised as making an important contribution to innovation and

diffusion studies though there are examples of suggestions that the framework/model should be

extended. Gayadeen and Phillips (2014) tested the Diffusion of Innovations (DOI) theory in

relation to public policy diffusion in what they described as 'a manipulated environment' (p. 229). They looked at the introduction of community policing in the United States in a context where the government manipulated the situation through the provision of financial incentives and politics. Very interestingly, this investigation found DOI theory did not hold as political decisions that led to financial incentives impacted the process as set out by Rogers and they concluded it was open to interpretation as to whether the rate of diffusion curve was S-shaped. Gayadeen and Phillips (2014) saw diffusion occuring in terms of public policy 'would benefit by understanding that financial resources provided…do not necessarily diffuse the innovation at a prescribed trajectory' (p. 239).

Despite Rogers's diffusion of innovations theory being very widely cited and applied, it has limitations. One shortcoming acknowledged by Rogers himself is the pro-innovation bias. This bias is an assumption that 'an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected' (Rogers, 2003, p. 106). A consequence of this bias identified by Rogers is that researchers neglect certain important aspects of diffusion such as non-adoption, discontinuance and reinvention. Another limitation is the lack of consideration of external influences on the process that often require attention to achieve successful adoption. These limitations do, of course, provide opportunities to build on the work of Rogers. For example, the question of what takes place from the point where Rogers's curves end. Does use continue or does discontinuance take place and if the former, how satisfied are adopters?

The second feature of Rogers's work explored in this review is the categorisation of potential adopters by their innovativeness. Innovativeness is 'the degree to which an individual or other unit of adoption is relatively early in adopting new ideas than the other members of a system' (p. 22).

The five categories can be summarised as:

1. Innovators - These are described as venturesome with an interest in new ideas. They can deal with uncertainty and are not risk adverse. Their role in introducing an innovation might be to launch a new idea and to act as gatekeeper in relation to communication of information.

2. Early Adopters - These are those who are of the first to take up an innovation and peers may look to them for advice and information. They would be well respected and can decrease uncertainty for others.

3. Early Majority - These may take some time to reach an adoption decision but they would be well linked into communication networks required for diffusion but would rarely lead the way.

4. Late Majority - These may take up an innovation because of other needs or due to pressure from peers. They are generally sceptical and adopt once most uncertainty about the innovation has been removed.

5. Laggards – These are the last to take up an innovation and require all uncertainty to be removed. They may resist not only due to scepticism but may also be held back by limited resources or other circumstances preventing adoption.

The categorisations based upon mapping groups against a normally distributed population. (See Figure 4.4).

Figure 4.4: Adopter categorisations based on innovativeness (Source: After Rogers, 2003, p. 281)

| Innovators | Early adopters | Early majority | Late majority | Laggards |
| 25% | 13.5% | 34% | 34% | 16% |
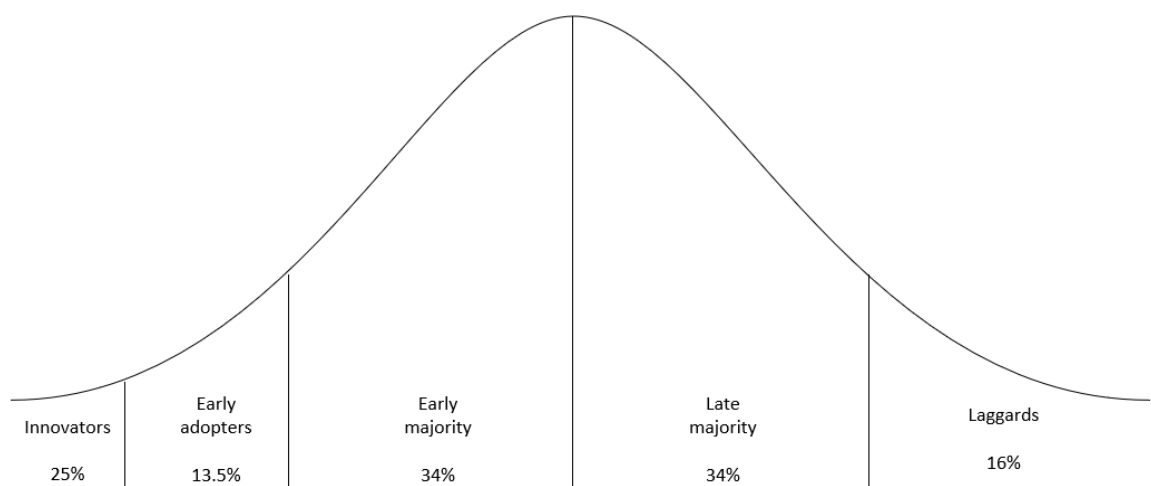
Assuming it is considered desirable to achieve adoption more quickly, the aim would be to skew the distribution to the left and thus increase the proportion of early adopters. The problem with this is there is often a lack of knowledge of how best to achieve earlier adoption.

Another issue with this theory is that it does not hold if only part of the population adopt. Rogers also argues the innovation-decision process is 'an information-seeking and information processing activity in which an individual obtains information in order to gradually decrease uncertainty about the innovation' (p. 20). In contrast, Gayadeen and Philips (*Op. cit.)* are critical of the assumptions made about the general categories of adopters. They suggest that laggards who could access grants to encourage adoption were therefore amongst the first to adopt. Research by Doyle et al. (2014) took place in a public healthcare setting. They looked at implementation of mobile devices in medical and nursing education through the review of fifty-two research studies for evidence of strategies for implementation. They suggest the model provides a helpful starting point but does not provide the full picture to helpfully assist adoption. They reflect on the categorisations of adopters too and suggest that 'the process may be iterative, and individuals may appear to be 'laggards' when in fact, they might be 'early majority' types who will engage in the technology when offered the opportunity at the right time' (p. 776). The police are likely to be held back by the availability of resources, yet these studies this indicates the position in adoption can change. Change in position would have an impact on the decision-making process. The process is said to comprise the five stages shown in Figure 4.5: knowledge; persuasion; decision; implementation; and confirmation.

The first stage (knowledge) is gained through previous experiences and practice but also through individuals' own needs and their degrees of innovativeness. This gained knowledge contributes to the next stage (persuasion) where, in the run up to the decision-making stage, the product characteristics become important. In Rogers' view this explains that these early parts of the process lead to the decision to adopt or reject an innovation. It is in relation to these early stages that he introduces the concept of preventative innovation. A preventative innovation is said to be 'a new idea that an individual adopts in order to avoid the possible occurrence of some unwanted

event in the future' (p. 176). This concept and its consequences could be particularly relevant to this research. The remaining three stages of the process - decision, implementation and confirmation - are also relevant to adoption but literature testing the theory has been hard to find.

Figure 4.5: The process to diffusion and adoption (Source: After Rogers, 2003, p. 170)
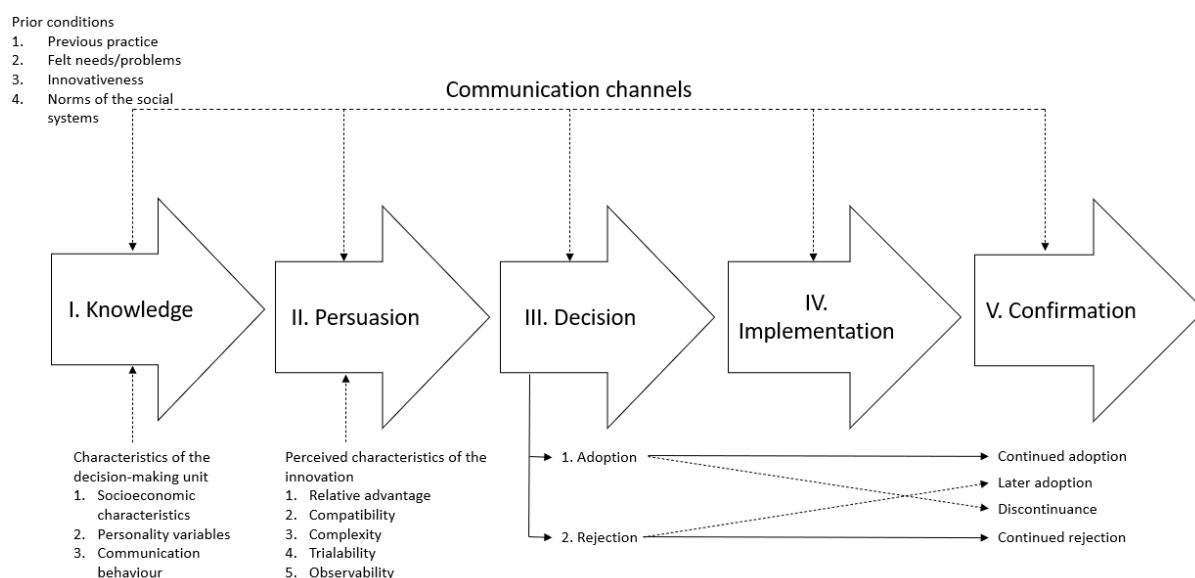
The final feature of Rogers's work to be considered here is the social system though it is not understood what the definition of that system might be and whether boundary judgements have been made or if a change in those boundaries would affect the diffusion and adoption. Rogers acknowledges the theory assumes all innovations are desirable yet innovations may be unattractive to the social systems involved.

More generally, Hoppe (2002) draws on a survey of literature on adoption models and on literature containing empirical evidence to discuss the timing of technology adoption. He argues that the timing and the nature of new technology are both issues in adoption. Hoppe identified two major categories of adoption in relation to timing: those where uncertainty surrounds the arrival and value of a new technology; and those said to be more certain where there is strategic interaction with the product market. For instance, 'a firm's incentive to adopt a new technology at a certain point in time may therefore crucially depend on the rival firms' adoption decisions.' (p. 63). In particular, Hoppe cited Farrell and Saloner (1985) to suggest the timing of adopters

taking up a new technology depends positively on the number of other adopters which can lead

to firms delaying adoption which results in a slower diffusion process. This accords with Rogers's

diffusion theory (*Op. cit*.) where adoption is likely to accelerate when more adopters take up an

innovation.

In the context of their policing research looking at the introduction of mobile technologies, Pica et

al. (2004) highlighted the need to consider influences of the context on implementation:

> …looking not at technology as a self-contained entity but rather as a highly contextualized
>
> tool which is affected by the social setting in which it is deployed and which in turn affects
>
> the social setting.

(Pica et al., 2004, p. 2)

Straub (2009) in a paper examining how and why innovations are adopted in the context of

individuals' computing adoption processes, argues that the adoption process is inseparable from

the diffusion process. He comments on Rogers's theory thus:

> Rogers's theory has been used broadly across disciplines to comprehend and predict
>
> change. Although Rogers's theory is a critical foundation, it is not always easily applied to
>
> understanding adoption. Although several research studies seek to understand adoption
>
> process, only a few theories are widely used in the current literature.

(Straub, 2009, p. 627)

Straub recognises Rogers's work is a critical foundation to understanding adoption theory broadly.

He points out that diffusion and adoption theories examine the individual and the choices an

individual makes to accept or reject an innovation but he argues that these factors are not always

interlinked. His concern attributes to Rogers a narrow view of the factors influencing an

individual's decision that contribute to diffusion and adoption and instead he suggests taking a

wider view of the situation, not just focusing on the pieces that make up the whole. He agrees

with Rogers that focusing on one factor does not guarantee success as contextual factors also

impact on adoption.

Straub draws three conclusions:

1. Technology adoption is complex, inherently social, development process;

2. Individuals construct unique (but malleable) perceptions of technology that influence the adoption process; and

3. Successfully facilitating a technology adoption needs to address cognitive, emotional, and contextual concerns.

(Straub, 2009, p. 626)

Staub's assertion indicates a potential gap in understanding the factors involved in implementing a new technology successfully. Understanding innovation is of great importance to preventing failure. In a review of Rogers' Diffusion of Innovations theory, García-Avilés (2020) supports the view that more needs to be known by broadening the theory 'a key challenge is to move beyond the models of the past and to keep broadening the conceptions of DOI theory in the network society' (p. 7). Rogers' (2003) DOI theory is regularly cited and small studies that examine the potential integration of two or more different diffusion and adoption frameworks/models were found (See Ikumoro and Jawad, 2019; Min et al., 2019; Bharadwaj and Deka, 2021). These papers suggest that DOI is useful when used alongside other frameworks/models such as Technology Organisation Environment by Tornatzky and Fleischer (1990) and/or Technology Acceptance Model by Davis (1986).

The next sections review literature on those frameworks/models.

Table 4.2 summarises the findings from this section.

Author, year and underpinning theory	Summary of literature and primary purpose/audience	Evidence of multi-agency working	Summary of gap(s) identified	Implicit use of systems thinking	Summary comment and rationale for taking forward in this study
Rogers (2003) Diffusion of innovations	Theory and processes for explaining how an innovation is diffused. Explains generally why an innovation infiltrates a population or not and thus whether innovations become adopted successfully or not. It provides frameworks/models for parts of the innovation process for a variety of disciplines.	Suggests the concept of a preventative innovation would be popular to tackle an unwanted event but does not give attention to multi-agency working. Critiques suggest that a wider range of contextual factors need consideration.	Refers to complexity but in terms of the use of the innovation. No prioritisation of the characteristics. Lack of clarity in adoption curve and what happens after adoption (Gayadeen and Philips, 2014). Lack of understanding about how to ensure the rate of adoption is high which the theory suggests leads to successful adoption. Not easily applied in practice. Little is said about what the external influences might be.	Consideration of a social system but there is no definition for the system. Explains diffusion as an uncertainty reduction process. Key individuals are important to the process. Suggests members of a system are important but lack of clarity what that system is and whether boundary judgements have been made.	Not easily applied to adoption and an assumption that an innovation is adopted by the whole social system. To be investigated further. There is good academic foundation and there may be opportunities to know more about the system, uncertainty reduction, multi-agency working and investigation of variables in the context.

Table 4.2: Summary findings from Rogers (2003)

This section revealed useful insight through the underpinning literature. It showed that explanations of innovation, diffusion and adoption are multi-faceted and there are existing frameworks/models that may help understanding of diffusion and adoption though there may be aspects of a situation that are not explored and there is potential to extend understanding by using systems thinking. This is especially the case where multi-agency working is involved and there is significant complexity and uncertainty.

The next section reviews the literature on frameworks/models that could add to further understanding of adoption.

4.3.2   Studies on technology adoption

This section examines frameworks/models on the adoption of innovative technologies.

Technology Organisation and Environment

The Technology Organisation Environment (TOE) framework/model (See Figure 4.6) was

introduced by Tornatzky and Fleischer (1990). It is a framework/model aimed at research and

development managers and claims those people can benefit from improving understanding of the

wider systems surrounding technological implementation but with policy in mind. The

framework/model is built from three principle contexts that are said to 'influence the process by

which it [a firm] adopts and implements technological innovations' (p. 152). These are: the

external environment; the technological context; and the organisational context. The TOE

framework/model addresses features such as technology integration, training programmes, the

environmental context and issues in project management. It also takes into account factors

including benefits, costs and barriers. The range of inputs to TOE especially in relation to the

external context are factors that have some consistency with systems thinking and could be useful

in this study.

Figure 4.6: The Technology Organisation Environment framework/model (Source: After Tornatzky and Fleischer, 1990, p. 153)
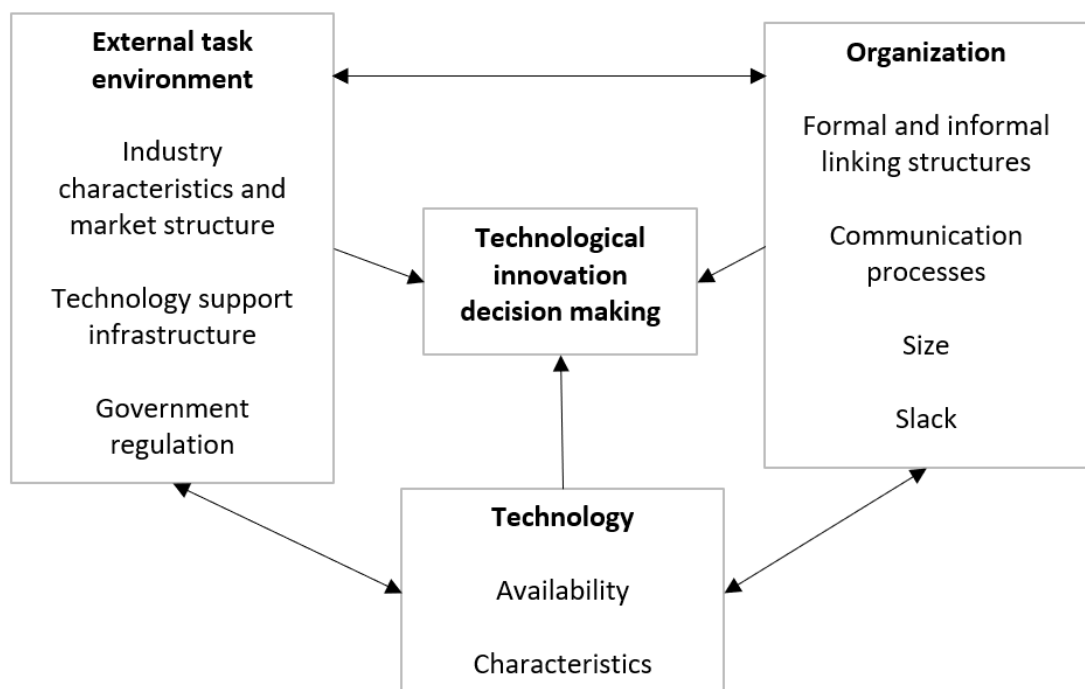
However the aspect of multi-agency working is often overlooked. Tornatzky and Fleisher (1990) often refer to the complexities:

> Technological innovation involves a rich embroidery of events: many activities, many decisions, and many bits of behaviour on the part of individuals and social units, most of whom are not even self-consciously aware of being part of such a process.
>
> (Tornatzky and Fleisher, 1990, p. 27)

Leading on from this they describe the life cycle of the innovation process and perspectives of the developer and user. Though they refer to innovation taking place within organisational settings usually with a hierarchy of levels (e.g., individuals, social groups, organisations, interorganisational links, industries and societies) and the wider context is important, it is unclear how to identify and explore interaction with other agencies that may even not be involved in the adoption a hierarchical way.

Chau and Tam (1997) looked at the adoption of open systems, they define as 'computers and communications environments based on de facto and formal interface standards' (p. 1), in organisational computing. They identified and explored seven factors they thought to be relevant to technology adoption in information systems infrastructure. These factors are summarised thus:

> Market uncertainty
>
> Perceived benefits
>
> Perceived barriers
>
> Perceived importance of compliance to standards, interoperability, and interconnectivity
>
> Complexity of IT infrastructure
>
> Satisfaction with existing systems
>
> Formalization on systems development and management
>
> (Chau and Tam, 1997, pp. 6-9)

They applied TOE to their research, arguing that it 'may provide a useful starting point to look into open systems adoption as it highlights the specific context in which the adoption process takes

place' (p. 4). Though they urge caution as variables such as management style, organisational structure and culture were not included in their research model. They suggest that the framework/models' variables should be tailored to the context of study. This suggestion of varying factors contrasts with other theories such as Rogers (*Op. cit.*) where validity is claimed across a wide range of applications. They assert TOE is a valuable framework/model to apply to innovations in complex information systems, though more context-based models of innovation adoption and additional variables should be added to the model.

Low et al. (2011) have also used TOE as the basis for research that sought to understand determinants of adoption in the context of Cloud Computing. They researched views from 111 different firms and found that the propositions they felt explained adoption in relation to web services were all classifiable by TOE. However, they acknowledge their study on this high-tech industry does not indicate the applicability of TOE to other industries so they recommended further studies in different contexts be carried out. Lippert and Govindarajulu (2006) also made use of the TOE framework/model. Their aim was to develop a conceptual model in relation to adoption of web services. One of the conclusions reached was 'since adoption behaviour is a significant component of organizational effectiveness, a better understanding of its determinants will improve overall organizational performance' (p. 154).

A paper by Schwarz and Schwarz (2014) raises points of influence that are potentially relevant to this study. They established that previous research focussed on individual perceptions and largely neglected contextual factors within which adoption takes place. They argued that, although the TOE framework/model had been applied in a variety of contexts and to both individual and organisational situations, the framework/model is not without its critics. They stated:

> None of the technologies that were previously studied [by applying the TOE
> framework/model] were mandated by an external institution. We postulate that heavier
> institutional pressure will alter the salience of environmental factors, while
> simultaneously altering the influence of the technology and organizational contexts.
> Specifically, we could speculate that institutional pressure from the environment could be

more significant in driving adoption, while assessments of the technology might be less

salient.

(Schwarz and Schwarz, 2014, p. 61)

They carried out research on Electronic Medical Record technology in a United States health

setting, a context chosen because it was one where adoption was strongly influenced by

institutional pressure, and they had found few previous studies to evidence this type of influence.

They debated whether adoption would be influenced through pressure altering the salience of

the environment or if pressure from within the environment may drive adoption. Either way,

more research was needed about the environment and context.

Commenting on their findings they said:

> In our context, one would expect that the penalties from the government (the institution
>
> seeking to encourage adoption) would be the strongest in influencing the adoption
>
> behaviour, but in reality it was the competitive pressure that had the most significant
>
> impact.

(Schwarz and Schwarz, 2014, p. 73)

A paper by Mohammad et al. (2022) applies TOE to technology adoption in the banking sector.

Using data drawn from a survey of 120 employees of one bank, factors thought to influence

adoption of business intelligence and analytic technology programmes were examined. They

argue TOE is a helpful framework though extension of the framework/model is recommended:

> Consequently, this study expanded the TOE framework by including new vital additional
>
> elements based on the recommendations…namely technology-supporting infrastructure
>
> and the presence of a champion.

(Mohammad et al., 2022, p. 3)

They also suggested the support of senior management and a 'champion' for the adoption was

necessary. The need to consider a wider range of variables and factors and support within and

across multi-agency working offers opportunity for more understanding through research.

Some studies suggest potential to expand understanding through integrating TOE with other frameworks/models such as DOI and Technology Acceptance Model by Davis (1986). (See Katebi et al., 2022; Zhang et al., 2022; Salimon et al., 2023). TAM will be reviewed in the next section.

Table 4.3 summarises the findings from this section.

Author, year and underpinning theory	Summary of literature and primary purpose/audience	Evidence of multi-agency working	Summary of gap(s) identified	Implicit use of systems thinking	Summary comment and rationale for taking forward in this study
Tornatzky and Fleischer (1990) Technology Organisation Environment (TOE)	The framework/model is built from three principle contexts that are the external environment; the technological context; and the organisational context. It is a framework/model aimed at research and development and managers responsible for R&D in an organisation. With policy in mind, it claims those people can benefit from improving understanding of the wider systems surrounding technological implementation.	Acknowledges there are other agencies involved but takes a hierarchical approach.	It is not clear how to assess or make boundary judgements about what the wider system is. Context in this framework/model is defined only as 'related goals, roles, rules, assumptions, expectations' though it suggests consideration of external factors such as market conditions but the social context refers mainly to the interaction of the technology.	Consideration of an external environment. Repeats a need to benefit from understanding the wider system.	A number of variables could be missing from consideration including management, culture and organisational structure. To be investigated further as there are opportunities to look at factors in the external environment and build understanding from the wider situation.

Table 4.3: Summary findings from Tornatzky and Fleischer (1990)

4.3.3 Technology Acceptance

This section reviews literature on the part of adoption when a decision on acceptance takes place. Acceptance of technology means 'whether the system is good enough to satisfy all the needs and requirements of the users and other potential stakeholders' (Nielsen, 1994, p. 24). Research on adoption has witnessed increasing interest in approaches that takes a quantitative approach by measuring data on what influences acceptance or not where the quantitative research is a data measurement process. (This is the definition used in this research). One of the models that use

this type of quantitative information is the well-known Technology Acceptance Model or TAM

(See Figure 4.7). TAM was first proposed by Davis (1986) who drew upon a variety of prior

research, including the Theory of Reasoned Action (TRA) (Davis, 1989). He was interested in being

able to predict and explain user acceptance of computer technology in order to be able to

improve users' willingness to accept and use available systems. The TAM is used to analyse

potential users' decisions about whether they will use the technology or not. It is said to be

capable of predicting a user's acceptance behaviour toward a new technology regardless of the

characteristics of the user population and the type of technology being introduced. It works by

applying two key factors said to determine whether, given a free choice, an individual will decide

to use a technology. The first is 'ease of use', which is an individual's perception concerning the

amount of effort needed to use the new technology. The second is 'usefulness' which is the

perception of the degree to which it will improve the task in hand. Both of these factors assume

there is one primary adopter.

Figure 4.7: The Technology Acceptance Model (Source: After Chau, 1996, p. 187, from Davis, 1989)
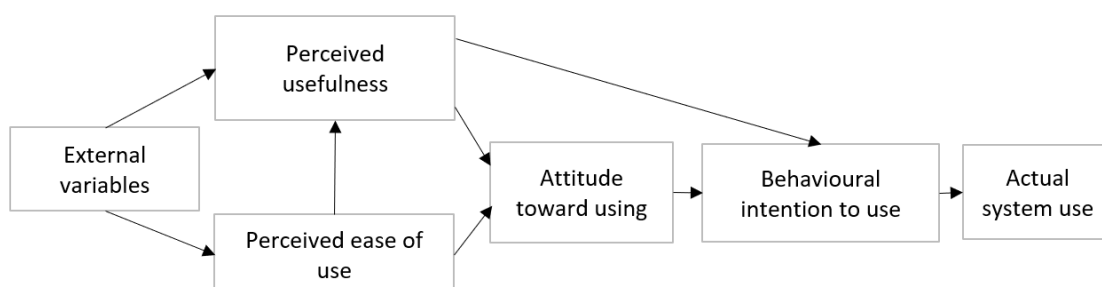
Davis undertook two studies to test the proposed model, one in a workplace setting and one set

up in an experimental laboratory. His research was carried out by asking 152 users to indicate the

extent to which they agreed with a series of statements about technology use. In the field study,

participants had already been familiar with the computing programmes they were asked about

whereas the laboratory study asked participants to respond to statements about unfamiliar

systems. This testing under different circumstances added validity to Davis's proposal and led to

the TAM being used as a new measurement scale for self-reported computer usage behaviour (p.

332).

Since the original work by Davis, the model has been redeveloped several times. Most of the modifications that have been suggested extending the model by the addition of new factors that should be considered when trying to predict acceptance. Only redevelopments that represent significant alterations to the model are included. TAM has been used widely to look at acceptance of certain categories of information technology namely software packages.

Chau (1996) an author with a research interest in information systems and information technology implementation and adoption, regarded the TAM as the most influential research model in the study of determinants of technology acceptance. He has himself constructed a modified TAM that allows the framework/model to take account of two distinct types of usefulness based on near and longer term perspectives. In order to develop these modifications, Chau collected survey data from 285 administrative staff in a large organisation and focused the study on software packages, Microsoft Excel and Word (which at the time of the study, were not routinely used by administrative staff). Ease of use was tested in the study, as per the Davis original TAM, but questions relating to usefulness were adapted to the theory of near and long-term factors having an impact on acceptance. Chau concluded there was little evidence of linkage between ease of use and usefulness, contradictory to the proposal by Davis, and that the comparison of both ease of use and usefulness determinants gave insight into adoption. Although the findings generally supported the TAM, both short and long-term perceptions of usefulness were shown to have positive impact but it was also found there was no significant relationship between ease of use and behavioural intention to use a technology. It was reported that as users gained familiarity with a technology over time, the effect of ease of use diminishes. While the study was limited in the size of the data set and to one organisation, it points to implications for practitioners and suggests successful implementation can be achieved if training emphasises the longer-term intention. A critical review of the TAM by Legris et al. (2003) led to similar issues with TAM being highlighted. Both studies by Chau and Legris et al. recommend that TAM needs to be integrated into a broader model that includes variables relating to human and social change.

Work by Colvin and Goh (*Op. cit.*) in the US conducted in a police setting examined the TAM's applicability to policing and as a result a basic theoretical model was developed that would explain why patrol officers accepted or rejected a technology. They adapted the TAM to use four constructs: ease of use; usefulness; information quality and timeliness. They concluded 'The findings suggested a strategy for even greater acceptance that would be achieved by considering the timeliness and the quality of information provided by new technology (p. 94). However, they also pointed out that a drawback of assessing perceptions of the technology is that the framework/model does not account for people's familiarity with the technology, which may also influence the acceptance decision.

Notably, the TAM was used to explain innovation acceptance, but it did not always cover contextual factors or consider differing perspectives that could be important in technology adoption. Also, the composition of the population surveyed in this example of qualitative research became important to assessing the validity of data. The reliance of the TAM on statistical data meant that other factors, such as relationships between stakeholders, especially those influencing an adoption and important in the context, were not taken into account.

In 2000 Venkatesh and Davis developed and tested an extension to TAM which they named TAM2. It retained the focus on a statistical evidence of user perceptions of acceptance and on usefulness and ease of use but incorporated additional potential influences on acceptance including social and cognitive processes such as job relevance, output quality and the extent to which take-up would be voluntary.

Bouwman et al. (2008) looked at the suitability of mobile services used by police officers in the Netherlands as the vehicle for another attempt to determine whether models such as the TAM are context sensitive. Although they opted to use the TAM in this piece of work they decided to extend it with the following additional concepts: urgency; physical context; task initiation and information use. When incorporating these concepts into a single model, they found: 'The TAM concepts are too generic to really understand and explain future behaviour' (p. 198).

Their results led them to suggest that context related issues were more important to managers, politicians and stakeholders in the police when they made their decisions whether to adopt a particular technology then the TAM concepts were.

A study by Lippert and Forman (2005) combined Rogers (2003) innovation diffusion theory with other Social Learning Theory and with the TAM (Davis, 1986) to explain how adopters come to accept and use a technology and to examine a set of hypotheses relating to perceived adoption decision making characteristics. The study looked at post-adoption behaviour in a US automotive supply chain through a process of interviews and surveys across many participants. The research provided empirical evidence to identify cognitive and experimental factors that influence the decision to use technology and offered some practical guidelines for considering post-adoption behaviour that broadly supported Rogers's theory. However Lippert and Forman (2005) acknowledge limitations of their research. They point out that not all variables affecting adoption could be included in the model and warn that studies such as theirs cannot capture the full complexity of the adoption and usage process.

A further development of the framework/model based on the TAM to emerge in literature is the Unified Theory of Acceptance and Use of Technology model (UTAUT). This is shown in Figure 4.8. Based on studies of Information Systems adoption which sought to explain individual adoption, the UTAUT was proposed and developed by Venkatesh et al. (2003) and focuses on technology acceptance. The research to develop the UTAUT was, like TAM, concerned with determinants of intention to use and usage behaviour but it also outlines three other determinants - performance expectancy, effort expectancy and social influence - and it also moderates data by age, gender, experience and voluntariness of use.

Figure 4.8: The Unified Theory of Acceptance and Use of Technology model (Source: After Venkatesh and Zhang, 2010, p. 8)
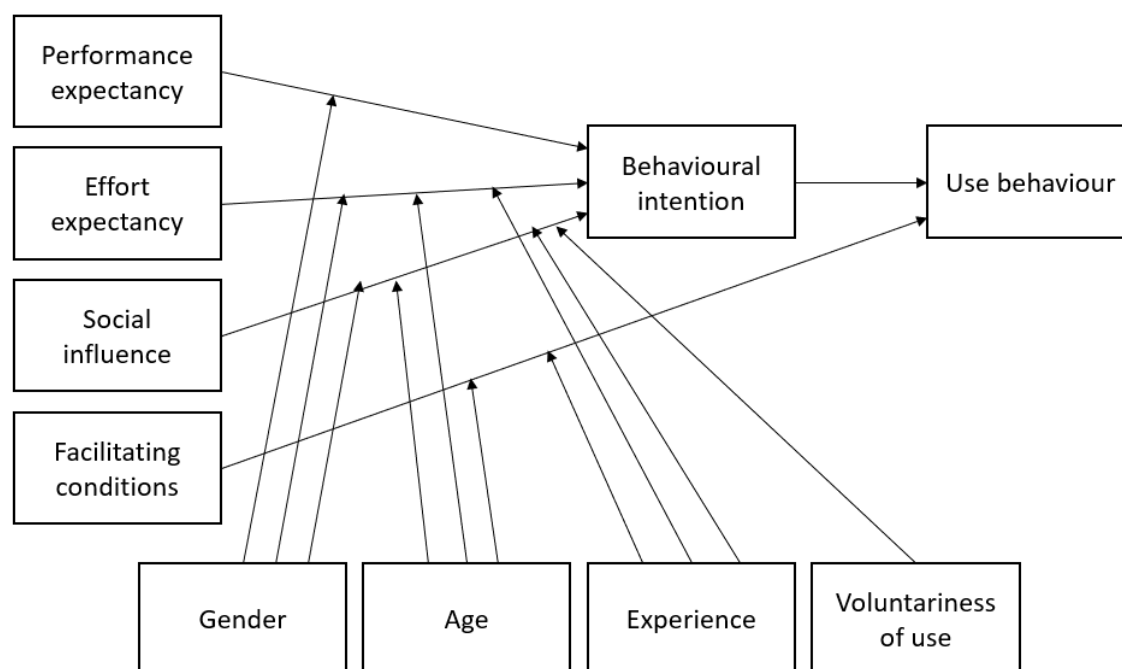
Carlsson et al. (2006) carried out an empirical research study in Finland that sought to test the UTAUT. Their research challenge was 'to understand how and why people adopt or do not adopt' (p. 1) through looking at the adoption of mobile services such as SMS (Short Message Service), ring tones and icons. These mobile service technologies had been reported as having slower than expected adoption rates in Europe, generally when compared to countries such as Japan. A survey was conducted among a random set of 300 Finnish consumers with a response rate of 52.3 per cent. They suggested 'the UTAUT…can be used as a starting point to find some explanations for the adoption of mobile devices/services' (p. 1). However, they reported a reservation about the model which was that they thought it required adaptation in order to account for contextual differences (between devices and services in their case). Venkatesh and Zhang (2010) also used an adapted version of the UTAUT model in their research on the impact of cultural differences between the US and China on technology adoption. They said 'understanding the role of culture in affecting the factors that influence an individual's behavioral intention toward technology adoption is critical for the success of IS implementations in China.' (p. 6). In their review of previous literature, Venkatesh and Zhang were critical of other applications of the UTAUT, suggesting other research had not always been carried out with the same procedures as were set

out in the original UTAUT (Venkatesh et al., 2003) which would make it challenging for practitioners to use such a model. In their study, fieldwork was conducted among employees in one organisation that spanned both the US and China. They found that the UTAUT could not be applied consistently in both countries due to differences relating to social influences. They proposed national culture played a part in adoption decisions and that further investigations were necessary to allow the effects of cultural factors in adoption to be understood more fully.

As the above section has shown, extension of the TAM framework/model to improve understanding of acceptance is often proposed. Literature can be found that suggests improvement can be made by combining one or more of these frameworks/models (e.g., DOI, TOE and TAM). For example, in a literature review of 56 papers on the topic of blockchain technology adoption (technology platform frameworks for managing cryptocurrency) by Taherdoost (2022), a list of factors and components used to assess adoption was examined. They found:

> The applied frameworks and the results were reviewed and summarised in the selected
> articles. The results show that TAM, TOE, DOI and UTAUT were used frequently in most
> of the studies. Moreover, many researchers have employed extended TAM/TOE
> frameworks by adding new variables or a combination of different frameworks instead of
> the traditional models and analysed the collected results to obtain the most significant
> factors among them.

(Taherdoost, 2022, p. 27)

Taherdoost suggests future research considers additional factors such as security and privacy as well as looking at influence on adoption and future studies investigate a new comprehensive framework (p.27). However, it is not found to be sufficient to rely solely on the pre-defined factors and variables to gain insight into diffusion and adoption especially in a multi-agency situation. Instead, understanding could be broadened by taking an approach such as systems thinking and considering elements of networked innovation affecting adoption.

Table 4.4 provides the summary findings from this section.

Author, year and underpinning theory	Summary of literature and primary purpose/audience	Evidence of multi-agency working	Summary of gap(s) identified	Implicit use of systems thinking	Summary comment and rationale for taking forward in this study
Davis (1986) Technology Acceptance Model (TAM)	Devised to explain how adopters come to accept and use a technology and, to examine a set of hypotheses relating to perceived adoption decision making characteristics. To predict and explain user acceptance of computer technology in order to be able to improve users' willingness to accept and use available systems.	Not identified.	Focuses only on the acceptance decision in the innovation process and is a predictive framework/model. Assumes there is one primary adopter and other agencies are not involved.	Consideration of a range of factors that influence a decision.	Reductionist and focuses on acceptance behaviour and decisions to use the technology not covering contextual factors or differing perspectives. To be investigated further as the adoption decision may well correlate with this this framework/model.
Unified Theory of Acceptance and Use of Technology model (UTAUT) Venkatesh et al. (2003) (based on TAM by Davis, 1986)	An extended version of the TAM. Based on the TAM, seeks to explain individual adoption and was developed in an attempt to have one model to explain acceptance and use of a technology.	Not identified.	Is challenging for practitioners to use and adapt to different contexts. Additionally, the range of potential variables to be investigated were not fully identified.	Consideration that there are a wide range of factors at play.	Discounted from further investigation in this study due to confusion in its use and lack of robustness for understanding adoption.

Table 4.4: Summary findings from Davis (1986)

In summary, the review has so far explored theoretical underpinnings of innovation, diffusion and adoption and Table 4.5 provides a summary of the existing diffusion and adoption frameworks/models.

Author and year	Underpinning theory	Summary of literature	Summary comments
Davis (1986)	Technology Acceptance Model (TAM)	Technology Acceptance Model is a model devised to explain how adopters come to accept and use a technology and, to examine a set of hypotheses relating to perceived adoption decision making characteristics.	Reductionist. Focuses on acceptance behaviour and decisions to use the technology not covering contextual factors or differing perspectives.
Rogers (2003)	Diffusion of Innovations (DOI)	Theory and processes for explaining how an innovation is diffused.	Not easily applied to adoption and a lack of prioritisation of which factors might be re important. What happens beyond diffusion – is it self-sustaining or what would need to happen. Assumption that an innovation is adopted by the whole social system (and it was unclear what Rogers defined as the social system). What happens in non-adoption situations, discontinuance or reinvention. Lack of consideration of external influences.
Tornatzky and Fleischer (1990)	Technology Organisation Environment (TOE)	The framework/model is built from three principle contexts that are the external environment; the technological context; and the organisational context.	Variables were not considered, e.g., management style, culture, organisational structure, not considered in the framework and authors suggest more variables are needed. Lack of consideration of external influences.

Table 4.5: Summary of literature: underpinning theory

It was found that literature tends to focus only on one organisation and not where several are interacting together. It was also found that there are examples of frameworks/models for understanding diffusion and adoption that take into account a variety of factors surrounding adoption but much of the literature reviewed recommends a wider view of factors and influences are taken into account or that these frameworks/models are combined or integrated. Table 4.6 summarises the literature relating to extension or integration of the existing frameworks/models.

Author and year	Underpinning theory	Summary of literature	Summary comments
Salimon et al. (2023)	TAM, TOE and UTAUT	Discusses electronic commerce adoption taking account of individual and organisational perspectives and factors influencing marketing.	The three frameworks/models are integrated and the constructs together are used to explain adoption.
Katebi et al. (2022)	TAM and TOE	Explores sustainable building construction and adoption of a prefabrication method. The perspectives of individuals and organisations are considered.	The integration of frameworks/models is proposed to provide a comprehensive set of factors and variables for investigation. The findings suggest studies in different contexts and with additional factors would be useful.

Author and year	Underpinning theory	Summary of literature	Summary comments
Mohammad et al. (2022)	TOE	Examines technology adoption in the banking sector.	The TOE framework/model was found to be limited and new factors were developed (e.g., to include infrastructure). The presence of a champion was also proposed.
Taherdoost (2022)	DOI, TAM and TOE	A literature review of 56 papers on the adoption of blockchain technology (technology platform for managing cryptocurrency).	Confirms DOI, TAM and TOE as regularly used frameworks/models. The need for extension of the variables and factors were noted as areas for improvement to understanding adoption.
Zhang et al. (2022)	TAM and TOE	Discusses adoption of electronic commerce in China and factors that affect take-up.	Suggests the integration of frameworks/models is useful to extend the number of factors researched. Though they acknowledge the full complexity of the situation may not be reflected.
Bharadwaj and Deka (2021)	DOI and TAM	Examines behavioural intention to invest in cryptocurrencies.	The frameworks/models were integrated in this study to broaden the number of variables examined.
García-Avilés (2020)	DOI	A review of DOI theory.	Found that DOI needed broadening to include more contextual information.
Ikumoro and Jawad (2019)	TOE and UTAUT	A study on the adoption of virtual assistants (Artificial Intelligence) in Malaysian Small and Medium Enterprises (SMEs).	Advises the number of variables and factors examined should be increased through integration of frameworks/models.
Min et al. (2019)	DOI and TAM	The adoption of an Uber mobile application by consumers is explored.	Advises the number of variables and factors examined should be increased through integration of frameworks/models.
Doyle et al. (2014)	DOI	Reviews 52 research studies in public healthcare settings.	The DOI theory was found to be helpful but was said not to provide the whole picture.
Schwarz and Schwarz (2014)	TOE	TOE in the context of adoption of Electronic Medical Record technology was examined.	Refers to improvements needed to understand contextual factors and pressures in the environment.
Low et al. (2011)	TOE	Discusses research in the context of Cloud Computing.	Advises that testing in more contexts is needed.
Straub (2009)	DOI	A paper on how and why innovations are adopted.	Suggests more needs to be known about contextual factors affecting adoption.
Bouwman et al. (2008)	TAM	Research on the suitability of mobile services for police officers in the Netherlands.	Recommendations made to extend the model by adding further factors and variables (e.g., urgency; physical contact; task initiation and information use).
Lippert and Govindarajulu (2006)	TOE	Research on the adoption of web services.	Advises more understanding of factors affecting adoption was needed.
Colvin and Goh (2005)	TAM	Examined the TAM's applicability to policing in the US.	The findings suggest factors of timeliness and quality of information should be added to the model.
Lippert and Forman (2005)	DOI and TAM	Discusses decision making characteristics in the adoption process.	Acknowledgment is made that not all variables affecting adoption could be included in the framework/model and the full complexity was not captured.
Legris et al. (2003)	TAM	A critical analysis of the TAM research model.	Found that though the TAM is a useful model, it should be integrated into a broader one (p. 191).
Hoppe (2002)	DOI	A review of adoption literature.	Two factors (uncertainty surrounding the arrival and value of a new technology and strategic interaction with the

Author and year	Underpinning theory	Summary of literature	Summary comments
			market) were found to be absent from the theory.
Venkatesh and Davis (2000)	TAM	A paper on potential extension of the TAM.	Extension of the TAM by adding new variables and factors was advised (e.g., job relevance; output quality and extent to which take-up would be voluntary).
Chau and Tam (1997)	TOE	An investigation into the adoption of organisational computing.	Variables such as management style, organisational structure and culture were found to be important to adoption but not included in the original framework/model.
Chau (1996)	TAM	Discusses adoption of software packages.	New factors were added to the model to take account of wider perspectives.

Table 4.6 Summary of literature suggesting improvements to existing frameworks/models

The next section looks at literature in the context of policing and whether they can shed any light

on diffusion and adoption.

4.4   Studies in the context of policing

This section will look at literature that identifies key issues concerning how innovation, diffusion

and adoption has taken place in a police setting.

4.4.1   Innovation in policing

Manning (1992) considered the effects of information management on police organisations and

outlined the potential for transforming police work. He began by looking back at major

technological innovations such as the telegraph, radios and computing and pointed out that:

> These innovations produced significant changes. The two-way radio and the automobile
>
> vastly increased the capacity of the urban police to allocate resources and respond to
>
> citizens' calls.

(Manning, 1992, p. 350)

Referring to literature dating back to the 1960s, Manning showed that introduction of

technological innovations was driven by the 'belief that such innovations might save money' (p.

350) but he argued that the main intention that was really behind innovation and the introduction

of technology was to gain efficiency benefits:

> Innovations carried out in policing in the last thirty years have focused on primary
>
> information and on routinization and control of officer discretion. For example, studies of

information technology in policing primarily illustrate managerial concerns such as increasing police operational efficiency.

(Manning, 1992, p. 388)

He went on to say:

With the exception of differential response and directed patrol studies and some innovations in expert systems, the innovations are means for managing the environment rather than changing it. They do not focus on events, nor are they "crime focused" or "order-focused" in their intent.

(Manning, 1992, p. 389)

A concern that innovation is reactive to manage the environment rather than a strategic choice to change it is interesting in this research. Referring to a lack of research on police adoption of information technology, he identified the following as fundamental factors in shaping the use of information technology in policing organisations: the traditional division of labour; information flow and usage; and practices and routines and said:

Theories of social change based on technological advances preceding social changes have grasped a kernel of truth, but they have overlooked the symbolic aspects of techno-logically driven change. They have perhaps underestimated the ways in which technology is a ploy in games of power and control within organizations,

(Manning, 1992, p. 391)

Features such as power and control could be investigated by taking a systems approach.

Work by Ackroyd et al. (1992) on innovation and new technology in practical policing emphasised how technology in policing was largely ad-hoc and could be both a consequence and a facilitator of change. An example they provided to highlight issues in adoption was the HOLMES system (Home Office Large Major Enquiry System) which was introduced in 1985. HOLMES was an application designed to assist complex investigations on serious crime and was introduced across all police forces in the UK. However, multiple issues with the system were reported, especially its inability to link incident information and its lack of support for working across police boundaries.

One example Ackroyd et al. (1992) used to illustrate the problems was a case involving 'the Fox' who, in 1985, committed a series of serious crimes in a number of locations including Bedfordshire, Buckinghamshire and Hertfordshire. The offender was eventually caught but only because information was linked as a result of a detective's 'hunch'.

Moving on to also review literature highlighting barriers to innovation in policing it is worth considering a study by Darroch and Mazerolle (2013). They investigated factors that influence innovation by looking at the introduction of intelligence-led policing (ILP) in New Zealand. Issues such as changes in technology management practice were discussed '…the failure to transmit leadership down through the middle ranks was an important barrier to innovation uptake' (p. 12). They said 'As our research demonstrates, innovations such as ILP are brought to life through changes in leadership, goals, technology, boundaries, practice and management arrangements' (p. 26). The authors conveyed their experience of gaps in the field of literature and said 'Even broadly defined there have been less than 10 empirical studies evaluating the determinants of organizational innovation in police organizations in the past 15 years' (p. 16).

4.4.2   Adoption: building an evidence-base

Pawson and Tilley (1994) explored what works in evaluation research in a policing context. They sought to highlight how gaps can occur in the research when applying an experimental approach to a situation of significant complexity. They said:

> The quest for control and certainty which is the raison d'être of the experimental
>
> approach, is, in fact, the very factor which obliges the method to overlook the importance
>
> of those mechanisms and contexts which constitute the programmes under investigation.
>
> (Pawson and Tilley, 1994, p. 292)

To show that gaps occur in an experimental approach, Pawson and Tilley discussed the implementation of community policing and, what had seemed to be a very robust research method. They were highly critical of the approach and said the results provided 'no generalizable conclusions' (p. 297) and 'Nothing much follows at all so far as policing practices go. We are left in the dark about whether, where, or how we might take community policing forward' (p. 297).

Summarising, they asserted that the evaluation research carried out was method driven and attempted to consider an isolated set of variables, which resulted in a focus on those variables to measure consistency. This reductionist position, and data focused activity, meant that key issues in the environment affecting implementation of community policing were missed. The authors recommended contextual factors should be properly accounted for in the research. Concerning CCTV, and an earlier paper in 1993 also by Tilley, research in that example started from considering a range of mechanisms for researching CCTV implementation through a variety of different contexts. They described 'what could be the first step of a progressive research programme' (p. 304). The idea to extend research knowledge of technology adoption in policing chimes with the use of systems thinking (Chapter 6). Rather than thinking about separate causes and effects, systems are used to deliberately generate variety in the way the situation is thought about. This variability is indeed useful to the aim of extending knowledge.

Chan (2001) sought to evaluate the impact of information technology on policing by looking at the ways in which the structures, culture and policing practices of an Australian police force had been modified as a result of adoption of information technology. The research included collection of a wide range of data through interviews with 23 people and 11 focus groups totalling 106 participants, a survey of 506 respondents, analysis of documents, and fieldwork observations. Chan concluded that information technology had become a large part of policing through changes to working practices but there were resourcing issues and the information technologies brought their own constraints; the police were spending more time in front of computers because of the technology introduced and there were many complaints about technical problems with the systems. Despite the report of issues with the systems, survey respondents were said to be generally positive about the impact of IT. As a result of her research Chan also concluded that technological change was driven through three imperatives which could be summarised thus:

1. Technology-driven: to improve effectiveness and efficiency in controlling crime.

2. Information-driven: to satisfy information needs of external agencies.

3. Policy-driven: meeting requirements of management and accountability.

Though Chan did not provide suggestions on how these three aspects might be practically brought together to assist diffusion and adoption.

A paper by Byrne and Marx (2011) presented a review of research examining technological innovations in policing. They pointed out 'we know remarkably little about how and why certain innovations are adopted, and the consequences - both intended and unintended - of technology-driven solutions to the problem of crime' (p. 17). One example they referred to was the widespread adoption of CCTV technologies in the United States despite limited evidence of its success. Indeed, they also pointed to the lack of empirical evidence on the impact of hard technologies more generally:

> There is currently no body of research evidence that spending money on the types of hard technology innovations described here will improve police performance. One has to ask: why are we so enamored with these innovations?

> (Byrne and Marx, 2011, p. 26)

Custers (2012) looked at technology used in police forces and in other criminal investigation agencies in the Netherlands to investigate potential improved use of technology in policing. Analysis of information on a range of police experiences, obstacles and needs gathered from more than 30 organisations showed that nearly all organisations were using over 20 different technologies. High levels of satisfaction with these technologies were reported though Custers cautioned that the high levels of satisfaction might be because the 'technologies are used in very specific situations for which they are suitable' (p. 65). In relation to obstacles, the research found that a large proportion of respondents indicated they had experienced legal, organisational and technological obstacles. Eleven per cent of respondents reported that technologies had yielded insufficient results but, as Custers noted, this did not necessarily mean the other 89 per cent of respondents had achieved successful results. Custers concluded that more needs to be known about technology in policing and suggested that case studies could help build better understanding because: 'Even without reliable statistics and verified casual relationships,

stories...show the potential of technology to contribute to better, faster and cheaper policing' (p. 63).

Sherman (2013) looked at the rise of evidence-based policing and argues the case for a more rigorous evidence base, especially where there is potential to adapt ideas from one setting into another. Sherman stresses that new technology can assist in the improvement of the quality of evidence. He sets out 'triple-T' strategies of priorities of Targeting, Testing, and Tracking and sets out three strategic principles that Sherman says both the demand for, and uses of, research evidence have become clustered around:

1. Police should conduct and apply good research to target scarce resources on predictable concentrations of harm from crime and disorder.

2. Once police choose their high-priority targets, they should review or conduct tests of police methods to help choose what works best to reduce harm.

3. Once police agencies use research to target their tested practices, they should generate and use internal evidence to track the daily delivery and effects of those practices, including public perceptions of police legitimacy.

(Sherman, 2013, pp. 6-7)

Sherman described the growing interest of these principles in policing yet acknowledges they did not emerge from any theoretical underpinning but occurred because of social trends and as a result of suggestions from researchers. Whilst making the point 'Most police practices, despite their enormous cost, are still un-tested' (p. 8), the author declares that innovations reach police leaders not through research but through the leaders' own theories and from precedence. One of the specific examples used by Sherman is the introduction of Body Worn Video (BWV) by agencies in the United States. This example was one of those used to show 'there has been less progress in using knowledge than in generating it.' (p. 39). He explained there had been a theory that BWV would generate fewer complaints against police officers because officers would be more polite when interacting with citizens and would carry out their roles in ways that were consistent with the rules that were in place. Conversely, it was also hypothesised that the public would be more

courteous to officers. Evidence showed that complaints against officers reduced but the

reductions also occurred on shifts where cameras were not used. Interestingly, 'one…[UK] agency

tried to incorporate [BWV] into stop-and-question procedures, but citizens who were stopped

refused to answer questions while police had their cameras on' (p. 39). It is also worth noting

that the suggestion that BWV would contribute to improved efficiency by replacing written work

is something Sherman said had not been looked at. Work by Fleming and Rhodes (2018)

questions whether experience can also count as evidence. With a focus on policy making and an

interest in use of evidence and other sources of knowledge these authors drew on data from four

UK police forces and suggested there was a major flaw in where a scientific evidence-base is not

sufficient. There are a variety of other experiences that need to be taken into account:

> By itself, evidence-based policing is not enough. We need the partisan evidence
>
> advocates but we need also the other types of knowledge. Craft knowledge, political
>
> knowledge, and research-based knowledge, all warrant a place at the table. These
>
> several strands need to be woven together. Craft knowledge not only needs to be treated
>
> as evidence in this weaving [together], …

(Fleming and Rhodes, 2018, p. 32)

This is interesting in the context of this research.

4.4.3   Adoption: technology devices

Moving on to studies that have looked specifically at the adoption of technological devices in

policing. The work by Pica et al. referred to earlier (*Op. cit.*) also tries to start to build a theory of

mobility. In order to do this they looked at the work activities of officers in two distinct roles

(Scenes of Crime Officer and Community Support Officer) in a police force in the UK. They put

forward the notion that 'mobility is linked strongly to work conditions' and that in order to

explore it more fully it was necessary to ask the question 'What kind of mobility do we wish to

support or can we support within a given work context?' (p. 8). They went on to say:

> This question can be answered only if we understand what kind of work is performed.
>
> Work can be generally divided into two distinct categories: structured – one which

required a high degree of routinized steps and a low degree of complexity or simplicity –

and unstructured – one which requires a high degree of improvisation…and has a high

degree of complexity…Our contention is therefore that the nature of work is the one that

determines the successful or unsuccessful usage of mobile devices.

(Pica et al., 2004, pp. 8-9)

The importance of this link between activities and the context could be relevant to this study. In

this thesis so the matrix proposed by Pica et al. (2004) (See Figure 4.9) may be useful to map work

roles to device interaction and context.

Figure 4.9: Re-contextualising mobile work (Source: After Pica et al., 2004, p. 9)

ENVIRONMENT TASKING	MOBILE DEVICE INTERACTION	
	STRUCTURED (Routine access to information)	UNSTRUCTURED (Ad-hoc access to information)
Active (Environment tasking)	• High usage for voice services on the go* • Low data usage on the go • Concentrate on exchange rather than processing of information	• Limited usage of mobile services while on the go • Mostly voice services • Concentrate on routing and filtering of information
Passive (Technology tasking)	• High usage of both voice and data services while on the go • Need for added intermediaries	• High usage of both voice and data service while on the go • High need for information and interaction filtering • Hybrid environments and mobile equipment

*'On the go' refers to usage of mobile device while performing mobile work

In other literature, Lin et al. (2004) sought to evaluate the COPLINK Agent system, a US data

management system that claimed to be an innovative technology solution to improve information

sharing and collaborative investigation of crime. The study used data provided by fifteen

detectives. To measure factors likely to affect system usability and acceptance by targeted users,

the following research was undertaken:

To measure the effectiveness of COPLINK Agent, each participating officer who had

received alert messages sent by COPLINK Agent was asked to assess the usefulness of

each alert and to provide a subjective rating of the alert received. Also included in our

data collection were relevant contextual information (e.g., case type, search parameters

used, and reasons for creating a monitoring profile) and follow-up actions taken upon

receiving each alert. To measure the efficiency, we recorded the self-reported time

required to create a new monitoring profile and time to learn criteria

(Lin et al., 2004, p. 29)

Analysis showed a link between perceived usefulness and acceptance. Lin et al. (2004) suggested

that efficiency gain influenced perceived usefulness which then influenced the intention to

accept. They claimed perceived usefulness was the main driver for the acceptance decision and

concluded:

Our analysis results provide government agencies and technology developers with

valuable insights into specific areas and factors that are likely to affect system usability

and acceptance by targeted users.

(Lin et al., 2004, p. 34)

It could be argued, however, that their findings relied too heavily on a small set of data and,

although they did triangulate data with a survey, only participants' perceptions were captured.

There was no attempt to examine other measures of what happened in practice.

Colvin and Goh (2005) also explore the technology acceptance decision through observation and

survey from a large participant pool of 430 patrol officers who were responsible for a particular

section of a large US West Coast city. Their research looked at the adoption of laptop computers

that facilitated police officers' use of crime databases, report writing and assisted computerised

despatch. The study found that information quality and timeliness were two important

determinants of acceptance. A potential problem with the research is that it was conducted

when the participants had already been using the technology for twelve months so it was not

possible to investigate the implementation of the laptops nor what led respondents to become

users. Although the acceptance decision is an important part of the story, it does not provide the

full picture of adoption.

An example of research that investigates adoption more fully is found in Allen and Wilson (2004).

Their study looked at the implementation of mobile wireless laptops in the Surrey Police Force at

two different sites and focused on gathering a rich description of activities undertaken during the

adoption. The technology was not entirely new but it was a new mobile application of an existing technology. The research took a longitudinal approach with observations of laptop use taking place before, during and after implementation. Remarkably, the study reported very different results between the two sites:

> …the implementations in the two sites took very different trajectories; in one the technology was resisted and eventually withdrawn while in the other it was embraced and embedded into working practices.

> (Allen and Wilson, 2004, p. 16)

At the site where adoption failed and the technology was ultimately withdrawn, issues contributing to its failure included conflict in roles and ambiguity in the reasons for implementation. Senior officers were thought to have had clarity on the vision for the introduction of the laptops and thus understood operational efficiency would be improved as a result, but the long-term goal of the implementation was said to be ambiguous to individuals who were required to make sense of the situation themselves. In contrast, at the site where implementation was successful, officers seemed better able to re-organise to accommodate the technology. The main limitation of this work is that the researchers were restricted to observing use of the technology inside the police station.

By contrast, a study by Lindsay et al. (2009) observed the use of Mobile Data Terminals outside the police station by 42 officers over a two-week period. Although the research focussed on knowledge management and not adoption, the findings in the paper are still of particular interest here. The findings referred to a range of issues with the technology and the authors recommended that 'specific technical issues that were common in the observation and post-trial groups be addressed' (p. 18). Issues included:

- Some requirements of the technology were unmet

- Training needed to not only emphasise technical use of the equipment but also account for change to communication and work protocols

- Some features of the devices were awkward to use

Despite these problems, the research still concluded that 'mobile technology has had a positive impact on policing and knowledge sharing' (p. 20) and 'Overall, the benefits afforded by the use of mobile technology appear to outweigh the risks' (p. 21). This contrast between reported problems and the positive conclusion raises questions about the technology adoption process. In another study by the same authors, Lindsay et al. (2011), factors influencing mobile technology acceptance amongst police officers in Leicestershire Constabulary were investigated. Again the researchers used focus groups, interviews, observation and questionnaires to gather evidence. They found:

> ...the main barriers to achieving officer acceptance are low awareness of the benefits that MDTs offer; reduced functionality; usability, security and reliability issues; increased isolation; minimal opportunities for familiarisation with MDTs in non-operational settings and minimal level of officer involvement in the decision-making process.

> (Lindsay et al., 2011, p. 402)

In concluding, the authors identified the following four categories of factors affecting officer acceptance that they said explained whether the technology was embraced or rejected:

1. Operational performance

2. Security and reliability

3. Management style

4. Cognitive acceptance

They also suggested the high-level nature of the findings could be applicable in other policing contexts.

Bouwman et al. (2008) sought to test a range of hypotheses to determine police officers' preferential choice of mobile technology. The research took the form of a survey of 106 police officers. (The response rate was not provided). One particular hypothesis that may be relevant to this study stated that 'police officers will not have a specific preference for specific devices or attributes when dealing with urgent tasks...in principal, any device that enables communication and information flows will do' (p. 193). The researchers found this hypothesis to be correct and

concluded police would make use of any device that helps them with their information gathering. The conclusion that the police may accept a multitude of systems suggests strategic issues may exist in identifying and deciding on suitable technologies to adopt.

One of the few academic studies found that focuses specifically on the application of the ID scanner, is research undertaken in Australia by Palmer et al. (2013). They focussed on patron experiences of the scanner and though they were not concerned specifically with technology adoption, they alluded to issues that are highly relevant to it such as the lack of guidelines for administering the technology and the lack of studies examining the effectiveness of ID scanners. In a later study utilising data from an ID scanner and aiming to examine patterns in attendance and detection of banned persons attempting to enter a licensed premise found that:

> …the value of ID scanners to passively collect data on nightlife patrons, while also demonstrating the potential ID scanners have in reducing alcohol-related violence inside licensed venues by alerting security, management and police to the attempted entry of banned patrons.

> (de Andrade et al., 2021, p. 13)

The authors also referred to the lack of an evidence base for the use of ID scanners in the night-time economy.

This section reviewed literature in the context of policing. Table 4.7 provides a summary of the literature in the context of policing explored in this section of the review.

Author and year	Underpinning theory (where used)	Summary of literature	Summary comments
Ackroyd et al. (1992)		Book including discussion of the ineffective use of IT in context of policing which gives examples of how crises in relation to crime can lead to technological change.	Found technology in policing was rather 'ad-hoc'. Technology was both a consequence and a facilitator of change.
Allen and Wilson (2004)	Theory of Reasoned Action	Investigation of the adoption of wireless laptops by mobile police officers in a large UK police force.	Found that a technology adoption had different outcomes at different sites. They alluded to the way the people organised the adoption as being a key factor.

Author and year	Underpinning theory (where used)	Summary of literature	Summary comments
de Andrade et al. (2021)		Using data from an ID scanner, examined patterns in attendance and detection of banned persons attempting to enter a licensed premise.	Utilising data from an ID scanner, identified some potential benefits and referred to a lack of an evidence base for the use of ID scanners.
Bouwman et al. (2008)	Diffusion of Innovations (DOI), TAM and Task Technology Fit (TTF)	Attempt to re-assess technology acceptance by testing a range of hypotheses relating to the context of fit between task and technology.	Identified that strategic issues may exist in adoption.
Byrne and Marx (2011)		A review of research on implementation and impact of technological innovations in crime prevention and policing.	Identified a lack of research knowledge about how and why innovations are adopted.
Chan (2001)		Looks at the impact of technological change and its impact on the field of policing using a case study in information technology.	Issues in adoption of the systems were noted but with little information on how to overcome these issues.
Colvin and Goh (2005)	Technology Acceptance Model (TAM)	Attempt to validate the technology acceptance model by exploring the acceptance of laptop computers by police officers.	Two factors of quality and timeliness were identified as important to the adoption decision but the full picture of adoption was unknown.
Custers (2012)		Enquiry into which technologies were being used in police forces and other criminal investigation organisations to record experiences and identify obstacles and police needs.	Concluded that technology contributes to better, faster and cheaper policing though several obstacles to adoption were noted.
Darroch and Mazerolle (2013)	Diffusion of Innovations (DOI)	Analysis of attitudes and influences on adoption of Intelligence-Led Policing to improve understanding of the uptake of this one innovation.	Communications failures from the leadership contributed to failure.
Fleming and Rhodes (2018)		Paper challenges evidence based policing and identified the wider context needed to understand and improve policing practice.	Suggests more needs to be known about different aspects of policing knowledge and included in research.
Lin et al. (2004)	Technology Acceptance Model (TAM)	An evaluation of the acceptance decision and implementation management of the US data management system, COPLINK.	A small study that gave some insight into the acceptance decision but reductionist overall.
Lindsay et al. (2009)		A study on the impact of knowledge sharing using mobile technology through a pilot implementation Mobile Data Terminals by Leicestershire Constabulary.	A contrast between reported problems and positive adoption outcomes being report was identified. More contextual research is needed.
Lindsay et al. (2011)	Technology Acceptance Model (TAM)	Investigation into factors affecting officer acceptance of Mobile Data Terminals to reengineer a theoretical model.	Suggests there are influences on perceived usefulness and intention to accept an innovation but more investigation is needed.
Manning (1992)		Paper seeking to identify effects of new technology on police organisations and practices and the potential for transforming police work.	Innovations were driven by a need for efficiency. The innovations were means for managing the environment rather than changing it.

Author and year	Underpinning theory (where used)	Summary of literature	Summary comments
Palmer et al. (2013)		An examination of the rationale for the introduction of ID Scanners as a method for reducing violence in Australia.	One of the few studies looking at the adoption of ID scanners referred to a lack of an evidence base for use of ID scanners in the night-time economy.
Pawson and Tilley (1994)		Exploration of what works in evaluation research in policing.	Experimental approaches to research were reductionist and left significant gaps in knowledge about police practices.
Pica et al. (2004)	Social-technical theories.	An investigation into mobile police work that seeks to propose elements for improving mobility in the police. Looks at the relationship between activities and the use of mobile information.	Suggests a link between activities and context.
Sherman (2013)		Paper proposing the introduction of evidence-based policing as a method for making decisions on what works in policing.	Promotes a reductionist scientific approach to gaining research evidence to improve policing practice.

Table 4.7: Summary of literature reviewed in the context of policing

4.4.4 Diffusion and adoption: multi-agency collaboration

The previous sections have explored the diffusion and adoption of technology in policing but little was found where the police are not in direct control of diffusion and adoption. Rather than looking just at diffusion and adoption in policing, there are other literature where technology is not much in evidence, but collaborative working has been investigated. Collaborations by their very nature are often complex and the academic field on collaboration and partnership is vast. This section looks at literature where there are similarities in the mechanism for multi-agency working and where there are lessons useful when considering diffusion and adoption in this setting.

In the public sector, literature exists showing there have been attempts to provide support for working across agencies (McCabe et al., 1997). In the realm of policy making, and as an evaluation and development manual, McCabe et al. (1997) define 'partnership' and 'network' as partnerships being formal relationships between agencies with clear boundaries and networks are those that operate through individual relationships. They note that these two types can co-exist. The manual is a consolidated collection of worksheets and guidelines developed because there

was 'little assistance for those who are involved in managing the complexities of these relationships on a day-to-day basis.' (p. 1). In a management paper directed at Local Authorities, National Health Service trusts and police forces (Audit Commission, 1998) the development of partnership working is welcomed and it suggests 'well-planned partnerships are one of the best mechanisms for improving quality and co-ordination of services...' (p. 9).

However, it also suggests that '...potential gains [from partnerships] are often difficult to realise in practice' (p. 6) and common difficulties are identified:

- Getting partners to agree on priorities for action.

- Keeping partners actively involved.

- Preventing the partnership from simply being a talking shop.

- Making decisions that all partners endorse.

- Deciding who will provide the resources needed to achieve the partnership objectives.

- Linking the partnership's work with partner's mainstream activities and budgets.

- Monitoring the partnerships effectiveness.

- Working out whether what is achieved justifies the costs involved.

- Avoiding 'partnership overload' particularly where agencies are each involved in large numbers of partnerships.

(Audit Commission, 1998, p. 7)

These points resonate with the partnership working taking place in this research. Though the question of not one person or organisation providing a central means for managing the partnership means many challenges exist.

So far this section has provided some background on public sector collaboration but the context of this research includes other sectors. In a variety of sectors, collaboration has long been an important element and is increasingly becoming a significant growth area for institutions. For example, in municipal waste management partnership working is reported as becoming a popular approach to strategic and operational ways of developing joint services (Slater et al., 2007). The study on management of municipal waste identifies and characterises types of partnership

between local authorities and service providers. Five different models of partnership are

suggested ranging from partnerships between two organisations to more complex arrangements

with many providers and between different types of partner such as those in public and private

cross-sector partnerships. Slater et al. (2007) propose six principles for making up a framework

for evaluating partnership working:

1. Acknowledgement of the need for partnership.

2. Clarity and realism of purpose.

3. Commitment and ownership.

4. Development and maintenance of trust.

5. Establishment of clear and robust partnership arrangements.

6. Monitoring, review and organisational learning.

(Slater et al., 2007, p. 652)

Though they discuss common difficulties including the culture in many local authorities.

Traditionally, local authorities were used to working in isolation but there are benefits to

collaboration which may be relevant to this study such as the inclusion of a variety of perspectives

and facilitating learning through sharing of information and knowledge. In another sector (the

higher education sector) an examination into the management of new models of transnational

education with multiple partners was examined (Henderson et al., 2017). Traditionally

partnerships had been characterised by a one-to-one relationship but partners were becoming

involved in several aspects of the delivery of higher education. This change brought new

challenges for the sector and for those managing the partnerships. They acknowledge complexity

where multi-agency working brings a variety of mandates, interests and drivers for the

partnership yet uncertainty exists on how progress is measured and, for example, who carries the

responsibilities to deliver many aspects of the provision. There is commonality with the context

of this study that also includes uncertainty and complexity. Henderson et al. (2017) urge higher

education managers to have frameworks and flexibility to balance input, objectives, resources and

capacity and to share lessons amongst partners whilst to be able to respond to external market

changes. Though there are some examples of police working to innovate collaboratively in areas like crime reduction and domestic abuse though studies where the police work together with other agencies and adopt technology as part of a partnership or network are hard to find.

In a paper by Wastell (2006), looking at the development of a Geographical Information System to support multi-agency collaboration, the area of crime reduction was focussed on through the Crime and Disorder Reduction Partnership set up through central government but, this was found to stifle innovation and learning yet, a more informal network called NightSafe was found to be beneficial and had a degree of openness that worked well. Wastell looked at 250 papers in the research but found only one specifically focussed on multi-agency collaboration as a primary topic. That was in the context of young peoples' services through Children's Trusts so the field was found to be generally neglected. In a paper by Koper et al. (2014), the need to improve research on police technology was highlighted. Research was needed in an attempt to shed some light on the contextual aspects of policing in a multi-agency study, that research used a variety of methods to assist understanding of:

> 1. the intended and unintended ways that technology affects police agencies (e.g., in terms of their operations, structure, culture, effectiveness, and legitimacy); and 2. the various contextual aspects of police agencies and their environments that shape the uses and effectiveness of policing technology.

> (Koper et al., 2014, p. 213)

Yet there was an absence of insight into the interactions between agencies, the authors noted several areas for improvement including need for staff input for technical assistance and training and having shared goals. They said:

> More generally, police and scholars would likely benefit from adopting a systems approach to technological change that integrates perspectives from different people and units within the organization and emphasizes experimentation, evaluation, and organizational learning towards the goal of improving overall system performance (Chapman, 2004).

It is this complexity and interconnectedness that requires more insight and understanding.

This section reviewed literature in the context of collaboration. Table 4.8 provides a summary of

the literature in this section.

Author and year	Summary of literature	Summary comments
Audit Commission (1998)	Management suggestions for developing partnerships in public services.	Suggests potential gains are difficult to realise in practice.
Henderson et al. (2017)	An examination of multi-agency working and complexity in Higher Education partnerships.	They identify uncertainty and complexity in multi-agency working and suggest frameworks are used by managers to help balance the variety of objectives, resources and capacity amongst partners.
Koper at al. (2014)	A review of 250 papers in order to shed light on multi-agency collaboration in police agencies.	Of the 250 papers, only one was found to focus on multi-agency as a primary topic. The need to improve research on police technology was highlighted.
McCabe et al. (1997)	As an evaluation and development manual to support policy makers.	Suggest there is little to assist those involved in managing complex relationships.
Slater et al. (2007)	Sets out models of partnership as an approach to strategic and operational ways of developing joint services.	They note common difficulties in partnership working in public services.
Wastell (2006)	An example of police working collaboratively in the area of crime reduction.	A formal Crime and Disorder Reduction Partnership was found to stifle innovation and learning but an informal network, NightSafe, was found to be beneficial.

Table 4.8: Summary of literature reviewed in the context of collaboration

Notably, there were several indications where using systems thinking could provide opportunity

to gain new knowledge and understanding. The next section summarises the literature review

and reports on the key findings from this chapter.

4.5   Summary of chapter

This section summarises the literature reviewed and the gaps identified in the literature.

Given the breadth of literature available on innovation, diffusion and adoption it was necessary to

concentrate on literature most closely aligned to helping shed light on the diffusion and adoption

of a technological innovation. The variety of frameworks/models and other literature covered in

this review has brought to light how difficult it is to analyse and understand innovation, diffusion and adoption.

The review started by looking at innovation. Innovation has its own vast field of research so the works selected were those most helpful to build the story for this research. Then diffusion and adoption frameworks/models were examined. Firstly, Rothwell's generations of innovation models were analysed early in the review. His points about the role of key individuals may well be a factor for consideration in this study as well as the 24 factors listed as 'being involved in increasing speed and efficiency' (p. 15) of innovations. The factors included top management commitment and support, adequate preparation and mobilising support and resources, high quality initial product specification (resulting in fewer unexpected changes) and close linkages with primary suppliers (pp. 15-22). The variety of factors could have relevance to this study as an indication of actions required to contribute to successful diffusion and adoption. The concept of Open Innovation was explored. Open Innovation built upon Rothwell's generations of innovation models and concentrated on the suggestion that wider knowledge and more successful innovation would take place with external input. Next, the well-known theory Diffusion of Innovations (DOI) by Rogers (2003) was explored. The DOI theory took into account a range of factors such as the role of key individuals much like Rothwell, this indication of a need for a champion seems important to the process of adoption. Though this theory by Rogers was also found to have several limitations in practice. It was not known how to prioritise different factors and although a social system was referred to, it was unclear how that system was or could be bounded and how external influences and perspectives could be taken into account.

Then two further frameworks/models (TOE and TAM) known to focus on adoption showed that there is difficulty understanding the contextual situation and its impact on diffusion and adoption. Both were found to be reductionist in nature and the TAM in particular focused only on the acceptance decision. The acceptance decision was found to be well researched but there were many gaps in relation to the overall picture of adoption. Similarly the UTAUT had been developed to move the TAM on but was not found to be helpful. Carlsson 2006 suggested 'the UTAUT…can

be used as a starting point to find some explanations for the adoption of mobile devices/services'

(p. 1). However, they reported a reservation about the model which was that they thought it

required adaptation in order to account for contextual differences (between devices and services

in their case). The main finding of their paper seemed to be that further research was needed

before conclusions could be drawn. The studies on UTAUT suggest that development of the

model is needed and therefore any reference to TAM in this research refers to the original

framework/model. This prevents an understanding of the actual contributions made during an

adoption process by differing agencies and where multiple perspectives have an impact on the

process.

Next, the review looked at technology adoption in policing from the point of view of innovation,

building an evidence base and the use of technology devices. The review found that is not

without its problems either. A wide range of factors were identified and said to have caused

barriers to adoption or failure to implement an innovation. Adoption has been shown to be very

reliant on social factors needed to facilitate innovations. One of the significant problems has

been to find out what happens in practice once an innovation has been diffused.

Having reviewed the variety of different frameworks/models and the literature in the context of

policing, there was no identification of one existing framework/model that would wholly fit the

context of this research. The extensive review of the literature established that existing adoption

frameworks/models made no explicit use of systems thinking but all have been found to have

some implicit use of systems thinking that can be explored further.

Table 4.9 provides a summary of the literature review findings.

Author, year, underpinning theory, summary of literature and primary purpose/audience	Evidence of multi-agency working	Summary of gap(s) identified	Implicit use of systems thinking	Summary comment and rationale for taking forward in this study
Rogers (2003), Diffusion of Innovations.

Theory and processes for explaining how an innovation is diffused. | Suggests the concept of a preventative innovation would be popular to | Refers to complexity but in terms of the use of the innovation.

No prioritisation of the characteristics. | Consideration of a social system but there is no definition for the system. | Not easily applied to adoption and an assumption that an innovation is adopted by the |

Author, year, underpinning theory, summary of literature and primary purpose/audience	Evidence of multi-agency working	Summary of gap(s) identified	Implicit use of systems thinking	Summary comment and rationale for taking forward in this study
Rogers (2003), Diffusion of Innovations. Explains generally why an innovation infiltrates a population or not and thus whether innovations become adopted successfully or not. It provides frameworks/models for parts of the innovation process for a variety of disciplines.	tackle an unwanted event but does not give attention to multi-agency working. Critiques suggest that a wider range of contextual factors need consideration.	Lack of clarity in adoption curve and what happens after adoption (Gayadeen and Philips, 2014). Lack of understanding about how to ensure the rate of adoption is high which the theory suggests leads to successful adoption Not easily applied in practice. Little is said about what the external influences might be.	Explains diffusion as an uncertainty reduction process. Key individuals are important to the process. Suggests members of a system are important but lack of clarity what that system is and whether boundary judgements have been made.	whole social system. To be investigated further. There is good academic foundation and there may be opportunities to know more about the system, uncertainty reduction, multi-agency working and investigation of variables in the context.
Tornatzky and Fleischer (1990), Technology Organisation Environment (TOE). The framework/model is built from three principle contexts that are the external environment; the technological context; and the organisational context. It is a framework/model aimed at research and development and managers responsible for R&D in an organisation. With policy in mind, it claims those people can benefit from improving understanding of the wider systems surrounding technological implementation.	Acknowledges there are other agencies involved but takes a hierarchical approach.	It is not clear how to assess or make boundary judgements about what the wider system is. Context in this framework/model is defined only as 'related goals, roles, rules, assumptions, expectations' though it suggests consideration of external factors such as market conditions but the social context refers mainly to the interaction of the technology.	Consideration of an external environment. Repeats a need to benefit from understanding the wider system.	A number of variables could be missing from consideration including management, culture and organisational structure. To be investigated further as there are opportunities to look at factors in the external environment and build understanding from the wider situation.
Davis (1986), Technology Acceptance Model (TAM) The framework/model was devised to explain how adopters come to accept and use a technology and, to examine a set of hypotheses relating to perceived adoption decision making characteristics. A framework/model to predict and explain user acceptance of computer technology in order to be able to improve users' willingness to accept and use available systems.	Not identified.	Focuses only on the acceptance decision in the innovation process and is a predictive framework/model. Assumes there is one primary adopter and other agencies are not involved.	Consideration of a range of factors that influence a decision.	Reductionist and focuses on acceptance behaviour and decisions to use the technology not covering contextual factors or differing perspectives. To be investigated further as the adoption decision may well correlate with this this framework/model.

Author, year, underpinning theory, summary of literature and primary purpose/audience	Evidence of multi-agency working	Summary of gap(s) identified	Implicit use of systems thinking	Summary comment and rationale for taking forward in this study
Venkatesh et al. (2003), Unified Theory of Acceptance and Use of Technology model (UTAUT) An extended version of the TAM Based on the TAM, seeks to explain individual adoption and was developed in an attempt to have one model to explain acceptance and use of a technology.	Not identified.	Is challenging for practitioners to use and adapt to different contexts. Additionally, the range of potential variables to be investigated were not fully identified.	Consideration that there are a wide range of factors at play.	Discounted from further investigation in this study due to confusion in its use and lack of robustness for understanding adoption.

Table 4.9: Summary of literature review findings

None of the frameworks/models investigated seemed wholly applicable to a multi-agency complex situation such as the one proposed in this study. There were also many questions regarding complexity and uncertainty that remained unanswered. Additionally, the research was often bounded in a way that left important areas of the context and its impact on the diffusion and adoption unknown. Prior studies had shown that a broad range of factors and variables is important in diffusion and adoption research but there needed to be new ways to enhance understanding of diffusion and adoption by expanding the number of factors and variables examined (See Table 4.6). Therefore three of the frameworks/models have been selected for further investigation in this research (as shown in Table 4.9). There are several reasons for a choice in use of framework/model and as this research proposes a complex situation that does not neatly fit any one existing framework/model, three that are different in approach but still may shed light on diffusion and adoption have been chosen. One is applicable generally to many situations and is used for simulation (Rogers' Diffusion of Innovations theory), one generating understanding (Tornatzky and Fleischer's Technology Organisation Environment), one predictive (Technology Acceptance Model by Davis). They are all closely aligned to diffusion and adoption but are different in approach. However, all focus on one organisation and how they will fare in a multi-agency situation needs further understanding. All three propose examination of factors and variables but they differ between them. They focus on a selection of factors and variables that

may influence diffusion and adoption and possibly, therefore, the reasons for adopting an innovation may not have been fully explored. Although this research had not been undertaken in a way to directly apply and compare frameworks/models, using multiple theories in this way allows new insights to be gained. Several studies reviewed proposed improvement through the integration of one or more of the existing frameworks/models so there is scope to expand understanding and knowledge using systems thinking.

In summary, the following shortcomings were identified in general in the review: existing frameworks/models do not sufficiently consider multiple perspectives in a multi-agency setting and the interactions between them; the frameworks/models do not report or explain in sufficient detail the impact of the factors and variables surrounding the situation and complexities involved; and they do not take into account influences on the diffusion and adoption processes.

This review has demonstrated there is a broad belief that innovations are worthwhile, they save money and result in improved efficiency and effectiveness. The review also reveals that academic research indicates more needs to be known about innovation, diffusion and adoption. Research is needed that looks at the process/interaction between all factors surrounding an innovation. This research aims fill that gap. Ultimately this study aims to understand whether systems thinking can enhance or replace those existing frameworks/models. The next chapter provides the methodology.

Chapter Five: Methodology

5.1   Introduction to Chapter 5

The literature review (Chapter 4) evaluated the academic literature on diffusing and adopting technology innovations in policing. It helped build understanding of gaps that existed and to understand whether there was opportunity for systems thinking to enhance, or replace, existing innovation, adoption and diffusion frameworks/models. In relation to current research, the literature review found that there were gaps to be filled. So now this chapter will address the question of how new knowledge might be gained from a research study and it focuses on the means for acquiring new knowledge.

The chapter is structured around a process to acquire that knowledge. First, this chapter gives an account of the research question and the methodological framework for the research. Next, the research position and the underpinning philosophy as the foundation of this study is explained and the rationale for the choice of approach is provided. The research design is explained and why the chosen approach answers the research questions is dealt with. Research ethics are covered and then the strategy and design behind the choice of methods and procedures for collecting and analysing data, what was done to collect and analyse the data and an account of the data analysis procedures enacted are described. Finally, a summary of the chapter is made.

5.2   Research questions

This study was guided by the problem set out in the previous chapters and was steered with the use of a main research question rather than being designed to test a hypothesis. The literature review (Chapter 4) provided a review of academic literature and its findings guided the development of the research question. The purpose of this research is to generate new knowledge on the potential use of systems thinking to understand diffusion and adoption in the innovation process.

Specifically, this study aimed to answer the following research question:

> In the context of multi-agency diffusion and adoption of a technology to enhance policing, can systems thinking techniques enhance, or even replace, existing frameworks and models?

The following questions will be covered by the research and contribute to answering the overall research question:

1. How does systems thinking improve the approach to learning about diffusion and adoption in a multi-agency situation?

2. How does systems thinking improve the recognition and understanding of the factors and variables affecting successful diffusion and adoption in a multi-agency situation?

3. Does systems thinking lead to a better framing of adoption decisions for decision makers within a multi-agency situation?

4. How does the addition of a systems thinking perspective to existing diffusion and adoption frameworks/models improve the ability to describe, explain or even predict the outcome of diffusion and adoption initiatives in multi-agency situations?

Before undertaking the research, it was necessary to design a methodology that would address these questions and generate new knowledge.

Figure 5.1 shows the approach taken to the literature review and Figure 5.2 shows the methodological approach to this study.

Figure 5.1: Approach to the literature review
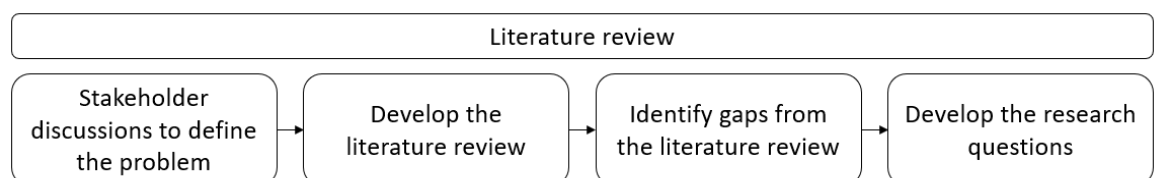
Figure 5.2: Methodological framework
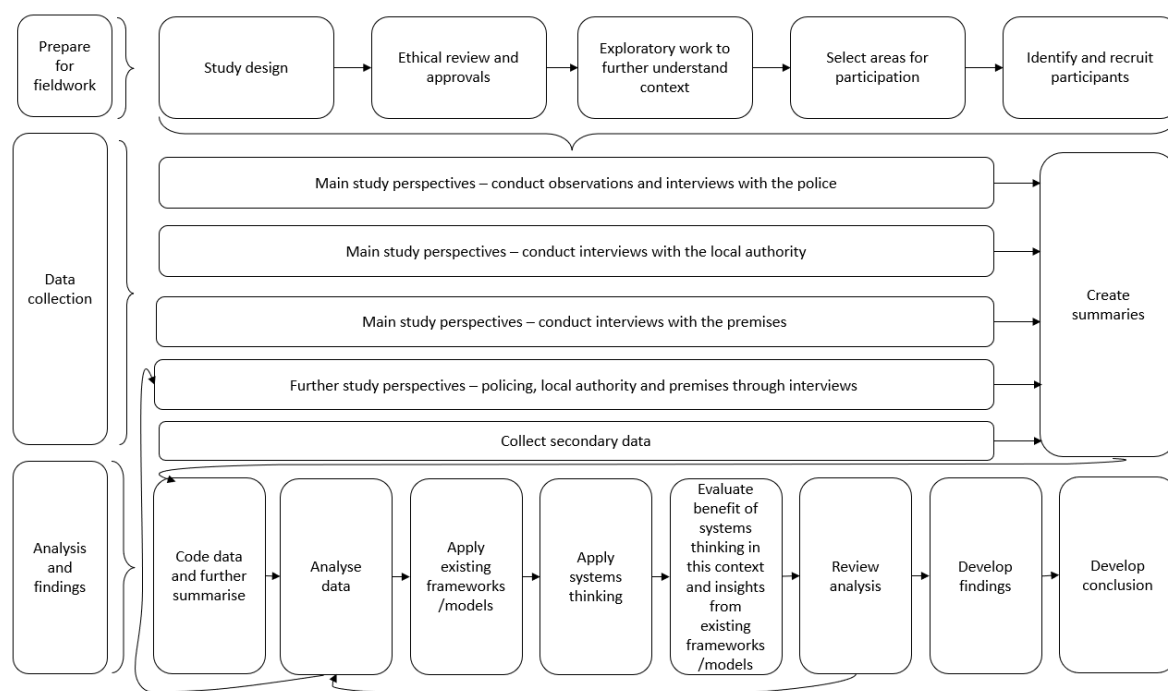
The approach to this research shows how the review of literature informed the research questions and the procedures for data collection.

The research philosophy that underpins this study is explained in the next section.

5.3 Research position

This section sets out the epistemological position and the rationale applied in this research.

5.3.1 Underpinning philosophy

Firstly, however, it is important to consider logics of enquiry and assumptions on which this research is based. Potter (2006) provides explanations of logics of enquiry. The explanations use the Burrell and Morgan framework (1979) who identify and explain 'four sets of assumptions related to ontology, epistemology, human nature and methodology.' (p. 1). A summary of Potter's explanations are found in Table 5.1.

	Ontology	Epistemology
Positivist	World is 'out-there' and separate from human meaning making.	Knowledge only gained through observing facts and taking a hypothesis approach.
Constructionist	The world as we know it.	Only world is semiotic and knowledge is constructed.

Table 5.1: Summary of philosophical underpinning (Source: After Potter, 2006)

The ontology is the belief about the nature of being and is interpreted as referring to the relationship with the reality of the study. Positivist ontology, shown in the upper left-hand quadrant on Table 5.1, suggests the world can be perceived objectively and regarded as an order system made up of events that can be observed. It assumes that if independent witnesses observe something then that something will consistently be viewed the same by all those observers. By contrast, the lower left-hand quadrant of Table 5.1 presents a philosophy regarding the world where individuals construct social reality. This constructionist ontology asserts that though something will appear the same to observers who take a similar standpoint, it may be interpreted differently by observers who have different viewpoints and therefore formulate different understandings. To improve understanding of the two ontologies discussed above, it was helpful to consider suggestions in Downs Jr. and Mohr (1976), based on work by the philosopher John Locke in 1691, that primary and secondary qualities exist. Primary qualities such as material facts like shape are those that will be viewed by all observers as the same and secondary qualities such as taste, colour and sound are open to interpretation. Primary qualities could be said to align with the positivist ontology (they will be viewed and interpreted as the same) and secondary qualities to the constructionist stance (they may be interpreted differently). There is a significant amount of published literature regarding qualities but for the purposes of this research, it is sufficient to have the knowledge that these differences might exist. Another way to demonstrate the validity of bringing together the two ontologies in this study is provided by Cupchik (2001). Cupchik explored an ontology that encompasses positivist and constructivist approaches and argued that the concept of validity need not isolate both scholarly communities. Whilst the philosophy underpinning this study aligns mostly to the constructionist foundation because the research data will be interpreted, positivist views of the world were also present as there were factual data collected in the research that would be viewed the same by all observers.

Epistemology, the research stance, is about how valid knowledge is developed. In this study, knowledge would be gained through carrying out interviews, observing situations, analysing

documents and by constructing interpretations from data. As this research study takes an

exploratory approach, an element of interpretivism is inevitable.

In some literature, it is suggested that positivism and interpretivism should not be combined but

Weber (2004), having looked at the alleged differences between positivism and interpretivism

(See Table 5.2), concluded that the two should not be mutually exclusive.

Metatheoretical assumptions about	Positivism	Interpretivism
Ontology	Person (researcher) and reality are separate.	Person (researcher) and reality are inseparable (life-world).
Epistemology	Objective reality exists beyond the human mind.	Knowledge of the world is intentionally constituted through a person's lived experience.
Research object	Research object has inherent qualities that exist independently of the researcher.	Research object is interpreted in light of meaning structure of person's (researcher's) lived experience.
Method	Statistics, content analysis.	Hermeneutics, phenomenology, etc.
Theory of truth	Correspondence theory of truth: one-to-one mapping between research statements and reality.	Truth as intentional fulfilment: interpretations of research object match lived experience of object.
Validity	Certainty: data truly measures reality.	Defensible knowledge claims.
Reliability	Replicability: research results can be reproduced.	Interpretive awareness: researchers recognize and address implications of their subjectivity.

Table 5.2: Positivism versus interpretivism (Source: Weber, 2004, p. 4)

Therefore Walsham's (2006) publication on conducting interpretive research was relevant as this

research would include contextual data. He explained that interpretive research is underpinned

by a range of ontological positions including constructionism and had been used increasingly in

Information Systems (IS) research. Walsham indicated that interpretivism overlaps with

qualitative research and the two can consistently be used together. As a way to apply the advice

to this research, Table 5.3 shows a mapping of this research to Walsham's application of

interpretive research in Walsham and Sahay (1999) longitudinal study on geographical

information systems (GIS) in India.

Theme	Area	This research study	Walsham's GIS research study
Carrying out the field work	Choosing style of involvement	Neutral observer, the researcher is not aligned to any particular stakeholder group and participants in the study recognise that. The research is not an action researcher actively attempting to change the situation. This does not mean the researcher is unbiased, the researcher's own worldview is understood.	Started as neutral observers but evolved into advice givers whilst acknowledging the bias of the researcher.
	Gaining and maintaining access	The researcher had good and appropriate fieldwork and suitable skills for organising that access. Maintaining access required an element of feedback to key stakeholders though presentation to participants.	Access also through independents and brokers. Access maintained through provision of presentations and workshops.
	Collecting field data	Interviews form a key element in this research but were supplemented by secondary data. Secondary data was collected through desk research to include crime statistics, media and other publications. Interviews were not to be recorded.	A large number of formal interviews were carried out. Systems demonstrations were observed and archival reports and documents collected.
	Working in different countries	Not applicable to this research though literature has been found on ID Scanners in Australia.	Language barriers occurred; fieldwork carried out using translators.
Theory and data analysis	Role of theory	A review of literature carried out, focusing on technology adoption and innovation.	The actor-network theory was used to analyse the GIS case study. Reading further about theory in related fields occurred over the course of the research.
	Choosing theory	Theory assessed and chosen is insightful to the researcher and is engaging.	Theories are chosen at different stages of the research, as choice is subjective. Theory chosen fitted well with the field data and offered new insights.
	Data analysis	Analysing themes and issues by using systems tools such as causal mapping.	Captured impressions from interviews, analysed sets of themes. Loosely compared to theory.
Constructing and justifying a contribution	Justifying your approach	Ensured consideration of the historical and social contexts and multiple interpretations were used.	Justified approach through authenticity, plausibility and criticality.
	Constructing a contribution and writing.	Consideration of the outcomes of this study and potential interest to different audiences.	Framed material for particular audiences.

Theme	Area	This research study	Walsham's GIS research study
Ethical issues and tensions	Confidentiality and anonymity	Confidentiality offered and data anonymised. Approval by the OU Human Research Ethics Committee was received.	Confidentiality offered.
	Working with the organisation	Acknowledged the potential that the research draws negative conclusions in relation to the use of ID scanners.	Consideration of the gap between the expressed purpose of the researcher and potential unwelcome news to sponsors.
	Reporting in the literature	Critical writing included suitable anonymity.	Consideration of criticality in writing.

Table 5.3: Reflections on the interpretive approach

It is therefore appropriate to use an interpretive approach for this research. The use of systems thinking is complimentary as it provides the opportunity to explore the situation as a whole. Systems thinking and the use in this study is explained in Chapter 6. The next section describes the research method.

5.3.2   Research method

Research methods are often broadly divided between quantitative and qualitative methods. Quantitative research primarily looks at numerical data that can be measured and statistically analysed and is usually collected through surveys and observations that involve counting (e.g., the number of times something occurs) and can be linked to the positivist ontology, described earlier in this chapter, because of its statistical base that frequently includes modelling. Quantitative data can be advantageous because it can be measured, analysed and results clearly defined. Studies based on quantitative data can often be easily replicated and findings compared. However, this approach has its limitations. The literature reviewed in this research found that quantitative data was commonly used to inform technology adoption in frameworks/models such as the Technology Acceptance Model (TAM) (See Chapter 4). The TAM is used to explain innovation acceptance but it did not always cover the multitude of contextual factors that may be involved such as consideration of differing perspectives or composition of the population surveyed. The reliance on statistical data meant that other aspects such as complex relationships between stakeholders would not have been considered. In general, the literature review highlighted a number of constraints with statistical modelling.   This research draws upon some

forms of quantitative data as secondary data such as crime statistics and other numerical data gathered by desk-based research where appropriate.

Qualitative research, on the other hand, delivers a broader range of data and can give results to a deeper level. Since the research approach was not designed to test a particular hypothesis but, instead, set out an overarching research question that would allow in-depth exploration to better understand the situation, the qualitative approach seemed suitable. A deductive approach to research typically starts with a hypothesis and uses theory and observation to dispute or refute an idea (Potter, *Op. cit.*). Using deduction was not appropriate in this study as there were no preconceived ideas of what the outcome might look like. Qualitative research uses non-quantitative data (Corbin and Strauss, 1990) and offers alignment with an inductive approach that is generally applicable to the constructionist ontology also described earlier in this chapter. The inductive approach (Potter, *Op. cit.*; Danermark et al., 2019) is exploratory in nature and starts from a position of observation and looks for patterns and issues in a situation. There are of course implications with this inductive approach as the research interprets observed data in order to make generalisations. (See Bendassolli, 2013; Danermark et al., 2019). The relationship between observational data and validation of that data is a cause for reflection. Abduction as an approach involves constructing new theory (Potter, *Op. cit.*) or frames theory in a new set of ideas (Danermark et al., 2019). Though there was an openness to whether induction or abduction would be most applicable to this study as both approaches share some similarities such as having an interpretive element and an intention to recontextualise or redescribe a situation. However, and on reflection, there was enough difference between the two approaches in relation to structure of the analysis process that an inductive approach was prioritised. This study aimed to explore what takes place whilst allowing some flexibility within the approach to respond to findings. In abduction, a more formal process of thematic analysis using theory (existing or otherwise) is involved. It would not be conducive to have had preconceived ideas in this study or to bring any in at the analysis phase. To ensure generalisability, the design and process by which this research would be carried out would be carefully documented.

However, there are some downsides of a qualitative approach to consider. The problem with qualitative research is in ensuring validity and reliability. Mechanisms such as data confirmation and ensuring a good selection of participants are made warrants that the data is appropriately validated and is reliable. Selecting a qualitative approach for this study means that the research is inductive and is consistent as a study that focuses on the process of data collection that did not set out to be based on the use of an already predefined theoretical model. The approach is suitable to providing an in-depth investigation of the situation. Taken from the general approach set out in Figure 5.2, Figure 5.3 summarises the process of data analysis.

Figure 5.3: Data analysis process
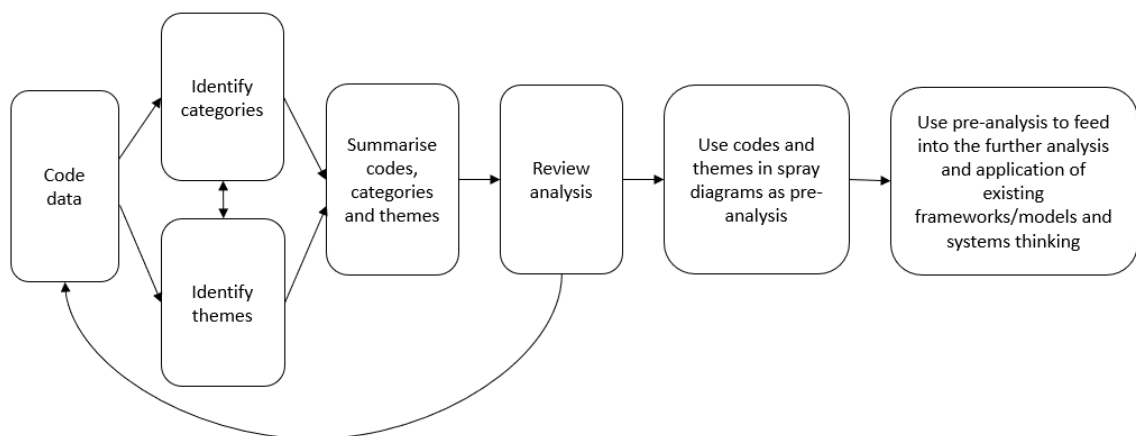
An experimental route was also considered as an approach but it was decided that it was not appropriate. The range of variables in the situation of innovation and technology adoption in policing cannot easily be replicated or controlled (Pawson and Tilley, 1994). Rather than thinking about separate causes and effects, system thinking is used to deliberately generate variety in the way the situation is thought about. This variety is indeed useful and necessary to the aim of extending knowledge. The next section explains the techniques used in this research.

5.3.3 Data collection instruments

Several instruments for data collection were used in this study. These included: interviews, observations and documents. Using multiple data collection instruments ensures the data collected will be comprehensive.

Interviews

Interviews in this study used a semi-structured approach (DiCicco-Bloom and Crabtree, 2006). The semi-structured interview process offered flexibility and is commonly used with qualitative research using open-ended questions. In this research, the interviews were used to gather primary accounts of what takes place in adoption. This allowed participants to share experiences, information and thoughts on the implementation of the scanner.

A framework of questions was used as pre-prepared prompts and were applicable to all interviews in this study to ensure fairness and consistency across all interviews in this research. the questions were not rigidly structured and were varied depending on the participant's involvement. The series of questions were developed using the 'five W's and H technique' (See Appendix D) and careful attention was given to the use of open questions to facilitate a deep understanding of the situation. The questions were tested and revised to improve clarity. Iteration of the questions was necessary as the study evolved. The broad questions asked were:

How did the participant become involved?

What was their role?

What activities and actions were they involved in?

Why the ID scanner is important?

How the ID scanner had been set up?

How did the activity work out?

What were the plans for the future?

Interviews were carried out either face to face or by telephone. Irvine et al. (2012) sought to consider differences that may be observed between these two interview modes. They summarised their findings thus:

- Completion or formulation of interviewee talk by the researcher was more common in face-to-face interviews

- Interviewee requests for clarification were slightly more common in telephone interviews

- Vocalized acknowledgements given by the researcher were less frequent in telephone interviews

- Interviewee checks on the adequacy of their responses to the researcher's questions were more common in telephone interviews

- Telephone interviews tended to be shorter than face-to-face interviews.

(Irvine et al., 2012, p. 101)

Irvine et al. (*Op. cit.*) describe this area of researching differences between telephone and face-to-face modes as an expanding area of research. In relation to this study, there was a perceived practical advantage to telephone interviews as note taking by the researcher would be hidden and would not detract from the discussion. In the data set analysed by Irvine et al. (*Op. cit.*), the telephone mode was not found to lead to increased difficulties in substantive understanding. There were also practical considerations in case telephone interviews would cause more fatigue to both the interviewer and the participant. It was decided that this research would prefer face to face interviews rather than telephone but that telephone interviews would not be ruled out should a participant be unavailable otherwise.

Considering how to capture interview data, Walsham (2006) points out some key advantages and disadvantages of recording:

One advantage is a truer record of what was said compared with the taking of notes during the interview, no matter how extensive. It is possible to return to the transcript later for alternative forms of analysis, and it is useful for picking out direct quotes when writing up. It frees the researcher to concentrate on engaging with the interviewee. Finally, it is popular with neo-positivist reviewers in some establishment journals. Against this, it is very time-consuming and/or expensive to do transcriptions and then to extract themes, and this time could be spent elsewhere, for example, on more interviews or analysis. A crucial disadvantage for me is that tape-recording may make the interviewee less open or less truthful. Finally, tape-recording does not capture the tacit, non-verbal elements of an interview, which are crucial aspects of the experience for the researcher.

Walsham refers to the disadvantage of interviews being potentially less open when recorded and this study required as much data as possible about all aspects of the situation, it was decided not to record the interviews. Instead, the researcher skilled in minute and note taking would conduct the interview in an open and fair way and carefully record the notes of the interview.

Observation

The role of observation in this research was primarily to observe the technology in use, to gain a better understanding of the context it was used in and the roles of different stakeholders and interaction between them with a focus on:

- Events or activities in which the police and door staff were involved.

- The activities (routines) and informal conversations taking place.

- The attitudes towards the task.

- Examples of interaction between the police, door staff and the public entering the premises.

Moreover, by using observation, interview data was not solely relied upon and data was made directly by the researcher. Observer bias would be avoided through clear objectives for the observation. The intention was to be immersed in the situation, not recording notes during observation, which was mostly not practical due to the nature of the observations (they took place at night) but to produce written summaries as soon as practically possible after the observation noting activity and interactions that took place with the devices.

Documents

Documents are useful to provide information about the setting being studied and the wider context. The documents are ways of gaining insights into the research context and the topic of study but they were not produced for the purpose of research and they do not provide direct answers to the research questions. They do, however, support the investigation. The documents provided a wider, formal, context of the initiative.

Table 5.4 provides a summary of the data used in this study.

Data collection tool/method	Analysed data	Rationale
Primary method		
Interviews	Interview summaries.	To obtain detailed information about feelings, perspectives and opinions from participants.
Supporting data		
Document analysis	Newspaper articles. Local authority reports.	To understand the setting.
Observations	Handwritten summaries.	To view behaviors and understand the setting.

Table 5.4: Summary of data

There are other instruments of data collection that were considered, for example, surveys and focus groups. In this study, a survey was not appropriate because of the exploratory nature of the study and the approach to recruitment of participants through snowballing did not allow an appropriate cohort to be identified early in the study. Focus group activity might involve bringing together specific groups of participants, perhaps from one stakeholder group or by mixing participants from different agencies together. However, to meet the requirements of this study, it was appropriate to have one-to-one interviews allowing for participants to openly express their thoughts and experiences and those multiple perspectives to be carefully captured. This openness would ensure the situation could be delved into in-depth. As Richard et al. (2021) point out, focus groups:

> …lack anonymity, discourage participation from hard to reach and distant populations, are limited in the number of participants they can accommodate, and can be relatively expensive to conduct…

(Richard et al., 2021, p. 32)

The next section explains the approach to data analysis.

5.3.4   Approach to data analysis

Grounded theory was considered from the beginning of designing the research approach. Rather than using grounded theory in its whole or complete form, this research draws on specific elements of the interpretation by Corbin and Strauss (1990) in the analytic phase. Corbin and Strauss set out a series of 'procedures, canons and evaluative criteria' (p. 3) for conducting qualitative research. However, this research uses some elements of grounded theory useful in

data analysis rather than using the theory in its entirety. For example, this research will develop categories and 'concepts that pertain to the same phenomenon [to] be grouped to form categories' (p. 7) and makes use of comparisons: 'Making comparisons assists the researcher in guarding against bias' (p. 9) but this research does not necessarily treat data collection and analysis as interrelated processes (p. 6).

There are researchers that have adapted their research approach by using elements of grounded theory, or by combining it with other approaches such as in Oreszczyn (1999) and Mann et al. (2007). These authors used themes as broad topics for investigation using qualitative descriptions as a less rigid approach to case study research. Their aim was to ensure the studies included the widest possible view of relationships and the magnitude of those relationships in the research. The adaptation works well with the use of systems thinking (Chapter 6).

Stillman (2006) explains a view on how grounded theory is framed by a systems perspective:

> Grounded theory…is a *systematic* research method in which the purpose of the researcher is to "generate a theory that accounts for a pattern of behaviour which is relevant and problematic for those involved" (Glaser, 1978, p. 93). …Grounded theory discovers a theory within a system…but that theory may transcend a particular setting, time, or place, and broaden to a more abstract system of interrelated concepts. Grounded theory, which itself is a process, is an organized set of principles and methodology. It can also be considered a *system* for discovering a theory…
>
> (Stillman, 2006, p. 499)

A qualitative analytic method would be used for identifying, analysing, and reporting on emerging themes (patterns) and topics in the data. The identification of coding themes is subjective so process akin to grounded theory took place. The data would be scanned for themes, given conceptual labels and these labels used to identify and develop concepts. As this research would apply systems thinking to the data, further analysis at this stage would not be conducted. By way of cross-moderation, the process takes place several times to ensure a robust set of concepts would be used to take forward into the next stage of applying systems thinking. Computer aided

analysis, using software such as Nvivo, was not used as data was analysed manually. It was more important in this example, to 'know' the data and the situation in all its richness. Acknowledging that qualitative researchers can have difficulty demonstrating research rigor, Gioia et al. (2013) suggests that 'Advances in knowledge that are too strongly rooted in what we already know delimit what we can know' (p. 16). They, therefore, articulate a framework for ensuring rigor in qualitative research. They suggest that this approach to research makes:

> …extraordinary efforts to give voice to the informants in the early stages of data gathering and analysis and also represents their voices prominently in the reporting of the research, which creates rich opportunities for discovery of new concepts rather than affirmation of existing concepts.

(Gioia et al., 2013, p. 17)

This research is conducted in a way that is consistent with the basis of grounded theory and the framework set out by Gioia et al. (2013). The approach ensures connections are made in the analysis among data, so that emerging learning about the situation is captured and, indeed, connections are made in the reporting of findings. However, it is appropriate to consider triangulation in research. It was not intended to triangulate data to cross check its validity in this research, but instead, use the data to compare the findings of applying systems thinking tools and with diffusion and adoption frameworks/models to answer the research question. This section has discussed the general approaches to this study, its alignment to the philosophical underpinnings of both constructionist and positivist ontologies and the intention to approach the research through interpretation based mainly on qualitative data. The section also provided the theoretical foundation for the data collection instruments. The next section defines the research design to ensure reliable and valid data was collected.

5.4   Research design

The methodological framework and the methods used within it was shown in Figure 5.2. The methods were structured in three stages: preparing for fieldwork; data collection; and analysis and findings. The data collection methods used during this study incorporated a collection of

qualitative data from interviews and observation for primary data and documented evidence for secondary data. Data analysis took place using initial data analysis and spray diagramming and further analysis by applying existing frameworks/models and systems thinking. The next sections explain the sample selection and the conduct of the data collection instruments.

5.4.1 Sample selection

It was anticipated that the design of the sample would allow the topic to be explored in depth by capturing multiple perspectives from a range of stakeholders and a more comprehensive understanding of diffusion and adoption would be obtained.

First, the organisations to be included in this study were identified. The geographical and police force choices were discussed in the research setting (Chapter 3). The Thames Valley Police area was chosen as the main example from a range of ID scanner implementations in England because of access to relevant information within the scope of this research, a mix of context and practice was evident and a network of stakeholders was involved. The initial fieldwork was undertaken in the Thames Valley Police area and the target for interviews was serving police officers and police staff. People from partner organisations were also invited to participate to give a more rounded view of the introduction and implementation of the technology. Partner organisations included the technology supplier and other decision makers that provided licencing, funding or other approvals for use of technology. As the research was interested in aspects that cross boundaries, it was imperative the choice of organisations included a selection of different business types and sectors also involved in introducing the ID scanner. Enabling a range of participants from organisations such as those in the entertainment industry, the police and local government meant that the exploration of the adoption of the ID scanner could be looked at in its widest sense, it would provide the most complete picture of diffusion and adoption and was consistent with the purpose of this study. Targeting one profession only, for example the police, would have resulted in a narrow view of innovation when adopting new technology and may have excluded important aspects where other organisations or roles are involved in the diffusion and adoption. It would also have proved challenging to identify a sufficient number of participants involved in a particular

geographical area. Five key sets of stakeholders were identified as important to the study. These were:

1. Police officers

2. Premises owners and managers

3. Local authority members

4. Door supervisors

5. The supplier (there was only one dominant supplier of the ID scanner)

It was important to ethically recruit participants. Ethical approval by The Open University's (OU) Human Research Ethics Committee was required and was granted (reference HREC/2014/1705/Barrett/1) (See Appendix A). An essential part of gaining that ethical approval was outlining a robust framework for data collection. As the study collected data on adoption of an ID scanner, this research did not give attention to one particular stakeholder group or at people at a seniority or rank of an organisation. Instead, it aimed to gain participants operating in different organisations and across a variety of functional roles. However, there were challenges in deciding which groups to target. For instance, decisions around policy and provision of technology strategy are made at managerial level whereas best practice is found at a user level. The breadth of the study in terms of participants spread across all agencies and in different roles was considered carefully. Too few from one agency risked having inadequate data and having the broadest input would increase reliability in findings. It was decided that there would be no selection of participants, the study was open to all. There were no instances of participants being declined to participate.

The number of interviews deemed suitable for this study would be around 50 participants spread across all agencies. This number of participants and the in-depth interviews with each would return significant amounts of data. Having too much data can be deemed unwieldy (Sandelowski, 1995; Cleary et al., 2014) but a large data set is an unlikely problem as systems thinking can be applied to large amounts of data. Data collection would be ended once saturation was felt to have been reached, that all questions had been answered in much detail and by sufficient

representatives from different groups of stakeholders or agencies. Though further interviews and follow up discussions as the analysis and writing stages took place were not ruled out.

The study required cooperation of a gatekeeper for access to participants for the police, a suitable senior officer was asked for permission. Potential participants were first identified and approached by the gatekeeper who circulated an invitation to participate written by the researcher (See Appendix B). As the study progressed, participants were able to self-nominate, where they had heard about the research through word of mouth and wanted to be involved, they requested the researcher contact them or made contact directly. Interviews in situ led to this process of referral and 'snowballing' (Biernacki and Waldorf, 1981). After interviewing a small number of participants, the network developed by the researcher enabled enough referrals of participants to meet the requirements of this study.

5.4.2 Conduct of interviews

On contact with the researcher, the volunteer was provided with an information sheet and consent form (See Appendices B and C) along with confirmation of the date, time and location for the interview. Each participant retained a copy of his or her signed consent form, which also provided instructions should the participant wish to withdraw from the study at any time.

Following an interview, an interview summary was provided to the participant who was asked to amend the summary where necessary and to confirm willingness for its use in the study. In some cases, participants suggested corrections to summaries and they were updated accordingly. The participants' names were not revealed to other participants, though some participants suggested potential interviewees through the snowballing process. All interviews were carried out face-to-face at a time and location of the participant's own choice, usually their main place of business. This meant that participants could feel comfortable with the interview. As interviews were not recorded, detailed notes were taken at the interview and a summary written up soon after and shared with the participant. Building good rapport with the participants leveraged sensitive information and the high-quality data in this study contributed to its reliability.

Of the data collection instruments, interviews were the most significant mechanism through which accounts of interactions with the ID scanner in the night-time economy were collected.

5.4.3   Conduct of observations

Opportunities to observe the ID scanner in use were taken early in the project and were particularly useful in informing the development of the interview questions. The police gatekeeper arranged direct observation. No personal data was collected from observation. The observational data was recorded by noting particular behaviour, activity and interactions with the equipment and reactions of those involved. Data collected through this mechanism was about use and performance of the technology and not individual data. The ID scanners are generally in public places where people pass through an entrance of entertainment premises. Observation was undertaken and notes were recorded in the form of written summaries completed after the event. Observation data was analysed for emergent themes and interpreted in relation to the research questions. Observation proved to be useful to this research as it helped to become more familiar with the application and status of adoption of the ID scanner and using multiple instruments in this way ensured a complete view of the situation was being captured.

5.4.4   Document identification and data capture

A number of official documents and a few newspaper articles informed this study. The selection and collection of these documents began in the very early phases of this study and lasted until the data analysis was completed.

5.5   Data analysis

The analysis in this study aimed to uncover common factors in the situation of technology diffusion and adoption in policing. This meant the data collected needed to be analysed through a method for identifying and categorising data so that similarities and differences were identified and were further explored. Analysis of the data was an iterative process in which induction was used to identify and draw out themes.

5.5.1   Approach to initial analysis

In this research, spray diagrams are a pre-analysis tool used to express and summarise the

research data. Spray diagrams are widely used as a thinking tool. In 1974, Buzan explained a

process for building a spray diagram from an initial idea and using outward facing branches until

the detail at the end of a branch is reached. The diagrams can be used in several different ways

such as: to display as much of the data from the situation as possible; for thinking about a topic

from scratch; for taking notes; and for setting out the elements of an argument.

A simple diagram is shown in Figure 5.4. The diagram shows several associations in relation to

key themes and further branches that can include influences, causes and suggestions.

Figure 5.4: Example of a spray diagram (Source: After The Open University, 2012)
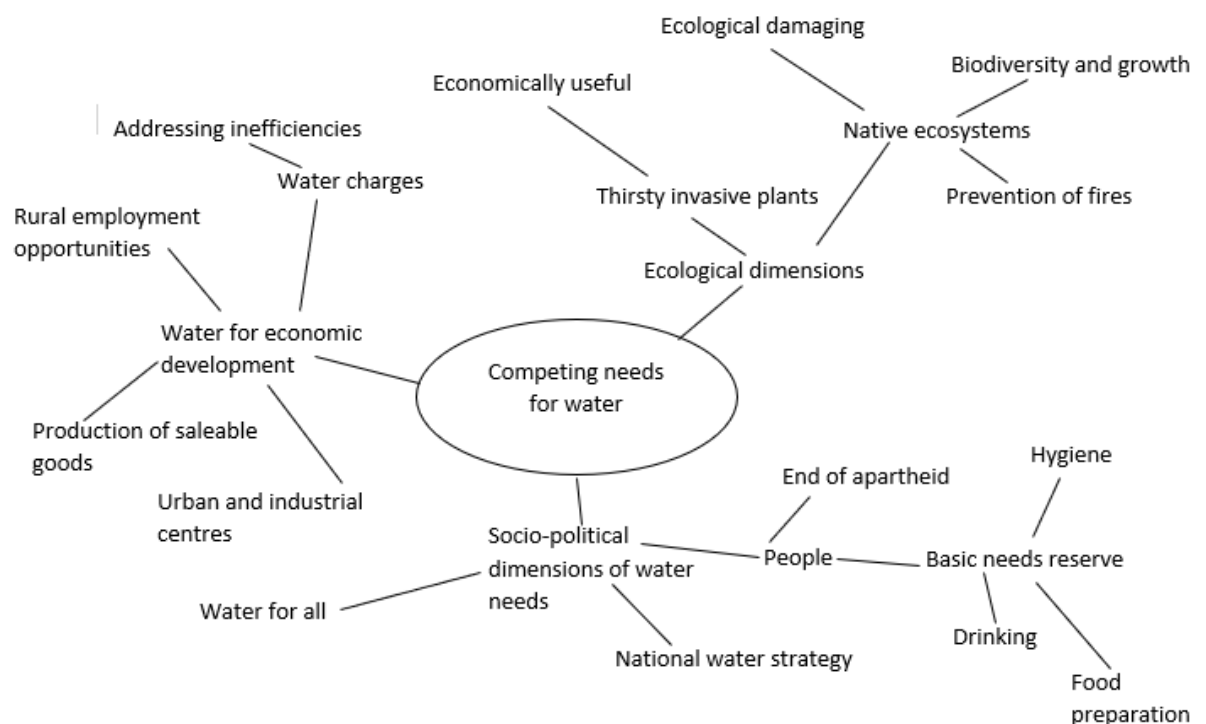
In terms of the analysis, firstly a coding frame and set of themes are derived from the data and

then those codes and themes are used to build spray diagrams for pre-analysis (See Chapter 7).

5.5.2   A framework for further analysis

To be able to assess the extent to which systems thinking can enhance or replace those existing

frameworks/models and to provide a structured report on the findings (from Chapters 7, 8 and 9)

a framework for further analysis was required. The framework would be used to provide a systematic and structured approach on which the outputs of the application of data could be aligned and the findings reflected upon. Reflection on the alignment of findings to this framework would allow the judgement to be made on whether systems thinking did enhance or replace those existing frameworks/models.

As the literature review demonstrated, other studies had been limited by using a set of pre-determined factors and variables. It was very important to design the framework in a flexible way so it did not constrain the data, the analysis or findings. Instead, a framework that allows comparison and discovery of new knowledge and understanding in this context was derived from the research questions.

This further analysis takes place by mapping the findings from the pre-analysis, the application of the three selected diffusion and adoption frameworks/models (Rogers' (2003) Diffusion of Innovations theory; Tornatzky and Fleischer's (1990) Technology Organisation Environment; and the Technology Acceptance Model (Davis, 1986)) and systems thinking to the framework. This process is encouraged by Gioia et al. (2013), referring to Bansal and Corley (2011), not to constrain the data by fitting it only into first and second order conceptualisations but to apply different approaches to retain the benefit and flexibility of qualitative research.

The framework for evaluating the benefits of systems thinking in this context and used in this study is found in Table 5.5.

Stage	Aims	Process	Output of the process	Criteria
1	To ascertain the extent to which each framework/model and systems thinking improved the approach to learning about diffusion and adoption in a multi-agency setting, including consideration.	Review of literature. Application of data to each selected framework/model (three in this research). Application of systems thinking to data.	Report on extent of systemic elements in the existing frameworks/models. Data mapped to the selected frameworks/models using relevant tables and diagrams and a report made. Systems thinking applied to the data and multiple cause diagrams, systems maps and influence diagrams used. The FSM also applied. A report is made.	Ease of application of the four approaches. Commonalities and gaps derived from each of the four applications.

Stage	Aims	Process	Output of the process	Criteria
2	Understand the factors and variables affecting successful diffusion and adoption by demonstrating the ability of each framework/model and systems thinking to identify, consider and understand factors and variables involved.	Application of data to each selected framework/model (three in this research). Application of systems thinking to data.	Relevant diagrams and tables used to examine the extent to which factors and variables can be identified, analysed and understood. A report is made.	Identification of the pre-specified factors and variables from each framework/model (and the extent to which systems thinking was able to address the same factors and variables). Assessment of strengths and weaknesses of each application. Identification of any further factors and variables that may have been found by using systems thinking and understanding gained.
3	Understand the framing of adoption decisions for decision makers in a multi-agency situation.	Application of data to each selected framework/model (three in this research). Application of systems thinking to data.	A series of spray diagrams. Report on the application of existing frameworks/models and the extent to which the adoption decision could be understood. A series of diagrams using systems thinking tools and techniques.	Understanding the framing of the adoption decision for each of the four applications. Extent to which each application considered influences and multi-agency diffusion and adoption and the understanding gained.
4	To identify any insights provided by systems thinking beyond those found by applying the existing frameworks/models.	Application of data to each selected framework/model (three in this research) Application of systems thinking to data.	A series of spray diagrams Report on the application of existing frameworks/models and the extent to which the adoption decision could be understood. A series of diagrams using systems thinking tools and techniques.	Any new insights (beyond those provided by the factors and variables in Stage 2) provided by each of the four applications.

Table 5.5: A framework for further evaluation

The framework covers possible issues and opportunities in discovering the different findings from the analysis and it takes account of the four areas for consideration within the research question: the approach to learning; factors and variables; framing the adoption decision and new insights.

Typically, such a framework might also include steps preceding the data analysis stage. However, this study had already identified and explored its purpose, the research setting and reported on an extensive review of literature.

The next section summarises this chapter.

5.6   Summary of chapter

This chapter started by providing the research questions, the underpinning research philosophy and the rationale for choice of approach. The chapter outlined the case for qualitative research.

A critical description of the data instruments selected and used for collecting and analysing data, including any issues faced, was presented. This study would use multiple data collection instruments including a large number of semi-structured interviews, observations and secondary data and the quality of data capture ensured through skillful recording of data. The research design ensured any risk of bias was reduced through the choice of instruments and the way they were conducted. The widest range of data and multiple perspectives would be collected in a robust and transparent way. Findings would be generalisable and set out against a framework for structuring the findings of analysis. Hence qualitative methods were deemed appropriate and a constructionist ontology but with some element of positivist in its use of factual data was adopted. The underlying epistemology is an interpretive one. Aspects of the research summary are found in Table 5.6.

Research design	Explanation
Aims of the thesis	The aim is to understand if, in the context of multi-agency diffusion and adoption of a technology to enhance policing, do systems thinking techniques enhance or replace existing frameworks and models?
Philosophy	This thesis adopts a constructionist ontology but with some element of positivist in use of factual data. Its epistemology is an interpretive stance.
Research questions	Research question: In the context of multi-agency diffusion and adoption of a technology to enhance policing, can systems thinking techniques enhance, or even replace, existing frameworks and models? Questions covered by the research and that contribute to answering the overall research question: 1. How does systems thinking improve the approach to learning about diffusion and adoption in a multi-agency situation? 2. How does systems thinking improve the recognition and understanding of the factors and variables affecting successful diffusion and adoption in a multi-agency situation? 3. Does systems thinking lead to a better framing of adoption decisions for decision makers within a multi-agency situation? 4. How does the addition of a systems thinking perspective to existing diffusion and adoption frameworks/models improve the ability to describe, explain or even predict the outcome of diffusion and adoption initiatives in multi-agency situations?
Methodology	Exploratory.
Component of analysis	Adoption of an ID Scanner in the night-time economy.

Research design	Explanation
Methods of data collection	Interviews, observation and documents.
Analytical strategy	A qualitative approach, data coding, pre-analysis and use of existing diffusion and adoption frameworks/models and systems thinking.

Table 5.6: Research summary

This methodology and its design maintained a level of flexibility that was practical and suitable for the field of innovation and technology diffusion and adoption. The main consideration in developing this methodology was that it was appropriate to this investigation to establish the factors and variables involved in implementing new technology in the modern police force and applicability of selected diffusion and adoption frameworks/models. The next chapter introduces systems thinking.

Chapter Six: Systems thinking

6.1   Introduction to Chapter 6

In this research, systems thinking is deployed as a way to explore, understand and deal with complex situations by taking a holistic approach. In general terms, complexity can arise in any situation and especially those where large numbers of people with different perspectives, experience and expertise are found and where there are a multitude of factors at play. Often understanding complexity involves challenging interconnectedness. Grasping the nature of the situation can be difficult let alone designing interventions to improve problems. Systems thinking aids the tackling of complex challenges whether it be a small organisational problem or addressing something as large as climate change in a global context. Systems thinking has evolved over many decades and its many notable advocates (Jenkins, 1969; Churchman, 1971; Wilson, 1984; Checkland and Scholes, 1990; Senge, 2006) claim wide success in making sense of complexity. They claim using systems thinking allows deeper understanding and insight than thinking that focuses on separate causes and effects.

This chapter begins by providing a brief history of systems thinking. Next, the notion of systems is examined, followed by descriptions of the main, potentially relevant, systems concepts. Then the types of diagram used in this research are outlined and explained and the processes for using them are set out. Finally, a summary of the chapter is provided.

6.2   Origins of systems thinking

This section looks at the origins of systems thinking. It introduces the main authors who have contributed to systems thinking and looks at their work. Throughout, the emphasis is on those contributions that are most likely to be relevant to this research.

Some writers trace the origins of systems thinking back to the ancient Greeks whilst others root it in the mid-20th Century. What is agreed is that systems thinking has emerged from many different disciplines such as biology, psychology, cybernetics, operations research and

management science. Whilst disciplines such as physics and chemistry provide a valid and fruitful approach for much scientific research, the scientific approach has a number of limitations when applied to many of the complex problems experienced in the real-world. This is because at its most reductionist a scientific approach usually involves breaking down problems into parts to explore the properties of those individual pieces. Interactions between parts can therefore be ignored. Systems thinking, by contrast, deals with the whole as well as the components of a system and takes account of the interactions between those parts.

First, to deal with the early developments, Ludwig Von Bertalanffy, who had a background in biology, was among authors who became aware of the potential to develop a theory for organized complexity. He first presented his idea of a 'General System Theory' (GST) in a seminar at the University of Chicago in 1937 (Laszlo and Krippner, 1998). He proposed that the 'forces' or interactions and relationships between components of a system could not provide a complete explanation of a system if the individual parts were looked at in isolation. Whereas if the collective of components [i.e., the system] was identified and the relationships between them examined, then the properties of a system could be known. In 1950 he identified the need to consider the effect of the environment of a system on a system and wrote about open and closed systems:

> From a physical point of view, the characteristic state of a living organism is that of an open system. A system is closed if no material enters or leaves it; it is open if there is import and export and, therefore, change of the components. Living systems are open systems, maintaining themselves in exchange of materials with [its] environment, and in continuous building up and breaking down of their components.
>
> (Von Bertalanffy, 1950, p. 23)

As his ideas developed, he became aware of the wider opportunities for his work to be used in other disciplines. He went on to describe essential details of the GST theory as follows:

> (1) There is a general tendency toward integration in the various sciences, natural and social.

(2) Such integration seems to be centered in a general theory of systems.

(3) Such theory may be an important means for aiming at exact theory in the nonphysical fields of science.

(4) Developing unifying principles running "vertically" through the universe of the individual sciences, this theory brings us nearer the goal of the unity of science.

(5) This can lead to a much-needed integration in scientific education.

(Von Bertalanffy, 1968, p. 40)

This trend towards integration meant that there was value in applying systems thinking to other disciplines. Some of that value was obtained from the emphasis on looking at the whole. Von Bertalanffy stated:

General systems theory, then, consists of the scientific exploration of "wholes" and "wholeness" which, not so long ago, were considered to be metaphysical notions transcending the boundaries of science. Novel concepts, methods, and mathematical fields have developed to deal with them. At the same time, the interdisciplinary nature of concepts, models, and principles applying to "systems" provides a possible approach to the unification of science.

(Von Bertalanffy, 1972, p. 415)

Following Von Bertalanffy's early work, the body of academic literature relating to systems thinking began to increase. There was a growing appreciation that the interaction between the individual parts of a system was important and the need to understand the topics of control and regulation when considering a system also became more widely appreciated. The concept of feedback was already commonly used in engineering where control devices were often incorporated into the design of machines but the notion of information being fed back into a system and future performance being modified as a consequence was used to a much lesser extent. Von Bertalanffy, amongst other authors, worked increasingly with his academic peer group. Also in Bertalanffy's paper in 1972, he referred to fields in modern engineering including that by Wiener and the study of 'communication and control' for techniques for handling

'systems' where technology and society had become complex and further approaches to systems were required.

Cybernetics, the name given to 'the scientific study of control and communication in the animal and the machine' (Wiener, 1948), pre-dated Von Bertalanffy's work. The early developments in computer technology combined with the realisation that feedback and control mechanisms were intertwined in systems, led to further progress in the field of cybernetics:

> Cybernetics as a specific field grew out of a series of interdisciplinary meetings held from 1944 to 1953 that brought together a number of noted postwar intellectuals, including Wiener, John von Neumann, Warren McCulloch, Claude Shannon, Heinz von Foerster, W. Ross Ashby, Gregory Bateson, and Margaret Mead. Hosted by the Josiah Macy Jr. Foundation, these became known as the Macy Conferences on Cybernetics.

(Heylighen and Joslyn, 2001, p. 156)

These same thinkers helped broaden the application beyond control and communication in engineering to social situations. The Macy Conferences became a well-regarded forum that contributed to the developing field of cybernetics. Further development came when the combination of cybernetics with the original ideas of GST led to the application of systems theories to a wider range of academic fields. One example is the work of Mead, an internationally renowned and well-respected cultural anthropologist. Mead was actively involved in the founding of the Society for General Systems Research in 1954, alongside Von Bertalanffy and others involved in the Macy conferences. As Mead became interested in cybernetics and GST, she recognised more and more connections with the world of social sciences. Mead wrote that '…few anthropologists have used the families of models that come from information and communication theory' (Mead, 1961, p. 479) when referring to a failure to make cross-disciplinary relationships. Another notable author combining cybernetics and GST into his academic work is Stafford Beer. With roots in Operational Research in the steel industry, Beer is credited with applying cybernetic principles to the management of large organisations and being a significant contributor to the

systems movement through creation of management cybernetics. One example of his practice was work done for the Chilean government where he developed a 'plan for the cybernetic regulation of the social economy of Chile' (Beer, 1981, p. 248). The plan would feature regulation of the social economy and support decision making in a different way that Chile had experienced under influence from the Soviet Union. Drawing on that work in Chile, Beer went on to develop the well-known Viable Systems Model (VSM) (Beer, 1984) and expanded the work to design a model for the whole Chilean industry economy. [Though political instability from 1973 drew a close to Beer's work in Chile]. Viable systems are recursive, i.e., each viable system can be considered to contain a hierarchy of viable systems that perform different functions. In broad terms, some systems are concerned with the 'here and now' of the organisation's operations whereas others deal with external, environmental and future demands and the balancing of the two.

Another relevant academic discipline is Operational Research (OR). OR is concerned with identifying a problem and using data to model a situation and possible solutions to its problems or improvements to its performance. Borne out of developments to radar systems, the term OR was pioneered in World War II when scientific research was used alongside military operations to improve air and land defences. Use of radar had revealed problems with fighter direction and control and the need to improve control room and communication systems. The evaluation of more general problems increased and OR, or operations research as it is known in the U.S., began to spread after the war because of a demand for greater productivity and because of technological innovation (McCloskey, 1987). Churchman, one of the notable authors who contributed to the development of this field, is known to have worked with organisations such as NASA and other U.S. government departments to improve their systems and together with Arnoff and Ackoff, other prominent practitioners and writers on systems, produced the very influential textbook 'An introduction to Operations Research' (Churchman et al., 1957).

Systems Dynamics (SD) had also been developing from the 1950s. Attributed to Jay W. Forrester, SD is an approach that aims to understand and model the complexity of a situation by analysing

feedback loops over a period of time and identifying behaviours/dynamics that could affect the behaviour of a system (Forrester, 1971). At the company General Electric, Forrester observed fluctuations in sales, inventory and number of employees and used modelling to identify feedback loops arising from delays between different departments. He analysed the effect of time delays, amplification and structure on the dynamics of the system (Forrester, 1961). As a consequence, his work brought a theory of feedback control to systems thinking. A later example of the continued use of SD in the field of management is Senge and Sterman's (1992) development of a modified version of the model that includes a series of interlocking feedback loops in order to make it more readily applicable to organisational learning and change.

Over time, systems thinking became known as a discipline in its own right and advocates began to develop methodologies for applying it. Some of these were especially designed for engineering applications such as the design and running of production lines and control rooms. In the UK, (Jenkins, 1969) developed a systems engineering approach for broad use. Its four stages were:

1. *Systems analysis*. Systems engineering starts with a common-sense analysis of what is going on, and why, and whether it might be done better. Then the system and its objectives have to be defined and the data gathered about its likely performance.

2. *Systems design (or systems synthesis).* First, the future environment of the system has to be *forecast*. Then a quantitative *model* has to be built and used to *simulate* or explore a number of different ways of operating the system, finally choosing the system or systems which are in some sense 'best', thus operating the system.

3. *Implementation.* The results of the system study must be presented and approval sought for their implementation. The optimized system will then have to be built, that is suitable hardware and/or software constructed. The project will require careful planning at this stage to ensure that the full benefits of the system approach are realized. After construction, the system will need to be checked for performance, reliability, etc.

4. *Operation.* A point will be reached when the system will need to be handed over to those or will have to operate the system on a routine basis. This is where great care is needed

to avoid misunderstanding and inefficiency and probably represents *the area which is least well done in any project.* Finally the effectiveness of the operational system will need to be assessed, and if unsatisfactory, the system 'tuned' or reoptimized, to operate in an environment which may turn out to be different from that which it was designed.

(Jenkins, 1969)

According to Jenkins, the many advantages of the systems engineering approach include that it:

- Provided an alternative to a piecemeal method by providing an overall approach.

- Dealt with complexity and reduced costs associated with costly errors in decision making.

- Made efficient use of resources by designing complex systems where sub-systems were designed, fitted together, were checked and operated to achieve the overall objective.

- Exerted a unifying influence on management by tying together the many specialist techniques needed to solve complex problems.

- Took an overall view by using a systems engineer, as a generalist, to ensure that the system objectives are correct, are communicated to all concerned so the objectives are achieved with maximum efficiency.

(After Jenkins, 1969)

Typically, application of the approach brought together a generalist, a systems engineer to lead the process and individuals representing a range of specialisms, including users of the system. An example provided by Jenkins is that of an oil refinery. 'Large oil companies operate huge refineries where plant units are strung together in series and in parallel so that the performance of any one affects the efficiency of the whole.' (Jenkins, 1969). Jenkins claims that several success stories had been observed where plants designed using the approach had benefitted from cost reduction and increased profitability and efficiency.

Stemming from Systems Engineering approaches in engineering settings facing human and organisational issues, systems methodologies increasingly tried to address organisational change. Initially, the term hard systems methodology was used for engineering type situations and a methodology was developed for what became known as the Soft Systems Methodology (SSM)

(Checkland, 1972; Checkland, 1981; Checkland and Scholes, 1990; and Checkland, 2000). The SSM is an approach for tackling complex and messy situations. Through a defined process of inquiry, a complex problem situation is looked at initially in an unstructured way and through further process steps, modelling is used to identify feasible and desirable changes to be made before action is then taken to implement change. The early stages of SSM suggest the use of tools such as rich pictures to aid systemic thinking.

Analysis-orientated methods have continued to develop. One of these seeks to understand how and why failures occur and how failure can be anticipated and prevented. The Systems Failures Method (SFM) (Peters and Fortune, 1992) uses a process of comparison where 'the situation is expressed in systems terms and compared with a conceptual model of a robust system that is capable of purposeful activity without failure'. This model, shown in Figure 6.1, is known as the Formal System Model (FSM) (Bignell and Fortune, 1984).

Figure 6.1: The Formal System Model (Source: Bignell and Fortune, 1984)
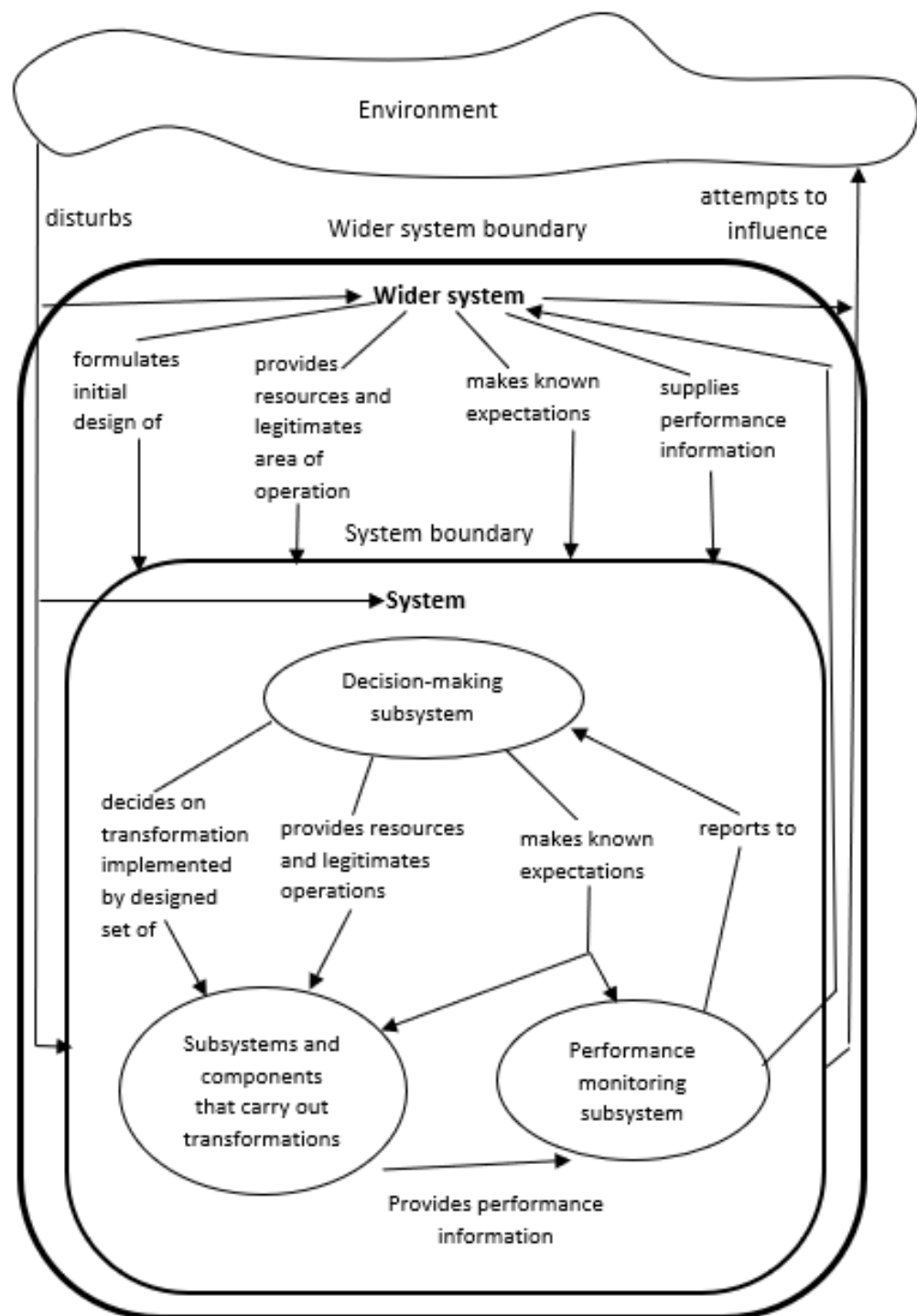
The FSM has a decision-making subsystem which decides on the transformations a system needs

to make and designs a set of subsystems and components to carry out those transformations.

The decision-making system must also provide the necessary resources required to carry out the

transformations. Additionally, there is a performance monitoring subsystem providing feedback

into decision making and the wider system. Finally, the system and wider system interact with

the environment. The environment disturbs both the system and the wider system, and the

system and wider system attempt to influence the environment (Fortune, 1993). The FSM offers

a way to clarify, investigate and deal with complex problems that are often neglected because

investigations are limited to individual processes. One more recent example of its application can

be found in the project-specific Formal System Model by White and Fortune (2009).

Despite the rich history, the language of systems thinking requires some explanation.

6.3   The language of systems thinking

The definition of the term 'system' as used in this study comprises four parts:

1. A system as an assembly of components, connected together in an organised way.

2. The components are affected by being in the system and the behaviour of the system is

    changed if they leave it.

3. The organised assembly of components does something.

4. The assembly has been identified as of particular interest.

(Bignell and Fortune, 1984, p. 154)

The notion of a system has a number of concepts associated with it. The next section provides

explanations of the key concepts relevant to this study: holism; worldview; boundary;

environment; subsystems; hierarchy; emergence; control; monitoring and performance; feedback

and communication.

6.4   Systems concepts

Some systems concepts such as system itself and control and feedback have already been

introduced in this chapter but other concepts are equally as important. Those concepts relevant

to this research are explained in this section.

Ensuring relevant features of a situation have been considered and all the likely angles of a

situation are covered requires taking a thoughtful overview of a situation. This view of the whole

is referred to as holism (Fortune and Peters, 2005). Ackoff (1995) refers to frequent failures in

management and suggests a common reason for failure is the 'failure to 'whole' the parts'.

He goes on to say, 'By 'whole-ing' I mean manipulating parts of a whole with primary focus on its effect on performance of the whole, not the parts involved.' (p. 43). A concept that needs to be taken into account alongside holism is *worldview* (taken from the German word 'weltanschauung') which is the distinct view, perspective or position a person may have. Variations in worldview mean that one person's view of a system may look different from that of another or that the system could be seen to be organised or behave in another way. The concept can help to explain differences in assumptions of stakeholders in a situation and can account for conflict of objectives or provide reasons for a particular agreement or decision being made.

As can be seen from Figure 6.1, a boundary delineates the components that are regarded as being part of the system and separates them from those that lie in the environment of the system. There is a very important distinction between the environment of a system and the environment in general which makes up the surrounding of the lived-in world – the materials, the living organisms and the concern there is today for protecting and improving the environment. In systems terms, the environment are the features of a system that sit outside the main systems boundary and those that can affect the system or be affected by it, not necessarily everything that exists outside of the system. If analysing a system for reducing the carbon footprint at work, main parts of what is also described as the environment can be found within the system. Fortune and Peters (2005) say:

> …whether some component is judged to be part of the environment is determined by whether or not it influences or is influenced by the system that has been perceived. …but while the environment can be influenced by the system it cannot be controlled by the system.

(Fortune and Peters, 2005, p. 51)

A system is likely to have a set of *subsystems* within it. Because of the *hierarchical* nature of a system and its subsystems, the concept of *emergence* is also relevant. Emergence occurs when the system or subsystem is observed to have properties which are not possessed by constituent

components and subsystems and only come into being when the parts interact. Checkland (1988)

describes emergence and gives an example:

> …properties which are properties of the whole and are meaningful only at the level of the
>
> whole. (The vehicular properties of a bicycle are emergent properties of a particular
>
> whole entity structured in a certain way; the braking system would be a sub whole within
>
> it, also possessing its emergent properties).

(Checkland, 1988, p. 243)

Emergent properties are the consequence of the connectivity and interrelationships or behaviours

within the system and are sometimes unpredictable. They can thus be intentional or

unintentional and desirable or undesirable. As Checkland (1999, p. 50) says, they are the

properties that make the whole entity 'more than the sum of its parts'.

Young (1964) identified a set of systems concepts and organised them into a useful set of

categories. Ackoff (1971) used this categorisation to form a 'system of systems concepts'

comprised of 32 concepts. The concepts that will feature in this work are mapped onto the

categories in the format used by Fortune and Peters (2005) in Figure 6.2. Although structural and

process concepts are shown in their own subsystems in the diagram, the overall boundary

indicates that all are required within a system for it to work successfully.

Figure 6.2: Systems concepts (Source: After Fortune and Peters, 2005, p. 58)

Structural Concepts

Structural features:

Boundary

Environment

Component

Connectivity

Subsystem

Hierarchy

Interrelationships

Dimensions:

Open - Closed

Hard - Soft

Process Concepts

Dynamics and change:

Adaptation

Regulation and maintenance:

Emergence

Feedback

Decline and breakdown:

Communication
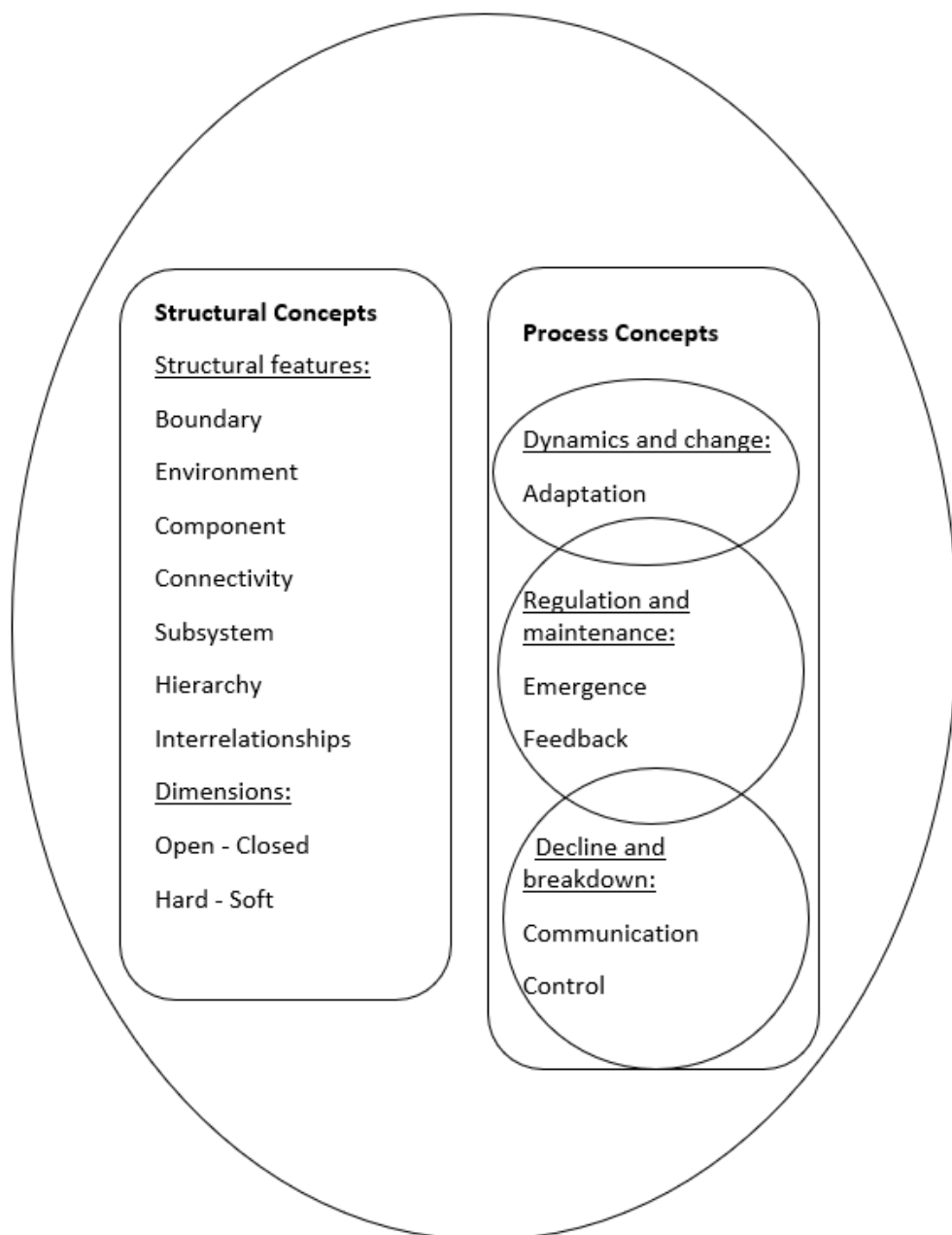
Control

Control is '…an action that a system or subsystem applies to its own activities in order to reach or maintain a desired state.' (Fortune and Peters, 2005, p. 61). Fortune and Peters go on to explain that the need for control is brought about by the environment influencing the activities a system carries out or by the complexity of the subsystems which cause variation and control is therefore achieved by modifying or adapting inputs or activities. Other concepts such as *monitoring* and *performance* and *feedback* are actions that a system or subsystem applies in order to reach or maintain a desired state.

Figure 6.2 also includes the concept of *communication*. Communication is vital in most situations especially those involving people. Several lines of communication may be at play and understanding the information processes and flows within a system and between the system and its environment is very important (Fortune and Peters, 2005).

In addition to the concepts required to understand systems thinking, diagrams are used to represent, analyse and model a situation. The next section introduces the diagrams used in this research.

6.5   Representing systems of interest through diagramming

Diagrams are visual representations used in systems thinking to help to learn about, understand and explore situations. They form part of a set of tools for thought and can be used to test thinking and assist communication about a situation of interest. Developing and using diagrams can reveal new insight about a situation being considered. Diagramming can be used in a variety of situations including:

1. When there has not yet been an identification of a system of interest within a complex situation and diagrams can be used to make sense of it.

2. When a situation of interest is being represented and diagrams are used with specific boundaries.

3. When a structure or process within a particular system of interest is being analysed in-depth.

<div align="right">(After Lane et al., 2000, p. 29)</div>

Developing diagrams often takes several attempts and the new insights and thoughts generated can then lead to further iteration and then redrawing (after Lane et al., 2000, p. 33).

Diagramming can benefit from participation by combining perspectives, thoughts and experiences of some or all of the participants in a complex situation (after Lane et al., 2000).

6.5.1   Spray diagrams

Spray diagrams are frequently used in conjunction with systems thinking to organise data and thus probe more deeply into the situation of interest. Using spray diagrams is the first step in defining and understanding a situation and identifying systems that might be worth considering. As explained in the methodology (Chapter 5), spray diagrams can be used in several different ways such as: to display as much of the data from the situation as possible; for thinking about a topic from scratch; for taking notes; and for setting out the elements of an argument. In this research, spray diagrams are a pre-analysis tool to express and summarise the research data. (See Chapter 7).

The other types of diagram that will be used in this thesis are: multiple cause diagrams; systems maps and influence diagrams. The explanations are important as conventions for diagrams sometimes have different interpretations and those found in this chapter are based on rules and guidelines set out in well-known literature (See Fortune and Peters, 1995; Lane et al., 2000; Lane, 2002; Fortune and Peters, 2005; Lane, 2013). Each of the types of diagrams used in this thesis will now be looked at in turn.

6.5.2   Multiple cause diagrams

Multiple cause diagrams are used to explore why changes or events happen (or not!) and look at interconnectedness in a complex situation. Unlike influence diagrams they do not use systems maps as their starting point but instead they start with the factor or event of interest and are worked backwards to explain what contributed to that point (the cause or effect). These points can be read in sequence. The diagrams are used to reveal and explore the interconnectedness between causes and effects and to generate a greater understanding of contributing factors. Where common patterns of cause and effect can be identified, this form of diagram has been a powerful source of insight for authors such as Senge et al. (1992). Senge reported on a systems investigation into a crisis of increasing cost and escalating insurance premiums in the U.S. insurance liability industry in the early 1980s. By capturing important dynamics and analysing

cause and effect, several implications were revealed by the modelling and positive interventions were developed. This type of diagram can be seen in Figure 6.3.

Figure 6.3: The format of a multiple cause diagram: user dissatisfaction with CUFS (Source: Fortune and Peters, 2005, p. 103)
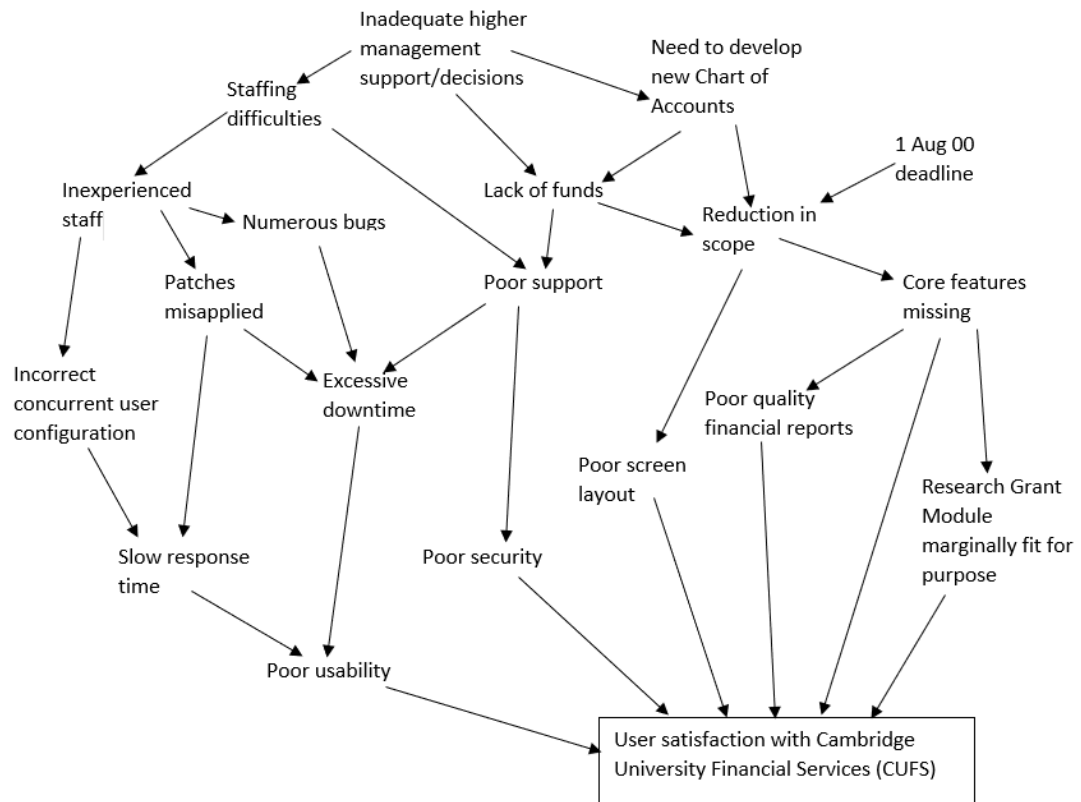
Figure 6.3 relates to an information system implementation project. The influence diagram would have provided opportunity to explore the causes of user dissatisfaction (its main topic). The arrows do not have to indicate cause but can also be 'leads to' or 'enables' or another related term. The interactions or relationships between components and the nature of those connections command awareness of the situation as unintended consequences of feedback and control applied in a system are often overlooked. Significant understanding of a situation can be gained where cause and effect appear to be linked by a loop, a *causal feedback loop*.

Systems dynamics models (described earlier) often focused on causal relationships and mutual influence (Black, 2013) and therefore relied heavily on feedback loops. Figure 6.4 shows a simple example drawn close to the onset of the Coronavirus pandemic in 2020.

Figure 6.4: The format of a feedback loop: shortages during the onset of the Coronavirus pandemic in 2020
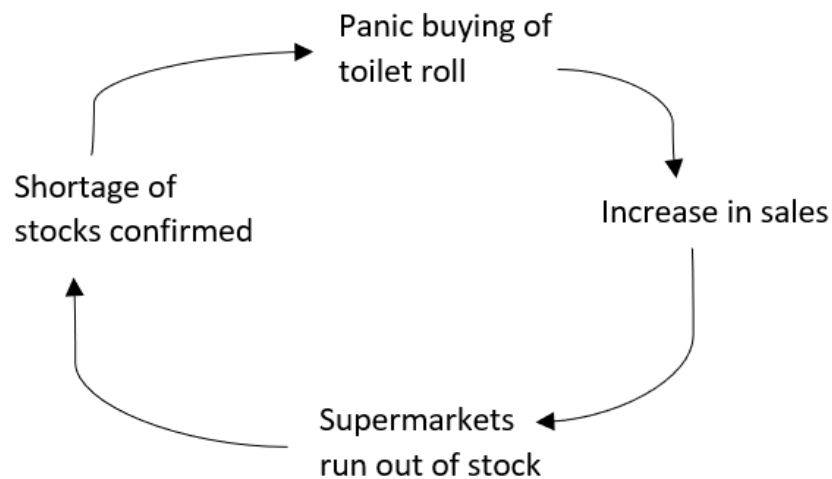
As the rumour of a toilet roll shortage in the UK began to happen, sales increased and stocks in supermarkets began to run out of stock. When the rumour was confirmed it became even more widely communicated resulting in even more people attempting to buy toilet rolls and all shelves became empty (Jones, 2020). Graphically portraying loops such as this example are a well-known way of exploring why something went wrong or something keeps occurring. The illustrations, usually originating within a multiple cause diagram, can be extremely helpful when investigating systems. Although taken individually feedback loops may appear simple but within a situation there are often several different feedback loops that result in conflicting changes or too much compensation overall. Detailed analysis of feedback loops can reveal several different or even interlocking loops.

As part of a review of the ideas and history in diagramming methods used in systems dynamics Lane (2008) examined the advantages and limitations of causal loop diagrams. At a broad level, loops can reveal continuous increase or decrease in activity or even provide examples when a stable state is encountered. Lane suggested the benefits of this type of diagram include: they are relatively simple to explain and for practitioners to use and understand; they work well with groups so that ideas can be considered in-depth and challenged; and their location within the bigger picture can be understood clearly (after Lane, 2008, p. 12). However, he also pointed out there were limitations to consider: they lack precision and detail; they do not reflect fully

influences over elements; and there is a risk that polarity errors can exist where the labelling becomes confused between positive and negative. Although it can be helpful to explore feedback loops, Black (2013) suggests they may not provide understanding of a complete situation.

6.5.3 Systems maps

Systems maps show structures of a system in terms of components, boundary and components of environment. The maps are normally used to represent an existing situation as a snapshot of the system and its environment at a particular point in time. Building a systems map can be a precursor to developing models such as the FSM in Figure 6.1, after which comparisons can be made. Systems maps are especially important as tools for thinking and for communication and, as Checkland and Poulter (2006) point out, they can help to structure an argument or debate.

Systems maps have a very simple form as shown in Figure 6.5. The darker line denotes the boundary that separates the system from its environment.

Figure 6.5: The format of a systems map
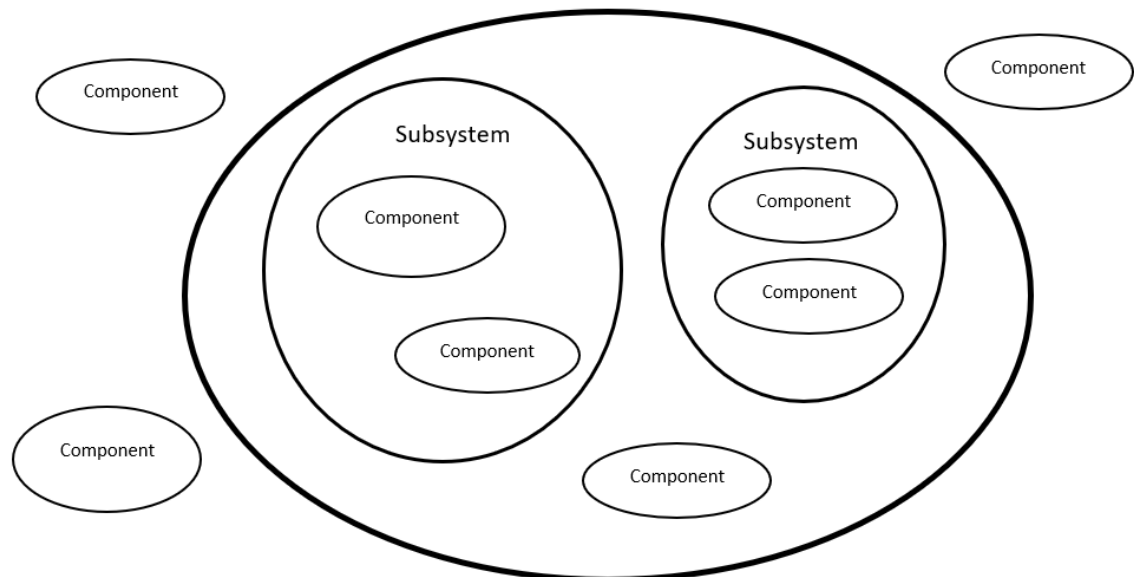
However, it is the process of identifying and defining a system that can reveal profound insight into a situation. The process of developing a map and often maps at different levels can result in new learning and insights and understanding can be gained. Often this is very effective when a group of people come together to draw maps. Subsystems may be considered as systems in their own right and explored with their own maps or as part of the wider system. It is usual practice to

experiment with different boundary lines to assist discussions and decisions about what level of analysis should be undertaken. As Chapman (2004) suggests, boundaries in systems diagrams convey much more than traditional or hierarchical organisational boundaries and therefore provide more insightful analysis and interpretation of the situation.

The positioning of components inside the boundary can be grouped as subsystems forming a hierarchy. Although there are no fast rules about how to position these subsystems, it makes sense to group important components close together and this will help to identify if there are common components that can make up a subsystem.

An example of a systems map of command and control is shown in Figure 6.6. A series of urban riots on the UK mainland in the 1980s led to the introduction of a three-tier command and control structure known as Gold, Silver, Bronze (GSB) by the London Metropolitan Police Service (Pearce and Fortune, 1995). This particular form of command and control was rolled out and used by other UK police forces. The GSB is clearly seen enclosed within the main systems boundary and is separated from the seven components in the environment.

Figure 6.6: A systems map of 'command and control system' (Source: Pearce and Fortune, 1995)
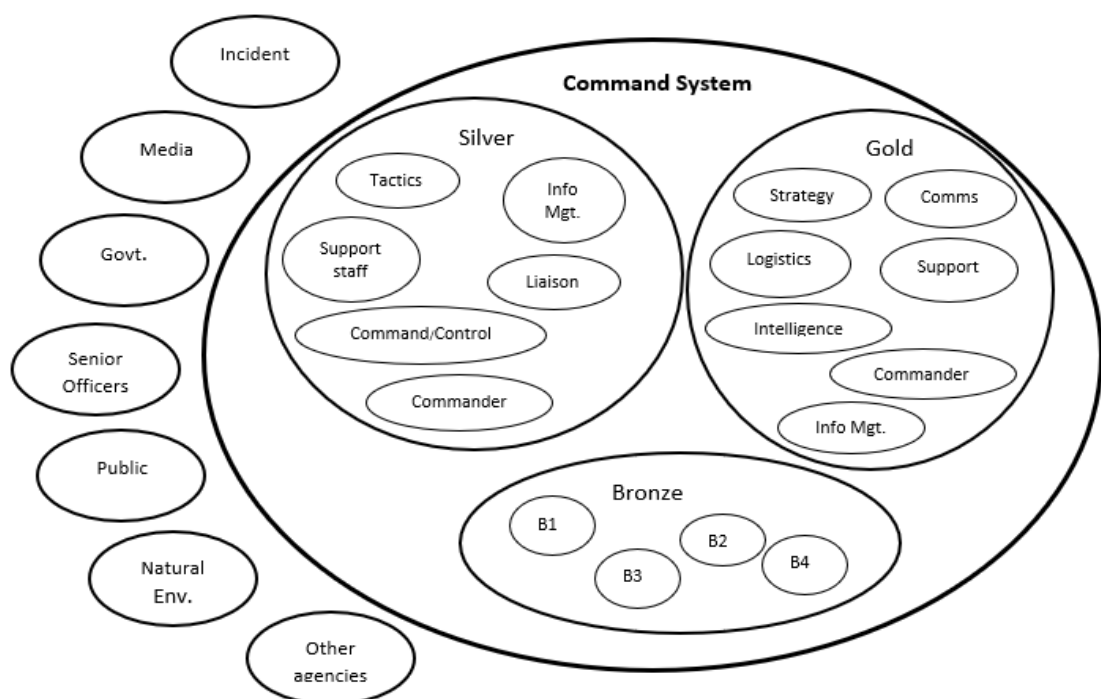
Where relationships are thought to be extremely complex, a sophisticated analysis such as the use of systems maps may be required to delve deeper into a situation and to analyse its components. It is the positioning of the components that make up a system that provides some information about relationships that may exist and can give a sense of the relative strength of relationships. Reflecting on the diagram may lead to lead to redefinition of a system if the boundary is amended or by changing the grouping of its components.

Modelling a situation to find out more about the complex relationships, hierarchy and interconnections in a system frequently requires further tools to be deployed. Another tool is influence diagrams which are introduced in the next section.

6.5.4   Influence diagrams

Influence diagrams are also a snapshot of a situation. They build upon a systems map to explore the important influences that are at work between components within a system and between components in the system and the environment. The influences are denoted by arrows. The arrows show the direction of influence and the strength of influence can be shown by the thickness of the lines or by using different types of line and arrow. An influence diagram of the development of the Humber Bridge and its construction system is shown in Figure 6.7.

Figure 6.7: An influence diagram of a construction system (Source: After Stewart and Fortune, 1995)
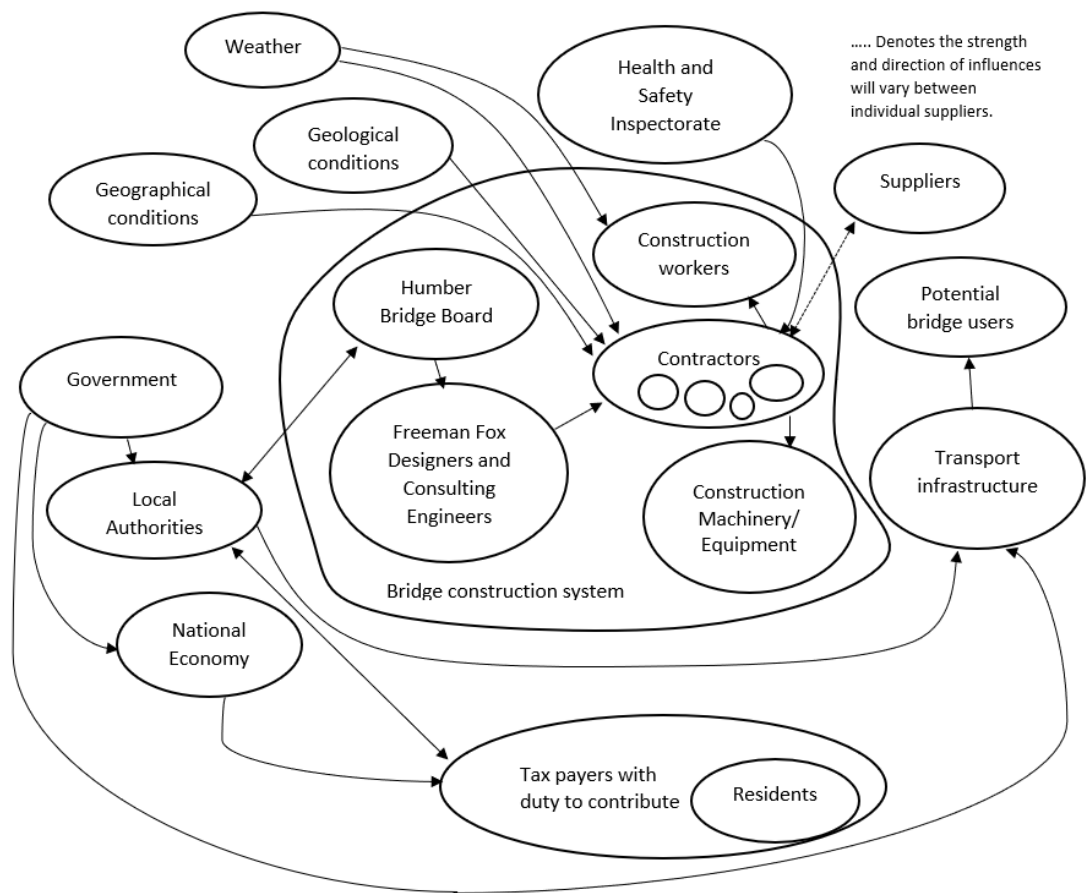
The diagram may be used to look at critical relationships between components such as between the government and the local authorities or by gaining a greater understanding of risk by modelling the situation and examining the decisions to be made, the activities that will be undertaken and the ways in which they would be controlled (Stewart and Fortune, 1995). Still, it is the process of developing the influence diagram that must not be overlooked.

The diagramming process can be as important as it was for developing a systems map. It is often the case that the diagram can be used to reveal several different variations in positioning of its components and the strength of influences may be varied. The influences are often analysed through several iterations of a diagram and different versions can be used to show different aspects of the system. These iterations may even lead to revisions to the groupings within the system or redefinition of the system. Some influences may be outside of traditional or expected hierarchies and may not have been identified if it had not been for a systems thinking approach.

The diagram can also be used to reveal aspects of the system that require investigation which may involve using another tool, multiple cause diagrams, to gain more understanding.

6.5.5   The process of using systems diagrams in this research

A process that sequences the different types of diagrams used in this research is shown in Figure 6.8.

Figure 6.8: The process of using systems diagrams in this research
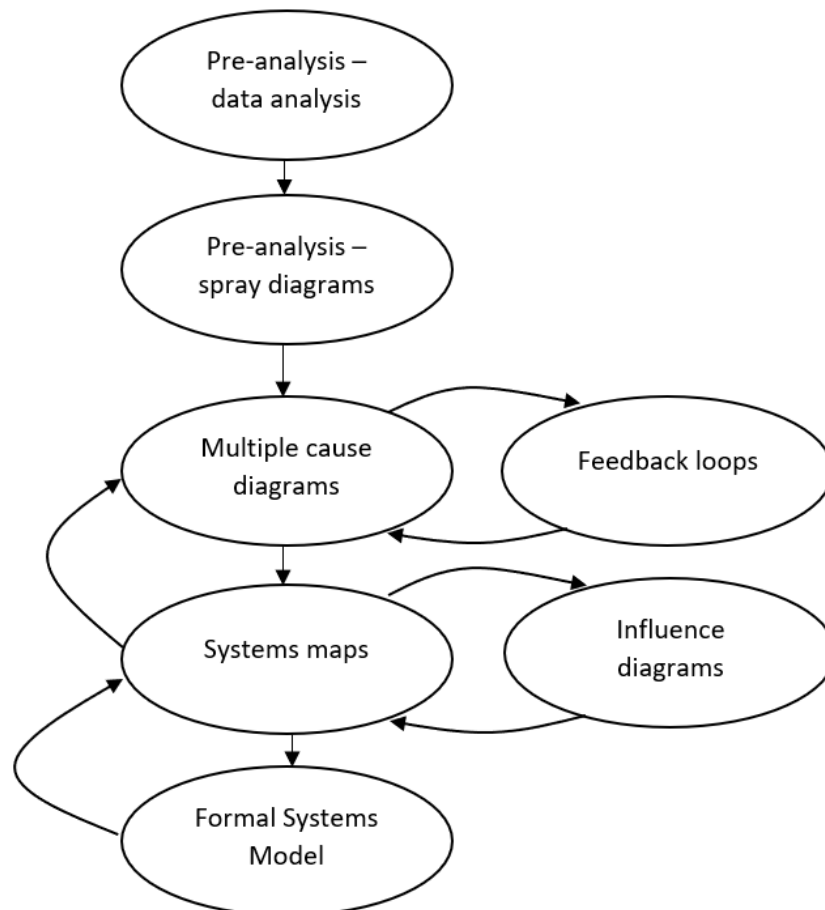
An important aim of the process shown in Figure 6.8 was to use a variety of techniques to analyse and depict the situation to improve understanding and ultimately contribute to answering the overall research question in this study. The initial steps will be carried out in two phases: first, through data analysis (See Chapter 5) to organise and categorise the data; and secondly, analysis using spray diagrams (See Chapter 7). The spray diagrams will be used to organise the themes, to probe deeply into the data, including examining interconnectedness to learn more about the situation and to identify areas of interest for further examination. Further investigation in turn allows a focus on developing multiple cause diagrams and any feedback loops present within

them to be explored. The multiple cause diagrams will then be used to generate more understanding of the factors contributing to diffusion and adoption of the ID scanner and how they are related. Next in the process, systems maps and influence diagrams will be used. These two types of diagrams examine structure and relationships between components. The next step will be to use the Formal System Model (FSM) to conceptualise the situation, gain further understanding and for making a comparison to the developed FSM. The results of the comparison should provide insight and further understanding of the situation. Importantly, iteration will be used throughout this process so that reflection and adaptation, where required, can be applied. The arrows in Figure 6.8 show the intended flow of review and reflection. Iteration allows for further examination and refinement as the developed diagrams may shed light on new aspects that then require further investigation. The diagrams presented in this thesis will have been iterated and expanded as new insights and grouping of elements were made. They will have been developed with a level of clarity and level of detail appropriate for communicating the ideas to be conveyed. Together, this process results in a variety of systems diagrams and an in-depth examination of the situation leading to new knowledge and understanding.

6.6   Summary of chapter

This chapter has explained the important and successful nature of systems thinking as a field. A field that has broad application in many disciplines and one which has a rich history and academic background shown to give understanding and insight into very complex situations. The chapter has provided a summary of some key developments which contributed to the modern field of systems thinking. The influences on contemporary systems thinking were introduced and the General Systems Theory explained as a major early originator. The field of Cybernetics followed and after came Operations Research and Systems Dynamics that were founded with impacts from the fields of science and engineering. More recently, the Formal System Model was developed. This detailing of the history is not comprehensive, but it does demonstrate the complexity of the many influences on contemporary approaches to systems thinking. Indeed, as global issues such as environmental and organisational problems require improvement, systems thinking is a highly

valuable approach to use. The chapter then introduced the language of systems thinking and provided definitions of a system and of the concepts used in systems thinking. Diagramming tools that facilitate systemic analysis, thought and understanding of intricate relationships involved in complex situations were described. The diagrams intended for use in this research are multiple cause diagrams, systems maps and influence diagrams and the process by which they will be used was shown in Figure 6.8. In the next chapter, pre-analysis of the research data is presented.

Chapter Seven: Pre-analysis

7.1   Introduction to Chapter 7

The approach to this research was set out in the methodology (Chapter 5) and the background to

systems thinking and the tools and techniques for use in this research were set out in Chapter 6.

This chapter presents the pre-analysis. The term pre-analysis is adopted here to mean an initial

analysis of data gained from the empirical research. Pre-analysis is necessary to explore the

research data and identify areas of interest for further examination. First, the chapter reports on

the results of data analysis. The codes and themes abstracted from the data are summarised.

Then, as outlined in Figure 6.8, spray diagrams are utilised to elicit relationships, and explore

different viewpoints and perspectives, and subsequently identify and capture key themes. Finally,

areas of interest for further examination are identified and a summary of the chapter is provided.

7.2   Data analysis

Data was collected from different sites. The Thames Valley area provided the main focus for

fieldwork and other locations were used primarily to validate those findings and explore potential

differences as well as maintaining a broad view of practise more generally.

A total of five formal observations in the main geographical area and forty-eight interviews were

conducted with forty-four participants (See Table 7.1).

	Main geographical area	Other area	Other national body	Total
Police	7	8	0	**15**
Local authority	6	0	0	**6**
Premises	6	1	3	**10**
Door supervisors	2	0	0	**2**
Other related agencies	2	1	7	**10**
Supplier	n/a	n/a	1	**1**
Total	**23**	**10**	**11**	**44**

Table 7.1: Summary of participants

In terms of timing, an hour was reserved for each interview; some were slightly shorter at around

45 minutes whilst others lasted longer. There were no instances of an interview being cut short

due to participant's other engagements. Interviews were carried out fully. Some participants were interviewed twice in order to update on progress throughout the data collection period. A single interview would only have given an indication of the project at that time and, in some instances, views on development of the adoption would have potentially been lost. This approach also helped with rapport building and ensuring that good quality data was being captured. The semi-structured approach to interviews gave every participant an equal opportunity to elaborate on the adoption of the ID scanner and on other dimensions of what happened surrounding its take up (or not). The participants' reflected on different aspects that encouraged or inhibited the adoption of the ID scanner and provided their perspective. Contact was maintained with the police and with other participants throughout the research study in order to monitor developments and changing perceptions. In this research, a considerable amount of data was collected and the number of participants was deemed sufficient for this substantial sized study.

In addition to interviews, observational data was collected on the use and interactions with the technology. It was interesting to view differences in practice surrounding the use of the ID scanner including how and when it was accessed and whether any resultant disturbance to work patterns were seen as beneficial or not.

To begin with, the analysis involved searching the interview summaries for common and emerging topics. This was done manually by looking for and coding recurring words and topics so that commonalities and differences could be identified. This first order analysis of interview content produced a set of codes which were then used to delve more deeply and create a second order set of major categories.

The codes, set against the major categories, are summarised in the initial data structure found in Table 7.2. Examples of the interview data mapped across to these codes is found in Appendix E.

Major category	Associated codes
Environment/ context	Alcohol use and social factors, case by case review, city accreditations, client welfare, communication with partners, competition, cost, crime displacement, enforcement, reduction, prevention and statistics, drug and violent crime, ease of use, evidence base, governance, hearing about the ID scanner, job requirements (training on ID scanners), licence management, maintenance, make up of population (students, visitors etc.), police influence on stakeholders, police resourcing, practicalities, preloading, privacy and client data concerns, professionalism of security staff, queues, relationship building, reporting, revenue generation, risks to using the scanner.
Collaboration	Communication with partners, police influence on stakeholders, relationship building, voluntary or forced use.
Business impact	Alcohol use and social factors, crime displacement, enforcement, reduction, prevention and statistics, drug and violent crime, make up of population (students, visitors etc.), pre-loading.
Cost	Cost, crime reduction and prevention, ease of use, maintenance, police resourcing, practicalities, privacy and client data concerns, technical issues, capability and supply.
Use	Ease of use, experience, job requirements, maintenance, privacy - client data concerns, professionalism of security staff, reporting, technical issues, technology capability.
Governance	Case by case review, evidence base, licence management, strategy and objectives.

Table 7.2: Summary of initial data structure

The most dominant category most frequently referred to, and that was emphasised by many participants, was the environment/context. However, as Table 7.2 indicates, five other categories referring to the situation were also elaborated upon. One of these subcategories is collaboration. These categories would be very relevant to the multi-agency aspect to diffusion and adoption.

Because many of the codes were linked in different ways to other major categories, it was important and appropriate to capture the linkages. Those codes and categories were taken and a set of major themes was developed from them. A matrix of themes against the categories and codes showing where they were also applicable is found in Table 7.3.

Code	Category	THEME					
		Adoption decision	Crime reduction and crime prevention	Technology	Premises perspective	Police perspective	Local authority view
Police resourcing	Business impact	X		X		X	
Queues	Business impact	X			X		
Revenue generation	Business impact	X			X		
Technology supply	Business impact	X		X	X		
Venue reputation	Business impact	X			X		
Communication with partners	Collaboration	X				X	X
Police influence on stakeholders	Collaboration	X				X	
Relationship building	Collaboration	X			X	X	X
Voluntary or forced use	Collaboration	X			X	X	X
Cost	Cost	X		X	X		
Risks to use the scanner	Cost	X			X	X	
Alcohol use and social factors	Environment/context	X	X		X		
City accrediations	Environment/context	X					X
Client welfare	Environment/context	X			X		
Competition	Environment/context	X					
Crime displacement	Environment/context	X	X		X	X	
Crime enforcement	Environment/context	X	X		X	X	
Crime reduction and prevention	Environment/context	X	X	X	X	X	X
Crime statistics	Environment/context	X	X		X	X	X
Drug and violent crime	Environment/context	X	X		X		
Hearing about the ID scanner	Environment/context	X			X	X	X
Make up of population (students, visitors etc.)	Environment/context	X	X		X		
Practicalities	Environment/context	X		X	X		
Preloading	Environment/context	X	X		X		
Case by case review	Governance	X					X
Evidence base	Governance	X				X	X
Governance	Governance	X					X
Licence management	Governance	X			X	X	X
Strategy and objectives	Governance	X			X	X	X
Ease of use	Use	X		X	X		
Experience	Use	X			X	X	X
Job requirements (training on ID scanners)	Use	X			X		
Maintenance	Use	X		X	X		
Privacy - client data concerns	Use	X		X	X		
Professionalism of security staff	Use	X			X		
Reporting	Use	X				X	X
Technical issues	Use	X		X	X		
Technology capability	Use	X		X	X		

Table 7.3: Matrix of codes and categories mapped to themes found in the data

The next step was to use the codes within the themes and start to build a picture of the key factors consistent with grounded theory (Corbin and Strauss, 1990), the codes shown in Table 7.3 were found to be repeatedly present in interviews, documents and observations. It was decided that conducting statistical analysis would not result in greater insight into the research questions, whereas 'knowing' the data would be potentially more fruitful. It was clear that uncovering not just the how, when and what was happening but the actions, behaviours and attitudes to what was taking place enabled the data to be looked at in some depth. One way of doing this was to consider the themes identified and to explore the elements that led to these themes and use spray diagrams as a way to draw out more detail.

7.3 The adoption decision

Figure 7.1 presents a spray diagram of the adoption decision and shows some of its complexity.

From the diagram three main areas are identified that warrant further exploration. These areas

are: crime and crime prevention; technology; and stakeholders (the police, the local authority and

owners/managers of licensed premises). Each of these areas of interest and how they relate to

Figure 7.1 will now be considered in turn.

Figure 7.1: Factors affecting the adoption decision in the night-time economy
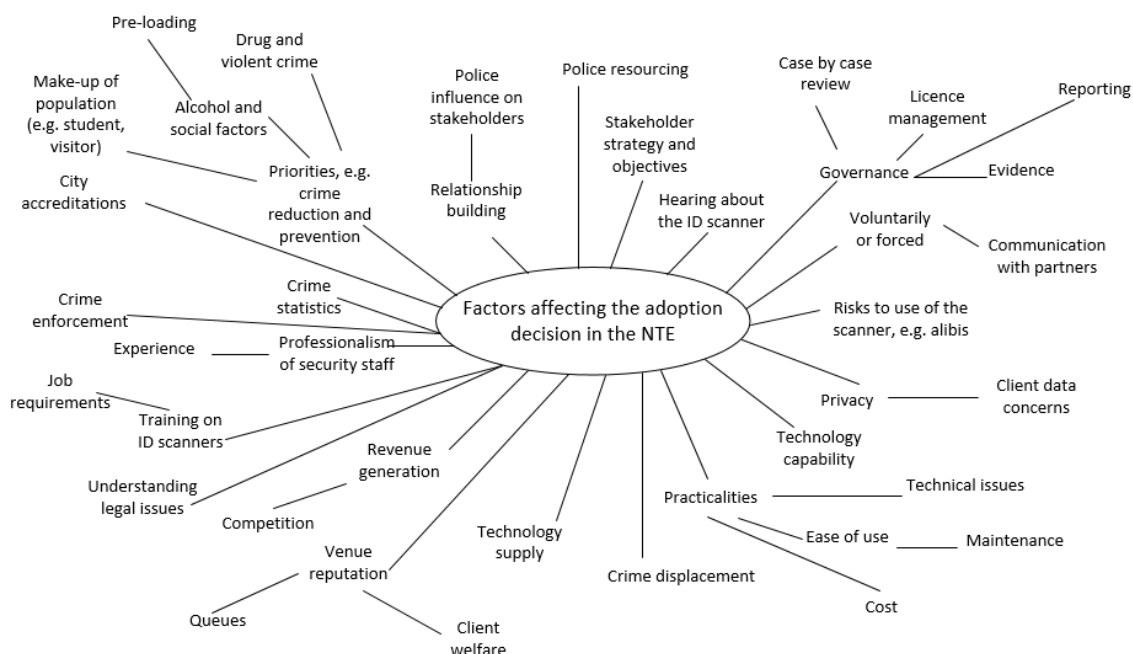
7.4 Crime and crime prevention

Using Figure 7.1 the area of crime and crime prevention was identified for examination (area

circled in Figure 7.2). Earlier in this thesis (Chapter 3) the research setting was set out which

explained the background to the problem of crime and crime prevention in the night-time

economy (NTE).

Figure 7.2: Area for examination identified from Figure 7.1: crime and crime prevention
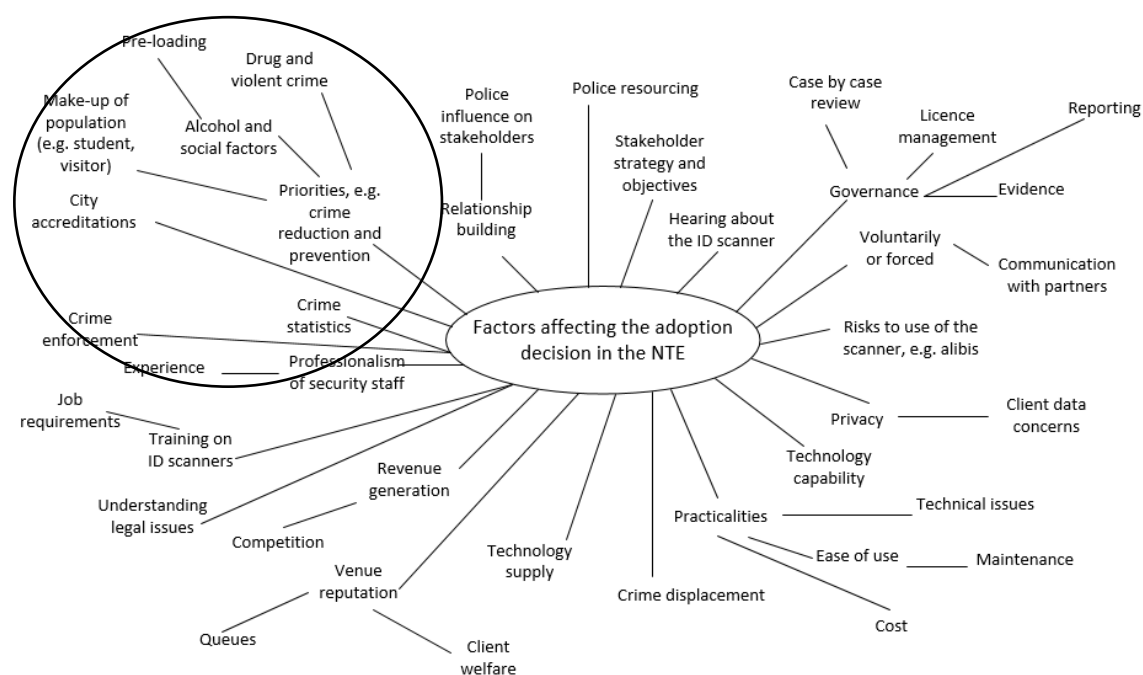
Population and the impact on crime

To understand why crime may occur or increase, one component cited in the data was the make-up of the population. A police participant (V8) suggested the student population caused higher workloads to the police due to the increasing number of counterfeit identifications presented and current social norms had changed the way the younger population drank alcohol. For example, participants said the student population were 'pre-loading' (which is the practice of drinking cheap alcohol obtained from supermarkets prior to going out at night). Because of this, the police would advise owners/managers of premises against holding under-age discos or any special event involving younger people. Another participant working in a governance role described issues with the population: 'there are an awful lot of students and late night venues which is an issue for neighbours and with what is going on around clubs, including drug dealing.' (V4). The data points to a need to consider the composition of the population when managing the NTE.

A need for crime reduction

Crime reduction as a general requirement was talked about frequently in the interviews with police participants: 'there is a particular need to reduce violent crime and theft in the city' (V13) and 'organised gangs [are] operating in the area where they use hire cars to drive into the city late

at night, carry out thefts in nightclubs and leave the city.' (V13). Another police participant

responsible for monitoring crime data reports concurred with this view. When pointing out how

the ID scanner could help reduce crime. They stated that a particular 'venue was being targeted.

When they got the ID scanner, they had an 80 per cent reduction in theft.' (V7). Although there

are other technologies available in the night-time economy to help tackle crime, including CCTV,

the indication that the ID scanner helps tackle crime is interesting and requires further

investigation.

Detecting and preventing crime

The broad idea of the ID scanner being adopted to address crime was one that clearly emerges in

many participants' accounts. A number of police participants reported the scanner had a positive

impact on police as a detection and prevention tool. One participant (V10) a premises manager

asserts that the scanner would act as a deterrent and reduce the number of people entering the

venue who were likely to cause issues. Evidencing crime reduction, another participant managing

a premises reported success after adopting the scanner:

> Since having the scanner, the number of thefts and bag dipping in the club has noticeably
>
> dropped. Prior to having the scanner, and as an example, there were around eleven
>
> incidents but in the three months of introducing the scanner, the number of incidents
>
> dropped to just two so we believe it contributes to a reduction in violent crime. (V12).

Other similar experiences were found:

> There is…a benefit of having a scanner to young vulnerable females…if a vulnerable young
>
> person/adult gains access to a club and is at risk of exploitation, ID scanning would deter
>
> the perpetrator. (V2).
>
> Benefits to the club are the reduction on entrants of people who cause trouble; it can
>
> scan and assess many different types of ID quickly. (V10).

In another geographical area in the further study also confirmed this experience:

Late night venues that are high risk is where the scanner is good at reducing crime…we welcome them and have only really positive experiences. Where incidents occur, and a scanner is in place, it is easy to identify offenders and witnesses. (W15)

Such comments indicate that attitudes towards the ID scanner were positive and there was an awareness of the benefits to using an ID scanner. These findings illustrate that crime reduction and prevention have several associations that may affect adoption of the technology. The next section explains more about the technology.

7.5 Technology

The analysis began to indicate that there are many benefits to the adoption of the technology but there are also downsides associated with the ID scanner. The research data includes potential risks that exist with the adoption of ID scanning technology. For example there were reports that the technology did not always work as expected and technical teething issues were experienced. Many participants also talked about technological aspects, the issues they faced and some suggestions of a negative impact on door supervisors. Figure 7.3 shows this area of examination concerning the ID scanner as a technology.

Figure 7.3: Area for examination identified from Figure 7.1: technology
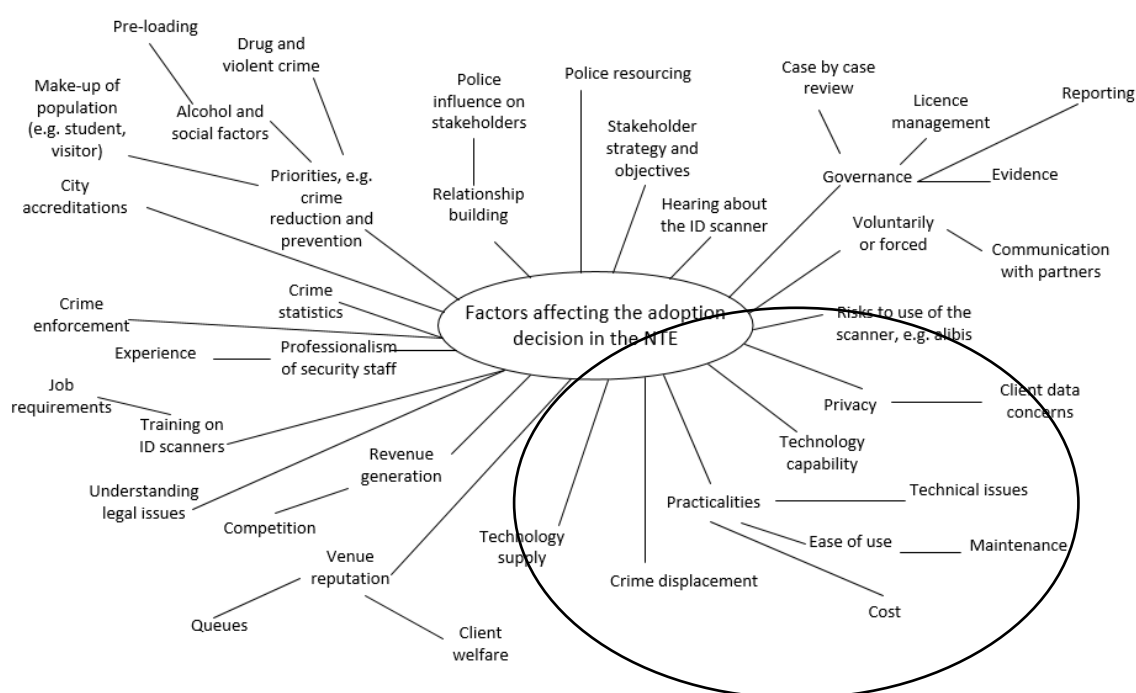
Technology issues

Although there were many positive stories about the technology, there were also risks and potential shortcomings reported. For example, a participating premises manager said 'There were some teething issues with the device technically, but now we have learnt so much about the machine, it is felt we could take it apart and put it back together again.' (V12). Components such as potential teething problems are expressed in the diagram but the spray diagram does not show enough information to understand what they are, how they came about and how they could be addressed. Another issue reported relates to practicalities with regular customers not initially bringing identification (when a scanner has just been introduced) and a concern by the owners/managers of lost business when taking up a scanner. Though it was said that once customers became aware of the technology and requirement to carry ID, the issue of failing to produce ID seemed to disappear. Another problem was infrastructure. A premises located in a basement expressed issues with putting a device at the entrance door. Instead, they resolved the issue by using a mobile device in place of a fixed machine. Yet, there were other problems with the technology and opportunities for crime prevention were missed. In one example where a female was assaulted inside the pub and a suspect was identified using CCTV. The scanner was used to identify the suspect but 'the person was off-screen when the photo was taken entering the club, the person was in the background.' (V9) and the opportunity was missed.

Technology capability

Capabilities of the technology were talked about frequently:

> Currently the device is stand alone and not networked with other clubs or the police.
>
> (V13)

In other examples, the scanner was networked and data shared amongst its partner premises. Other capabilities, some for use in the future, were described including fingerprint technology and the ability to hold images. On future capability, one participant was unclear whether the device had facial recognition capability. Whilst one club was noted as having concerns with privacy and information handling due to a risk that data could be misused. The police reported they were able to access and use the data from the scanners.

The ID scanner's other benefits, talked about by participants, included marketing capability. The ability of the device to offer data for marketing purposes had been a strong enough benefit for the majority of participants to persuade them to adopt a scanner. For example, a premises manager (V10) thought the device was a useful tool for distributing marketing and promotional communications. Whilst other participants disagreed and thought the marketing capability was an unnecessary feature. One participant explained that because of the international nature of their clientele, they would use Facebook or other means to promote their premises instead.

Next, it is useful to examine the analysis so far according to the three stakeholder groups (the police, the local authority and the owners/managers of licensed premises) which also featured in Figure 7.1.

7.6   Multi-agency working

The roles and interests of stakeholders may affect a decision on whether to adopt an ID scanner. Figure 7.4 highlights three main stakeholder areas for examination in this section. The analysis indicates that there are several stakeholders involved in the situation and though the perspectives of the police, the local authority and the premises and will differ, these three groups are key stakeholders involved in adopting an ID scanner.

Figure 7.4: Area for examination identified from Figure 7.1: Police, Local Authority and the licensed premises
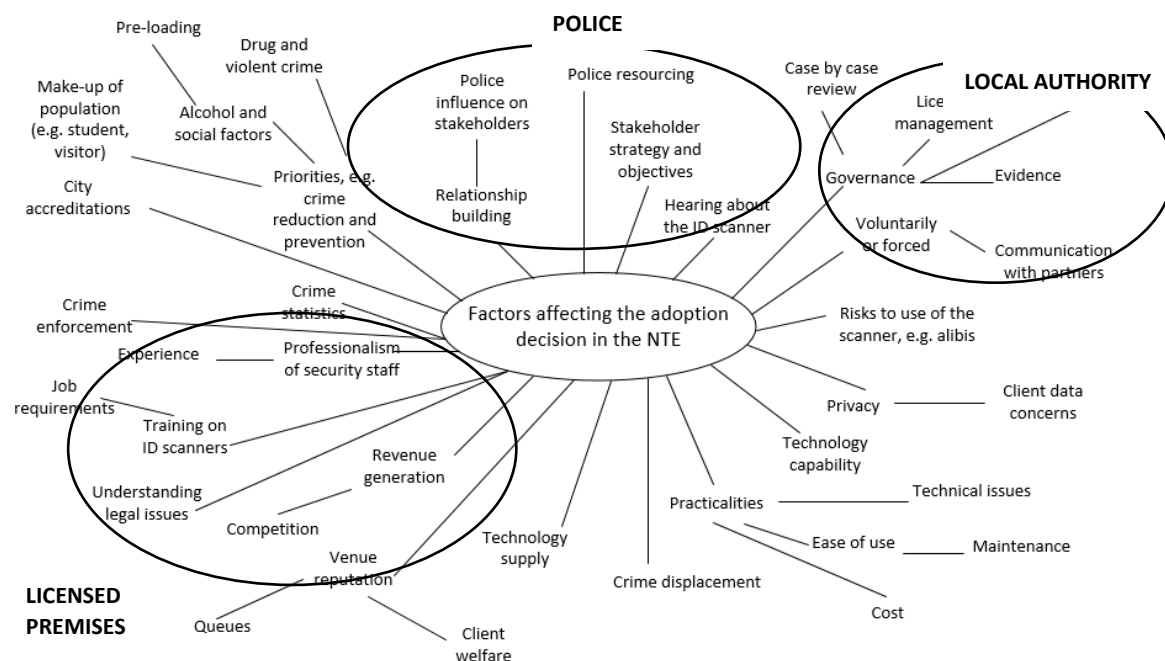
The groups' different roles and concerns include: the police and its role in crime reduction and prevention but also its resourcing issues; the owners or managers running premises and their role in preventing crime and management of data; and the local authority as governance and its role as the regulator.

Participants commonly reported that relationships and other stakeholder groups or agencies were involved in the adoption. These others included organisations such as Neighbourhood Action Groups (NAGs), local resident groups and Pub Watch (in the diagram under 'relationships'). These partnerships strengthened links to help make the city safer. Participants often reported working together with partners to encourage adoption of the ID scanner. One participant said:

> Relationships with the club owners and managers have been built up and communication
> with them regularly takes place. The relationships helped the process of selling it to every
> club. (V11)

The expectation of the role of the police relationship was reported by some as being a liaison role between stakeholders (W16) and as a source of advice and guidance. Whilst others said that the decision to adopt an ID technology rests with the licensed premises and the local authority for

regulatory matters only. In most cases, good relationships were reported with the police and this was seen to benefit the situation.

7.7   Using spray diagramming to explore the role of the police

This section examines the research data in relation to the police. Having presented the data in the spray diagram in Figure 7.1 and considered some contextual components, the next stage of the analysis is to consider in more depth the role of the police in the adoption decision. The police are not the primary adopter yet their involvement in the adoption of an ID scanner may influence the adoption decision. Figure 7.5 shows this area of examination and continues the discussion in more detail.

Knowing about the innovation

The starting point for many police participants and hearing about the new technology was similar. Police participants said they had heard about the ID scanner, its possibilities and capabilities, from others who already had experience or had known about a scanner. Officers interested in technology, and those who look for a solution to a problem, would share their thoughts with colleagues. One participant remarked 'We get to hear about the technology from being out and about.' (V9) Where the ID scanners had been implemented, an officer had seen reductions in crime at those locations and passed them on. In another example:

> It was a colleague's idea that the scanner for clubs could be introduced to help with violent crime in the night-time economy and support the work of the Night Safe teams.
> (V11)

This participant went on to explain that the ID scanner was known to work in other areas and have benefits as a detection and prevention tool. Emails and articles about the benefits of having a scanner are also reported to have been received:

> The ID scanner itself was introduced by the ID Scan salesperson who did a presentation and engaged people; he was a character. (V1).

The same participant, who previously attended a marketing presentation on the scanner, went on to talk about when the project to introduce the scanner came to fruition. The project was first introduced:

> …through receipt of an email where an article about ID scanners was shared – it provided an example of where a serious incident had taken place and the investigation had been helped by making identification [of the perpetrator] using the ID scanner. (V1)

From knowledge to influence

Even though information was shared through relationships, some bargaining by the police was required to encourage venues to take up the scanner:

> If a club has problems or needs an extension to its licence, such as the one that had issues with its door staff, it was negotiated that they introduce the scanner as a measure for tackling its issues instead of being taken to a licence review. (V11)

Figure 7.5 illustrates there are a number of factors surrounding the role of the police who play a part in communicating the benefits of the scanners to others.

Police strategy and resource

A driver for the police encouraging uptake of the scanner reported was the high number of mobile phone thefts and organised gangs operating in the area. For the police, the scanner had originally been proposed specifically to target these types of crime but there were other benefits for the police such as being able to access data to identify suspects where a crime may have been committed. An officer gave an example of the issues being faced:

> This area didn't have a known problem of under-age entry to clubs but did have an issue with a high number of thefts; this area contributed a high proportion of thefts as highlighted in the wider area statistics therefore there was a need to address the issue. Statistics showed the peak number of thefts tended to be during the night-time economy so a way to address the problem in nightclubs was needed. (V1)

The increase in number of thefts in one area had been noticed by a desk-based officer who collated regular, internal reports on incidents at night-time. Another feature contributing to

increased crime was that gang culture had spread into the area. Crime displacement was

reported when one club had adopted a scanner:

> [Club A] did have gangs in their club but problems tailed off since they had the scanner
>
> but people are going to [Club B] instead now. (V8)

On the surface, the data shows a positive view of the scanners though it could be argued that

crime was just moving elsewhere (displacement relates to context, technology and police so is

shown as its own entity on Figure 7.1 but in more detail in Figure 7.5). Indeed, a police participant

reported that this effect was quite normal:

> It does seem to have a displacement effect…but displacement is quite normal. Think
>
> about it from burglary or other crimes, criminals move to other areas. (V9)

Police resources can be scarce and with the data from a scanner, the police became more

efficient. The police reported that the scanner provided useful data in many instances. Anecdotal

evidence of this was reported, even where incidents occurred outside of a venue:

> …a taxi driver was assaulted and though it didn't happen in the club but we knew the
>
> person had been in there so we used the data in the ID scanner which helped the case.
>
> (V7)

Although in general, the police interviewees were very positive about the scanner there were

concerns for the impact on resources. As mentioned earlier, the use of counterfeit IDs led to

increased reports to police which resulted in higher workloads. Even so, participants reported

that the use of data from a scanner significantly reduced the workload for officers when having to

investigate an incident that has taken place and an offender can be quickly identified:

> The impact on officers and efficiency is that it would significantly improve workloads
>
> when quick identification can be made and the sooner forensic evidence can be gathered
>
> then there is a greater chance of proving an offence and improving chance of prosecution.
>
> (V1)

Figure 7.5: The role of the police in the adoption decision

Police roles in governance and enforcement

The role of police in governance and enforcement requires explanation. The police take responsibility for enforcing a licence. Most police participants reported that one route to adoption was to have installation of a scanner attached as a condition to a venue's licence. CCTV, for example, is generally accepted as a condition on every licence and not having the scanner as a regulatory measure led to some process difficulties:

> 90 per cent of issues we deal with are honest business mistakes [but] where there is a condition to have a scanner, we would take them to the council, make a case and say they hadn't taken it on board. (V8)

An officer talked about witnessing door staff letting in known criminals where the door staff were familiar with people and those people were left unchecked. If the scanner had been a condition on a licence, the police would have been able to reprimand the licence holder for not scanning every person into the venue:

> The PCs [Police Constables] would deal with it and we look at how the premises managed it and how they dealt with it. We would provide words of advice to them, it's not always

like that, if the advice didn't work, there would be a chain of escalation to the council.

(V8)

Though they said:

Feedback is given if things are going well. (V8)

Others described the governance situation:

The requirement for a club to have an ID scanner is not included on the club licence; this

is a big difficulty and makes it problematic to enforce in that way. However, in general,

door staff and others in this area tend to act in a professional way and there hasn't been

the need to review the licence on that basis. However, recently, a club was called in for a

meeting as it had seen an increase in trouble. The club's licence was older and needed

renewing but although they had other conditions added to the licence, on legal advice the

need for a scanner wasn't added to the licence on the basis that it may affect the ability

to resell the club. …Another club was supportive of the technology but is without a

scanner – as it went to the licensing authority for an extension to its licence there was

potential to have the requirement for a scanner included on the licence but a council

member objected. (V1)

Clubs are heavily taxed and therefore finances are tight which can be a reason for not

introducing the scanner, but licensing reviews can be costly for the club also. (V11)

A role of the police in the wider community is where they briefly stop people in the street

because of other circumstances. A benefit reported by the police in this study was that more

people were found to be carrying ID at night-time and this assisted them in their identification.

From this pre-analysis using spray diagrams, the role of the police is shown to be focused on

encouraging adoption. It is clear there are many benefits to the police but the adoption decision

for the other stakeholders requires understanding.

7.8   Using spray diagramming to explore the role of the licensed premises

The operators of venues that hold a premises licence are important stakeholders in the adoption

as the main user of the technology. The spray diagram in Figure 7.6, extends Figure 7.1 and

shows that the premises have many considerations to make. They weigh up the many benefits and downsides of adopting an ID scanner when deciding whether to invest in the technology.

Figure 7.6: The premises' perspective of the adoption
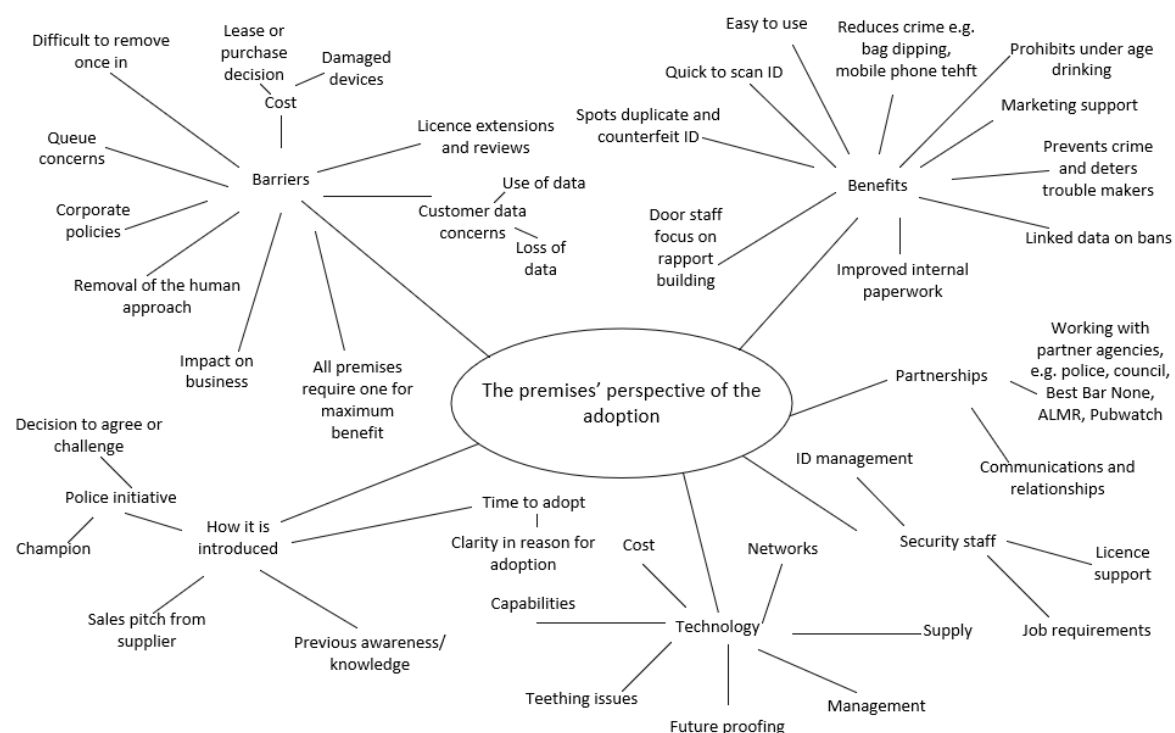
Figure 7.6 shows key areas including how the ID scanner was introduced, the components relating to the use of the technology and benefits and barriers to adoption.

Knowledge about the innovation

Owners/managers reported different mechanisms whereby the idea of the ID scanner had been introduced to them. A recurring theme seemed to be the collaborative working arrangements between all stakeholders and relationships built through strong communications. For example, several participants referred very positively to the working relationship with the police in Oxford:

> …work takes place collaboratively with the police. When ID scanners were proposed, it's been through discussion and communication with the police and with other club managers. (V10)

Benefits

A range of benefits to having an ID scanner were reported. For prevention of crime, one interviewee said 'it is good to have the details of customers in case they are involved in an incident' (V6). Others suggested that 'customers reg flagged in other locations can be noticed'

(V6). This meant that where someone had been previously banned from a venue, and where the technology is linked, then they would be indicated to door staff so a decision could be made on whether to grant them entry. A significant benefit was in the reduction in crime levels (V6).

There were also reports of unintended benefits such as 'Siblings using their older brother/sisters ID is a common thing that happens, this can be difficult to spot.' (V6). The owner/manager did not know this duplication was an issue until the scanner had been introduced.

Barriers to adoption

Barriers were described in detail, indicating that downsides are carefully considered when assessing the business case for adoption. Barriers reported in interviews included that there is a risk that once a machine is installed, it would be a permanent commitment. Once it has been in use then it would be difficult to withdraw from (V14, V15).

The technology was reported as not being failsafe and not all people may be scanned all the time (V14, V15). Another interviewee thought that many troublemakers do not carry ID (V6) and that crime would continue but may be displaced. There was also a concern for people barred elsewhere and whether the previous incident had been managed correctly or if networks are not in place (V14, V15).

Cost was reported as prohibitive (V14, V15) and the monopoly of the supplier a concern as there is only one major supplier (V14, V15) but the data for this stakeholder group suggests that they weigh up the benefits and downsides to the adoption and consider components such as cost. This view differs from that of the police, as crime does not feature at the top of the objectives for operators of the premises.

7.9   Using spray diagramming to explore the role of the local authority

This section considers the local authority as a stakeholder. Figure 7.7 is a spray diagram of the local authority view of the adoption.

Licensing and procedure

The local authority provides a governance role and is mainly process orientated. There are some commonalities with the previous two diagrams (Figures 7.5 and 7.6) where components are

related to crime concerns but there are differences in how the relationships work in the situation

with the local authority. The participants from the local authority were less knowledgeable about

benefits of the scanner but noted that reputation of the city was high on their agenda. This may

indicate the wider role the authority has in governing the area. Reflecting on the actions taken

after the adoption decision, one participant thought there was not a further role for them once

adoption had taken place. This is a difficult position for them, as they said they felt constrained

and talked about a variety of uncertainties such as the impact on civil liberties and privacy

concerns, whether best practice knowledge was available and whether there were options for

funding the introduction of such technology.

From the licensing perspective, efforts in the local authority were made to be open and

consultative and meetings were facilitated between premises owners/managers, police and the

public in accordance with policy frameworks and guidelines. There was general agreement that

anything that improved the night-time economy was helpful, but a case-by-case approach would

be taken when assessing conditions added to a licence.

Figure 7.7: The local authority perspective of the adoption

Some licensing decisions were complex and the need for the local authority to receive qualitative evidence on the impact of ID scanners on reducing crime was raised (V16). There was some general discomfort around the objectives for adopting an ID scanner. One participant (V17) thought that the police interest was in the scanner as an investigation tool but, for a scanner to be added to a licence, a genuine, evidence-based proposal would need to be put forward for approval through the formal process. The local authority has a duty to mediate between parties and, at the same time, ensure licensees are not overburdened. Only in exceptional cases would an ID scanner become a condition of a licence (V17). Another participant (V2) had observed, with the police, the city at night and thought that the benefits for police were clear. He thought that the scanners did not disrupt the operation of the club and that it would assist the police becoming proactive rather than reactive.

There was a general understanding by participants that, although the governance process was sufficient to address the proposals brought forward, that the local authority did not have full awareness of all activity in the city.

7.10   Summary of chapter

The spray diagrams offered an illustrated summary of the themes extracted from the research data. They provided insight into the decision making to adopt a technology like the ID scanner. Then the situation for police, operators of premises and the local authority were looked at. In the face of competing objectives, and in the context of their organisations, their accounts were summarised in a further set of spray diagrams. Spray diagramming, as part of systems thinking, helped to bring together these themes. There were commonalities in themes which were grouped together in the diagrams but there is also a complexity in the situation which spray diagramming has not yet shown. These are the associations between themes and any interactions between them. Though the use of the spray diagrams may be limited in making explicit the systemic nature of the adoption situation and so other techniques will be used in subsequent chapters to develop a more sophisticated understanding. Further analysis is required through using the existing frameworks/models identified earlier in this thesis and the application

of systems thinking through tools such as systems mapping, multiple cause diagrams and

influence diagrams before further discussion can be made.   The next chapter looks at the data

through the lenses of the existing frameworks/models.

Chapter Eight: Applying existing frameworks/models

8.1   Introduction to Chapter 8

The literature review (Chapter 4) identified and evaluated existing frameworks/models that can be used to explore diffusion and adoption and reported the main strengths and limitations of different frameworks/models found. Three of those frameworks/models that were seen as representative of the types of framework/models that have a broad application were then selected for further study. In this chapter, the three selected frameworks/models will be explored in greater detail in the context of this study. Table 8.1 provides a summary of those three diffusion and adoption framework/models selected from the literature review in the order they will be looked at and sets out their key attributes that are said to facilitate successful diffusion and adoption.

Framework/ model	Major focus	Facilitating factors	Advantages	Weaknesses
Diffusion of Innovations (DOI) (Rogers, 2003)	Explains how an innovation is diffused.	Social system Communication Innovation (idea, project, practice or object) Time Categorisations of potential adopters.	May explain why an innovation is communicated through certain channels among the members of a social system. Considers characteristics of the innovation. Takes communication into account Considers timing of diffusion.	Unclear whether diffusion is self-sustaining or what happens for continued adoption. Pro-innovation bias and the assumption that all members of a social system should adopt the innovation. Lack of consideration of external influences. Unclear how to prioritise factors that may assist a successful adoption.
Technology Organisation Environment (Tornatzky and Fleisher, 1990)	Uses three principle contexts to influence the process of adopting and implementing technological innovations.	External task environment Organisation.	Considers benefits, costs and barriers.	Variables such as management styles, organisational structure, culture not considered and requires tailoring to the context. Some concern where external mandate or influences may exist (Schwarz and Schwarz, 2014). Timing and nature of technology not considered

Framework/ model	Major focus	Facilitating factors	Advantages	Weaknesses
Technology Acceptance Model (Davis, 1986)	Discusses the acceptance decision in relation to technology adoption.	External variables. Usefulness. Ease of use. Attitudes, behaviour and actual use.	Well known for predicting and explaining user acceptance.	Does not always convey contextual factors or take account of differing perspectives. Has a reliance on statistical data.

Table 8.1: Summary of diffusion and adoption frameworks/models

This chapter will begin by looking at the application of Rogers' (2003) Diffusions of Innovations (DOI) theory in relation to the diffusion and adoption of ID scanners. DOI is relevant to this research as a popular theory that indicates a broad view of innovation can be taken by looking at the innovation, communication and the social system. Next, the chapter examines Technology Organisation Environment (TOE) by Tornatzky and Fleischer (1990). TOE suggests that a wide view of a situation can be taken by considering the technology, the organisation and the environment. After TOE, the Technology Acceptance Model (TAM) by Davis (1986) is examined. The acceptance decision is said to affect the take up (or not) of an innovation. Finally, a summary of the chapter is presented.

8.2   Diffusion of Innovations theory

Diffusion of Innovations theory (Rogers, 2003) seeks to explain how innovations are taken up in a population. The aim of the theory is to understand the trends and consumer groups for the manufacturer to 'roll-out' the innovation with the goal of as many as possible taking up the innovation. Innovation, communications, time and social systems are four key factors that, according to the theory, are required for successful adoption. Rogers claims that an innovation is the perceived 'newness' of an idea (p. 12) and often problem solvers want to speed up the process of adoption and research how early adopters differ from later adopters. There are three aspects to the theory that suggests positive adoption is encouraged:

1. Characteristics and the degree of benefit an innovation may have that make an innovation spread successfully

2. The innovativeness of the adopters

3. The innovation-decision making process

In order to evaluate the theory against the data in this research the three points above are discussed in more detail in the following sections.

8.2.1   Characteristics that make an innovation spread successfully

Rogers' Diffusion of Innovations theory (*Op. cit.*) is said to be an uncertainty reduction process. To learn more about the applicability of the theory in this context, the data in this research was mapped to five characteristics required for determining the success of an innovation. They are: relative advantage; compatibility; complexity; trialability; and observability. Examples from the data in this research are found in Table 8.2.

Characteristic	Summary	Example from the data
Relative advantage	The ID scanner has a relative advantage as it is currently the only option for providing an ID scanning opportunity for venues in an attempt to reduce crime.	• Police: 'The ID scanner was first introduced through receipt of an email where an article about ID scanners was shared – it provided an example of where a serious incident had taken place and the investigation had been helped by making an identification using the ID scanner' (V1) • Local authority: 'There is…a benefit of having a scanner to young vulnerable people. ...ID scanning would deter the perpetrator, as it is a powerful tool for detection.' (V2) • Premises: 'Benefits to the club are the reduction on entrants of people who cause trouble; it can scan and assess many different types of ID quickly.' (V10)
Compatibility	The extent to which the ID scanner as an innovation is consistent with values of adopters or with past experiences is unclear. The data from this research demonstrates that there were a mix of experiences but that adopters did not have a particular value or stance on the innovation.	• Police: '…has a huge surge of mobile phone theft…[I] would see the patterns and spikes in theft [in reports]. The venue was being targeted. When they got the ID scanner, they had 80 per cent reduction in theft.' (V7) • Local authority: 'The scanners were first heard about from the police. The benefits to the police are clear.' (V2) • Premises: 'It has now been implemented and used in the other venue successfully for the past nine months, but there are some blockers and downsides and there is a risk with how transient it is.' (V5)
Complexity	If considering just the technology, its ease of use was found to be easy to understand and little training was necessary. However, much complexity existed surrounding the influences and relationships affecting the adoption.	• Police: 'if this [the ID scanner] were in place it would be more straightforward to identify the crime and for the officers to make an arrest.' (W21) • Local authority: 'The introduction of new ideas just happen, there are networks of key stakeholders that work together even though the members of the networks are sometimes not the decision makers…' (V16) • Premises: 'As a club's manager and owner…I am aware of ID scanning as I have it in a previous venue to where I work now. I don't know how I first heard of it but the security I have now works just as well, if not better than the scanner.' (W18)

Characteristic	Summary	Example from the data
Trialability	The ability for potential adopters to view and try the innovation before adopting is also not straight forward.	• Police: 'It was a colleagues' idea that the ID scanner could be introduced to help deal with violent crime in the night-time economy.' (V11) • Local authority: 'I have some awareness of the ID scanner but am not that familiar and I don't use one. I've only really seen the machine here at [a] conference where it is on display exhibition.' (W19) • Premises: 'There was previous knowledge of ID scanners but as at the time they were not as advanced…The police approached us about the current system and it has helped us with one of our biggest problems.' (V6)
Observability	Referral to the degree to which results are visible to others in the social system also the opportunity to try the innovation before adopting.	• Premises: 'An officer has been involved in getting ID scanners into the City Centre…one of the interesting aspects is to be able to show the benefits…so they [the venues] can see the value of the technology…' (V13) • Local authority: '…the benefits of scanners can be understood. There is no involvement in the continued introduction of scanners.' (V16) • Premises: 'I am aware of the device from colleagues and am deciding whether to adopt a machine.' (V20)

Table 8.2: Data mapped to the characteristics that make an innovation spread successfully

According to the theory, those innovations exhibiting relative advantage will be adopted more quickly. The ID scanner has good relative advantage but that does not necessarily affect adoption in this context. The ID scanner was found to be compatible and easy to use (not complex). The final two characteristics, trialability and observability, refer to the ability to see or trial the innovation but that route to adoption was not found in this study.

While it was possible to map the interview data to these characteristics, there remains a significant amount of uncertainty and conclusions about the success of the adoption cannot be drawn.

Table 8.3 below summarises the benefits and downsides found in the data.

Benefits	Downsides
The ID scanner could reduce the prevalence of issues in the night-time economy.	The ID Scanner could be an expensive measure to manage exceptional behaviour.
Reduces crime including low level theft (mobile phone, passport, ID); duplicate or fake ID; high level assault and serious crime. Deters criminal activity.	Collaborating on adoption of the ID Scanner depends on personalities.
The scanner works quickly and effectively helping door staff where they would be unable to keep track of assessing different IDs from around the world.	Some expression of issues concerning public surveillance and privacy.

Benefits	Downsides
The technology can meet future technological capability demands (e.g., fingerprinting, facial recognition).	Teething technical issues on introduction.
Improves crime detection, investigation, police workloads and can lead to timely prosecutions.	Without the scanner as a licence condition, it difficult to enforce adoption.
	Supplier monopoly and cost.

Table 8.3: Benefits and downsides of adopting an ID scanner

Also noticed is that many of the elements that match observability and trialability are managed through networks and partnerships. Mapping the research data to diffusions of innovations does not help to unpack many of the complexities surrounding those relationships. If each of the criteria is looked at in isolation, there is a strong case for adopting the scanner. As found in the literature review, there is little said about the prioritisation of these characteristics and which may be more important to assist adoption of the innovation. It is possible that application of systems thinking may reveal more about the situation and linkages between these points.

8.2.2   The innovativeness of the adopters

Taking the second point, that innovativeness of adopters is a core principle in the theory of diffusion. Theory suggests that as the innovation spreads from early adopters to majority audiences, communication becomes very important. There is a belief that the population can be broken down into five different segments based on their propensity to adopt: innovators, early adopters, early majorities, late majorities and laggards. It is also believed that, once identified as belonging to a segment, adopters remain static in that category. Therefore attempting to understand this research data in these terms might be helpful.

The importance of communication through peer-peer conversations and networks was more evident in the data than any demonstration of innovativeness of the adopters:

> The ID scanner project was first introduced through receipt of an email where an article about ID scanners was shared. It provided an example of where a serious incident had taken place and the investigation had been helped by making identification using the ID scanner. A colleague had also heard about the use of scanners in another area. (V1)

Impersonal marketing appears to have spread information about the new innovation but conversations led to the adoption. Early adopters were the exception to this rule and instead were on the lookout for advantages and tended to see the risks as low. Key priorities for the premises as adopters was the impact on crime and protection of their licence but risks included the cost of the agreements to small scale and independent businesses:

> At the end of the contract term the agreement has to be renewed or the technology handed back. This high cost is the reason why we would hold off installing it in [our] other venues. Most of the late night economy…is independent businesses. (V5)

The theory suggests the rest of the population require assurance from peers that the innovation is do-able and provides genuine benefit. Though some benefits were clear, the route to adoption through assurance from other adopters would not be linear. A tailored approach to meet the needs of the adopters may be necessary. This is interesting and reveals a lack of support for police and other agencies on how to initiate, build or enhance these networks and influence over the diffusion and adoption.

8.2.3   The innovation decision making process

On the third point, the decision making process was essentially a business decision process. Figure 4.5 sets out the five key steps of the adoption decision from knowledge (step 1) through to confirmation following implementation (step 5). It is fair to say that the data demonstrated that knowledge led to persuasion and that in turn influenced the decision. However, the ID scanner was not regarded as desirable in all cases and it would not be easy to distinguish what influences there were on that social system as a result of looking only at the decision and the practicalities that come after adoption and that could lead to continued positive adoption.

This reflection shows the theory has not provided enough understanding about influences on the adoption decision. Any learning is limited because the ID scanner is an innovation that has already been adopted in other places.

8.3   Technology Organisation Environment

Tornatzky and Fleischer's (1990) Technology Organisation Environment (TOE) is an organisational focussed framework/model that considers an organisation's adoption and implementation of a technological innovation. The framework/model is illustrated in Figure 4.6. TOE posits that the organisational, technological and environmental contexts influence the process by which an organisation adopts an innovation.

While useful in the context of this study, there are several assumptions associated with the framework/model that may not always be valid. Firstly, it assumes that the organisation defines a problem that requires resolution before it considers a range of possible solutions and then arrives at a decision to adopt any of them or not. Innovation in the context of adopting the ID scanner does not directly follow this process. Complicating matters further is the fact that there are many stakeholders involved in the situation. As a consequence, it would not be straight forward to identify the need and assess potential solutions:

> This area didn't have a known problem of under-age entry to clubs but it did have an issue with a high number of thefts. This area contributed to a high proportion of thefts as highlighted in the wider area statistics therefore there was a need to address the issue.
>
> …Previous experience of working with investigative tools meant that the potential value of the ID scanner was recognised. (V1)

In practice, assuming only one organisation is involved in the adoption is a narrow approach to understanding adoption. In this research, addressing problems in the night-time economy requires collaboration with multiple organisations. The multiple views and complexity surrounding the adoption decision is an area that systems thinking may generate additional insights about the adoption of ID scanners in the night-time economy and could highlight areas that may not be considered using the TOE alone.

8.3.1   Technological context

Taking a look at further detail under the factor of technological context, Tornatzky and Fleischer (1990) suggest that the technological context surrounding an organisation plays a role in the adoption activity by that organisation (p. 163) but is often overlooked.

One of the features referred to by Tornatzky and Fleischer (1990) that can affect adoption activity is the technical opportunities in the industry. In this research, the night-time economy is mature and there has been little change to the technologies it uses. As described earlier in Chapter 2, two-way radio and CCTV have been major technological solutions to addressing crime for the police. Also, affecting the industry, the nature of crime has changed. High levels of alcohol-related violence is one of the drivers increasing the need for different innovations to be introduced to tackle issues. This changing context might indicate that there are available technologies designed to address the problems and that organisations have a choice. However, the ID scanner has little competition – it does not replace another technology.

Two features suggested as important in the technological context are the characteristics of the available innovation and whether the innovation is incremental (features or enhancements are added to the innovation over time) or discontinuous. The ID scanner fits closest with the definition of discontinuous in that it 'represent[s] significant departure…from existing equipment' (p. 165). Use of a framework by Tushman and Anderson (1986) (in Tornatzky and Fleischer, 1990, p. 165) allows this to be looked at further. They set out two types of discontinuous innovation: 'competence-enhancing' provides the opportunity for an organisation to improve a product or process; and 'competence-destroying' where technologies and expertise are lost. Interestingly, the ID scanner was said to be both. The majority of participants described the scanner as a more robust way to assess ID to identify fraud and prevent unwanted characters entering the venue (competence-enhancing).

Other participants described the risk that the adoption of the technology removed the human element in the form of the door staff (competence-destroying). Without the ID scanner door staff

would build a rapport with customers and talk to them to assess their suitability to enter the venue and make a judgement on their entry. Other participants thought that, if managed well, the scanner supported the door staff in their jobs.

Almost all participants described the key characteristics of the ID scanner as having beneficial capabilities such as its ability to: identify fraudulent ID; verify age and previous banned persons; deter criminal activity; share data; and its potential for future technological development including the integration of biometrics. It was also described as being easy to use and not complex. Though there is evidence of relationships between the technological context and the adoption activity, more understanding of their nature is needed.

8.3.2   Organisation context

The second factor for analysis is the organisation context. The TOE suggests that descriptions of formal and informal linking structures, communication processes, size and slack define the organisation context. (This was first discussed in Chapter 4). This research involved five principal sets of stakeholders where each were subject to their own prescribed governance arrangements. The police and the local authorities have formal structures and processes shaped and defined by the very nature of their work, through which they up-hold the law and ensure public protection. For example, the police have complex formal structures with responsibilities to government and other authorities as well as being governed by legislation. Local authorities have their own formal governance structures and their licensing committees oversee the regulation of premises. There are some formal linkages between these organisations. The premises are responsible for incident reporting to the police to the and keeping records of crime in their venue. Door supervisors operate within a venue but are subject to external formal scrutiny by the Security Industry Authority. These formalities found in the data present both opportunities and constraints for adoption of an innovation such as the ID scanner. In addition to these formal connections, interesting informal linkages contributing to the organisation context emerged in the research. The data in this study suggests that there is a variety of informal influences on adoption of the ID scanner. A range of participants talked about their previous experience of ID scanning technology

(35 per cent of participants specifically talked about their prior experience) and their previous knowledge influencing their adoption of ID scanners. A point of interest to this research was the large number of participants who described boundary-spanning groups that link stakeholders together. Table 8.4 provides a summary of findings.

Agency	Formal	Informal linking structures
Local Authority	Committees Regular reporting	Community safety partnerships Recognition schemes
Police	National Police Chiefs' Council Night safe reports National Leads Meetings	Neighbourhood Action Groups Pubwatch Business Crime Reduction Partnerships
Premises	Incident logs and analysis	Pubwatch Industry bodies
Door supervisors	Training	WhatsApp Radio link Pubwatch
Other bodies		Local publican's associations National Proof of Age Standards Scheme (PASS) National Police Chiefs' Council Trade associations Local alcohol partnerships

Table 8.4: Summary of formal and informal linking structures

Communication processes between stakeholders were found to be a prevalent factor in the research data. There were several initiative-taking 'champions' utilising their previous knowledge to communicate the benefits of adopting an ID scanner. This communication acted as bridge between stakeholder groups and, especially in the case of communication by the police, added more influence to the pre-adoption decision. The importance of this is acknowledged in Tornatzky and Fleischer (1990):

> 'There is rich literature on the role of informal internal linking agents, such as product champions…These are roles that are typically not prescribed by the formal organisation, but that employees acquire because of interest in an area or activity.' (p. 159)

In relation to organisation size, literature on adoption has, in the past, suggested that the larger the organisation, the more likely adoption will take place (Tornatzky and Fleischer, 1990, p. 161). However, they identify a problem with this finding. Size can be calculated using a range of measures such as number of employees or revenue; there is no agreed way to determine size. In this research, some small independent premises successfully adopted the ID scanner because of

the autonomy they have in decision-making. Successful adoption was also reported from some groups that owned large chains of premises, though in some cases, due to economic problems, they took a strategic approach and prioritised placing ID scanners in their premises where the most value was placed on a retaining a licence. This is interesting as it shows that variables such as 'size' do not map neatly as discrete factors.

Tornatzky and Fleischer discuss slack in the TOE framework/model as relating to the availability of slack resources (p. 160). Literature has suggested that organisations may wait to adopt because of the availability of resources (Christensen and Bower, 1996; Rogers, 2003). However, the data in this research identified no issues with the availability of resources. Financial slack refers to instances where organisations are cash rich. For instance, where an organisation may run efficiently to create high profit but they wait before choosing to convert some of that profit into resource in order to adopt. In the case of the ID scanner, the economic situation in the UK at the time of the research meant that premises are often running with small profits. However, all premises run the risk of losing business, and therefore profit, if their reputation is impacted negatively by rising crime levels. They, therefore, may choose to adopt the scanner or indeed, they be forced to adopt it through implementation of a licencing conditions. This demonstrates that many decisions to adopt an ID scanner are influenced by affordability suggesting that venues might adopt even if they have not really got the spare cash – so in fact 'affordability' is more about protecting against even poorer profits than it is about spending ample profits which challenges the TOE framework/model.

8.3.3 External environmental context

The TOE framework/model states that there are two key determinants of innovative activity. These are 'the competitive characteristics of its industry, and the existence of a relevant technology support infrastructure' (p. 167). Although the adoption of the ID scanner involves a range of different stakeholders, all share the problems caused by crime and the need to uphold regulation through the licensing objectives. They also have in common opportunities to improve the area's reputation and build a successful economy. The night-time economy is not growing

and organisations in this study approached the adoption of the ID scanner in different ways.

Some were forced to adopt through conditions placed on their licence whilst others, encouraged

through their competitors use of the scanner. Once a number of premises had adopted, there

was evidence that criminal activity was displaced to those venues without the ID scanner. Others

had different reasons for choosing to adopt the ID scanner such as protecting their staff from

having to make age verification decisions.

The technology support infrastructure was not of major concern to those interviewed in this

research. Little training was required as the ID scanner was easy to use and the supplier of the

scanner provided support and implemented software updates when they were required. There

were no additional labour costs. Government regulation in this industry is discharged through the

licensing objectives enforceable by the police and regulated through the local authority. In this

case, the regulation sought to encourage use of the scanner rather than deter its use.

This section offered a review of the TOE theoretical framework. The data in this study can be

mapped onto the TOE framework as shown in Figure 8.1.

Figure 8.1: The data mapped to the Technology Organisation Environment framework/model

External Task Environment
Mature but declining industry
Competition between venues
No additional labor or skills costs
Regulation through licensing

Technological Innovation Decision Making
By venue owners and managers

Organisation
Stakeholders with independant formal structures
Informal linkages
Collaboration between stakeholders

Technology
Usually mature technilogical solutions in this industry
ID scanner is robust through its charcteristics and available with few alternatives

The application of the TOE framework/model demonstrates that the context has influence over the adoption of the ID scanner and is consistent with the conclusion that 'While the context almost never determines the process, it does serve to constrain or facilitate it' (p. 175). Applying the framework/model enabled examination of some factors such as: the nature of the industry the adoption takes place in; the type of technological innovation proposed for adoption; and risks relating to affordability of the device. However, it did not provide much insight into the perspectives of the stakeholders who were engaged in the formal and informal linkages or the potential impacts on adoption. It provided limited understanding of management and organisational structures and culture. Therefore, it can be argued that applying the TOE has not enabled all the important points to be identified and explored.

8.4 Technology Acceptance Model

The section begins by looking at the notions of technology acceptance through application of the Technology Acceptance Model (TAM) and then, taking each factor in turn from the model, it discusses the relationship with the data collected in this research.

The five factors used from the TAM for this analysis are: external variables; perceived usefulness; perceived ease of use; attitude; and behavioural intension to use. As set out in the literature review, Davis (1986) proposed the Technology Acceptance Model, illustrated in Figure 4.7 (Chapter 4), as a model used to predict a users' decision to use a technology or not. The TAM posits that adoption occurs when the perceptions of usefulness and ease of use are positive. However, the TAM has limitations to explaining adoption. Literature on the TAM focuses on the user and frequently applies it to quantitative, statistical analysis and as the literature review suggests, a much wider range of factors influence technology adoption. Certainly, in this study, stakeholders who are not actual users of the system also influence adoption:

> Relationships with club managers have been built up and communication with them
>
> regularly takes place. The relationships helped the process of selling it to every club.
>
> (V11)

It is encouraging that research on adoption is broadening by testing the TAM through qualitative methods instead (See Wu, 2009; Aucamp and Swart, 2015). They argue that a mixed methods approach to qualitative research can also garner relevant information. Although the literature review reported on several developments where the original TAM had been extended through the addition of new or different factors, for the purposes of this study the original TAM provides the basis for analysis.

Despite limited users of the ID scanner (premises owners, managers and door staff), it is nonetheless possible to explore acceptance of the technology by mapping the data to the TAM. Data was collected over several geographical areas to test particular aspects of adoption but when applying the TAM to this data, the data was not divided geographically for reasons discussed below.

8.4.1   External variables

The data in this research demonstrates that there are a variety of influences affecting adoption of the ID scanner within this theme of external variables. When speaking about external influences to accepting the scanners, participants of this research often stated multiple factors influencing the situation. Five key factors stood out in the data. These were:

1. the police influence;

2. licensing;

3. crime;

4. networks;

5. economic situation (cost).

The initial suggestion to adopt the scanner generally came from the police and there were a number of examples where the police were seen to influence introduction of the technology beyond that initial suggestion. For example, the police were also described as being a source of advice and support when issues required action.

Only one participant specifically discussed the geographical area in which they are located. There were few references to the geographical positioning or contextual influence but those that were

made referred to the positioning of the entrance to the venue which would affect the ability to adopt. It overwhelmingly pointed to high perceived costs of taking up a scanner as being the most significant barrier to adoption. Some participants referred to examples where initial funding had supported acceptance of the ID scanner and therefore adoption. Generally, it was acknowledged that the cost for venues could be high. Other issues that were mentioned by participants included concerns about the capability of the technology itself or about privacy. However, these issues were more suited to analysis under Rogers' (2003) Diffusions of Innovations theory.

8.4.2 Perceived usefulness

As expected, the police participants were the central stakeholder group to identify that the core usefulness of the system was to tackle crimes such as theft and violence. They overwhelmingly agreed that the scanner helps to reduce crime and also noted that it can increase productivity in relation to investigations. However, premises owners also acknowledged there were broad, positive aspects to adopting an ID scanner, including speeding up the queues outside of a venue and helped door staff to process customers more quickly and more accurately '…it was found to process [clients] very quickly with it coping with around 800-1,000 people per night.' (V12).

In this research, participants from the premises said there was little option for users to reject the technology once the decision had been made to install a scanner. Even though they could in in theory change their mind, any issues arising from rising crime in the premises or a major incident would have serious consequences not only in terms of the licence and impact on the business but also on the public in terms of confidence and safety in the premises and in the surrounding area. Therefore, the risk to uninstall is too high. Usefulness can refer to job related benefits of having knowledge of a particular technology to support future careers which is not a relevant point in this research as the scanner is extremely easy to use, and it is very unlikely door supervisors would view the technology as career enhancement.

8.4.3   Perceived ease of use

All participants acknowledged the ID scanner was easy to use and many reported that no, or very little, training was required. Therefore, ease of use is not in need of further analysis.

8.4.4   Attitude

Attitude was more difficult to ascertain but participants did discuss whether they thought positively or negatively about the ID scanner. Nearly all participants had a positive attitude towards adopting the ID scanner albeit with some concern about cost and installation issues. Other bodies such as national networks expressed concerns about the scanners' use for age verification purposes and issues of privacy.

8.4.5   Behavioural intention to use

The main group to decide to accept the scanner were the premises owners and managers. The police and other stakeholders were also asked for their views. As expected, the police would like to see the ID scanner adopted in all premises. For the premises as the primary adopter, some already had a positive intention to use. Therefore, intention to use is another point not in need of further analysis. Given that once the ID scanner is installed it is mandatory for staff, there is little choice in the intention to use.

Whether the attitude towards adopting the ID scanner was positive or negative, it did not have a large influence over the take-up of the scanner. It was clear that the scanner was very useful and very easy to use and so perceived usefulness and perceived ease of use, the two biggest influences in TAM, meant that these two factors always had a positive influence on adoption.

The results show that there are a variety of external influences affecting adoption of the ID scanner. External variables were wide ranging and appear to have the largest influence over whether a scanner is adopted or not.

The data from this research is mapped onto the TAM in Figure 8.2.

Figure 8.2: The data mapped to the Technology Acceptance Model
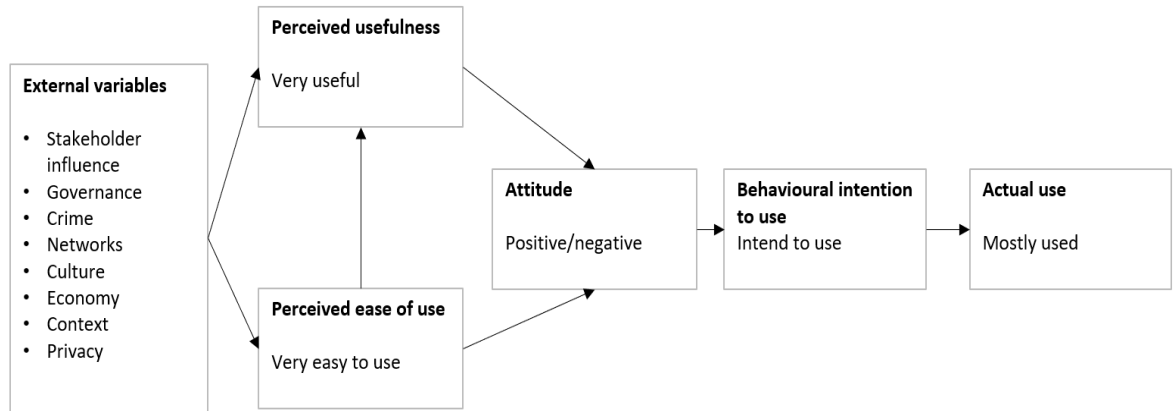
In summary, attitude and behavioural intention to use have a small impact and perceived

usefulness and perceived ease of use have very positive outcomes in this research yet have little

influence on the adoption of the ID scanner.

8.5   Summary of chapter

This chapter reported on the application of the research data in this study to three diffusion and

adoption frameworks/models. The chapter began by providing an explanation of the data

mapped against Roger's Diffusion of Innovations theory then it assessed the Technology

Organisation Environment framework/model by Tornatzky and Fleischer and finally, it examined

the Technology Acceptance Model by Davis. Table 8.5 shows how well the framework/model may

be helpful to technology diffusion and adoption in a complex multi-agency setting by summarising

by themes.

Main themes covered by the frameworks/models	Diffusion of Innovations (Rogers, 2003)	Technology Organisation Environment (Tornatzky and Fleischer, 1990)	Technology Acceptance Model (Davis, 1986)
Communication	X	X	X
Environment	X	X	
Interrelationships			
Market	X	X	
Technology	X	X	X
Uncertainty	X		

Table 8.5: Main themes covered by the diffusion and adoption frameworks/models

This chapter found the existing framework/model facilitates some understanding about the diffusion and adoption but there were gaps in the themes covered. The next chapter seeks to examine the data using a systems thinking approach.

Chapter Nine: Applying systems thinking

9.1 Introduction to Chapter 9

The interviews with participants provided a set of data about their experience with the adoption

of an ID scanner in the night-time economy. The pre-analysis in Chapter 7 brought together the

empirical research data and identified the most salient viewpoints and perspectives to be

considered. Further use of the data was made in Chapter 8 which looked at the three diffusion

and adoption frameworks/models selected for further investigation. Using the initial analysis and

the further analysis from Chapter 8, the adoption decision was identified as this main area for

further exploration through the application of the systems approach. The analysis so far has

shown there were three main areas contributing to the adoption decision: crime and crime

prevention; technology; and the multi-agency partners. Figure 9.1 provides an illustration of the

linkages between those areas.

Figure 9.1: Linkage of the main areas contributing to the adoption decision
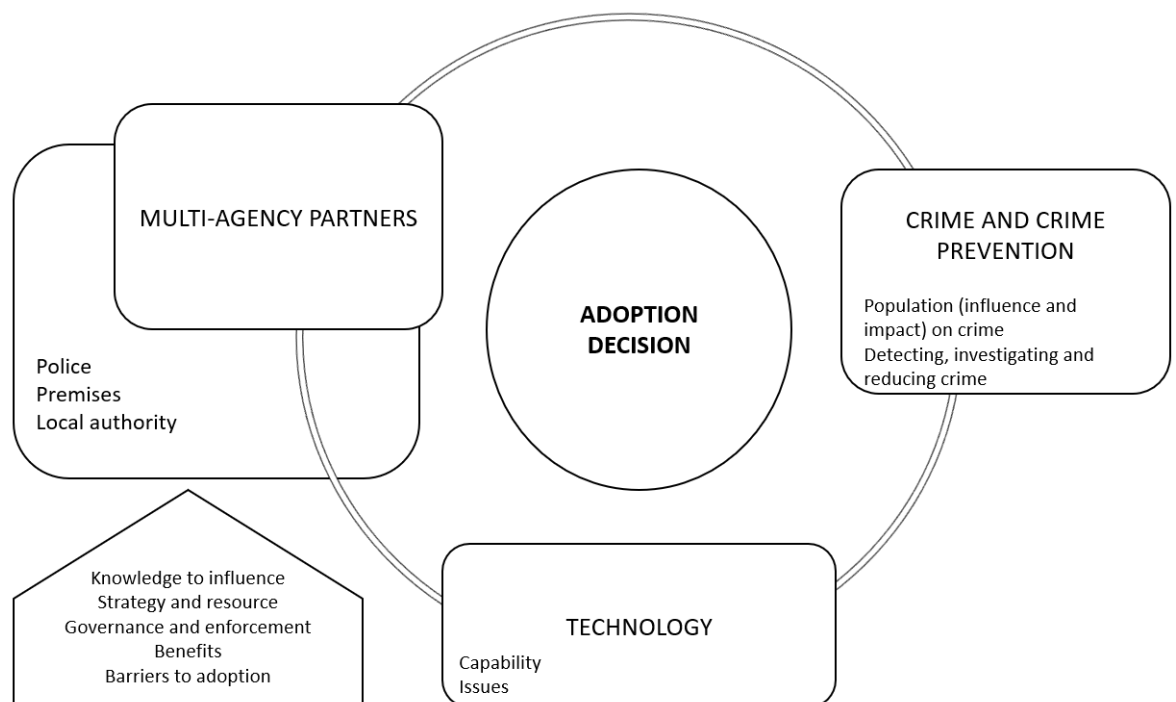
The aim of this chapter is to use the data to apply systems thinking as an analytical framework to explore the diffusion and adoption of an ID scanner in the night-time economy. The chapter uses systems thinking to explore the situation and to identify and examine a system that could be constructed with the aim of advancing understanding of diffusion and adoption. First, multiple causes are looked at and possible systems of interest identified. Next, the situation is modelled using systems maps, influence diagrams and then the Formal System Model is applied. Finally a summary of the chapter is made.

9.2 Identifying the system of interest through multiple cause diagramming

Introduced in Chapter 6, multiple cause diagrams are used to look at why changes or events happen (or not!) and look at interconnectedness in a complex situation. The overall adoption decision is considered both to draw together the information presented earlier and to explore the potential causal relationships. Figure 9.2 shows the many causes affecting the decision whether to adopt an ID scanner.

Figure 9.2: A multiple cause diagram of a positive adoption decision
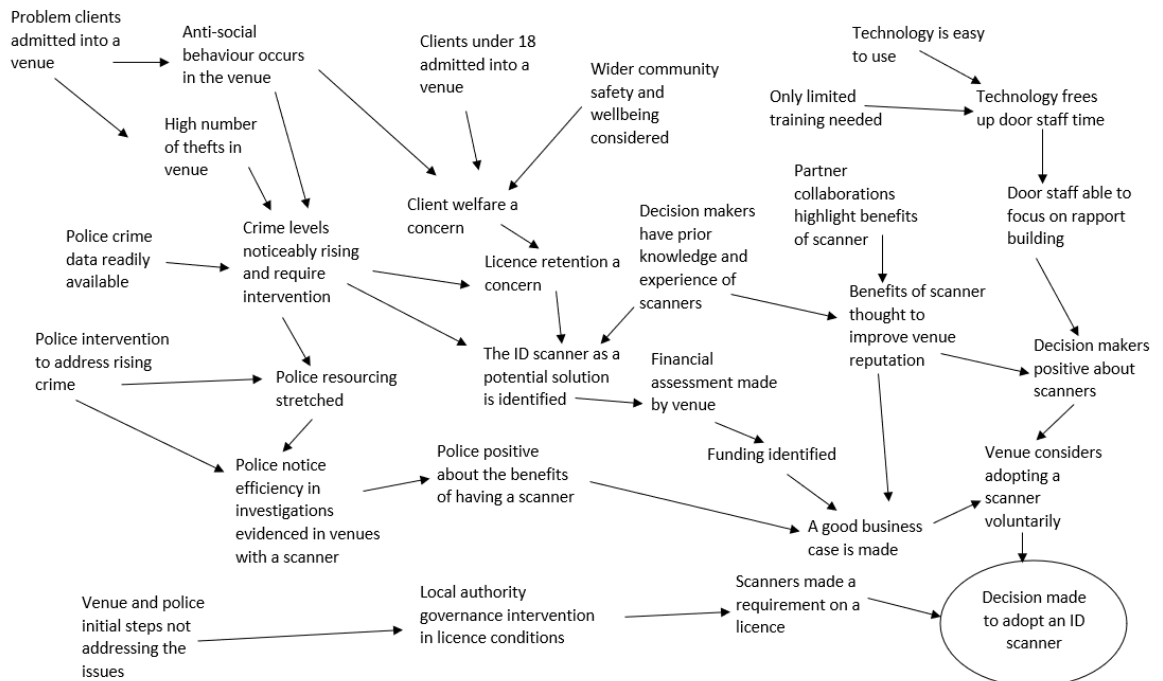
The diagram shows there are two main influences feeding directly into a positive decision to adopt. These are the premises adopting an ID scanner voluntarily or as a result of a mandatory

decision taken because of licensing conditions. These influences have a strong impact on the premises and are worthy of further consideration. The major options influencing the adoption are the local authority making a scanner a requirement on a licence or the premises making its own voluntary decision. This identification of different routes preceding the adoption decision is something that the earlier diffusion and adoption frameworks/models did not reveal, but they are options that have great impact on whether the innovation is adopted or not. First is the voluntary decision-making element whereby decision makers are positive about ID scanners and therefore more likely to bring about the adoption of the scanner. When the premises voluntarily adopted a scanner several common factors that influence the decision were identified including: those involved having prior positive knowledge about ID scanners; the reputation of the venue being improved through tackling problem clients; the benefit to door staff and rapport building with clients; and the wider positive impact on the reputation of the area. Perception of the ID scanner as an effective technological solution to addressing crime featured as important. Rising crime resulted in police seeking ways to take action and those actions usually have an impact on police resourcing as more resourcing is required to increase the presence of the police or when investigations take a substantial amount of resource and in investigations that involve many before being able to identify suspects: 'We think getting a scanner will improve business and has safety benefits.' (V20). Another participant, W14, referred to the police and local authority pressure to adopt a scanner to improve police performance addressing alcohol-related violent crime and as part of promotion of licensing objectives by the local authority. These very different reasons are important aspects on the adopters' decision but had not been identified using the existing frameworks/models. The majority of participants reported previous knowledge of the ID scanner, either because they had previously used one or just because they had heard about it before, so having prior knowledge of the innovation features as important. Use of the diagram allows those elements to be identified and their causes examined. Participants from the local authority said generally that they were not aware of the ID scanner until it was brought to their attention by the police. This provides a sense of the police role in championing such an

innovation. There was also a clear sense of collaboration through multi-agency working: 'there are networks of key stakeholders that work together even though members of the network are sometimes not the decision makers but [they] can facilitate the new idea.' (V16).

When the ID scanner is not adopted voluntarily, the police, with the local authority, sometimes must take a decision whether to tackle the premises to address its problems by negotiating improvements with the owner and manager and/or using the licence review process to assist enforcement. Liaison with the local authority takes place to bring a review that hopefully results in a successful outcome.

The diagram also shows causes affecting the reputation of the premises and of the local area. Both of these were important to many participants. The causes mapped also show a threat to the public from rising crime and that increased crime can affect public confidence. One of the factors contributing to the crime level is underage drinking. If alcohol sales to the younger groups are on the increase or if there is an increase in anti-social behaviour the premises will need to review the options, including technological solutions, for tackling those issues.

A feature of the technological solution in the form of the ID scanner was its ease of use. The technology must be seen to support the role of the door supervisors in assessing ID for age-related entry and for counterfeit ID to enforce compliance with legal requirements, thereby protecting the premises' licence. In the long term, this discourages those who are underage or holding counterfeit ID from attempting entry. Ease of use is something that an existing framework/model, the Technology Acceptance Model (Davis, *Op. cit.*), provided for but it only provided one aspect of the picture on the acceptance decision.

One of the benefits of systems thinking is that it can identify factors that need to be the subject of further investigation. The existing frameworks/models did not reveal the need to look more deeply into what is happening in the situation. One aspect of this situation that is very interesting is the police role and their influence. To look at why the police are positive about the ID scanner, the multiple causes affecting the police can also be delved into (See Figure 9.3).

Figure 9.3: Multiple cause diagram showing the positive perspective of the police on an ID scanner
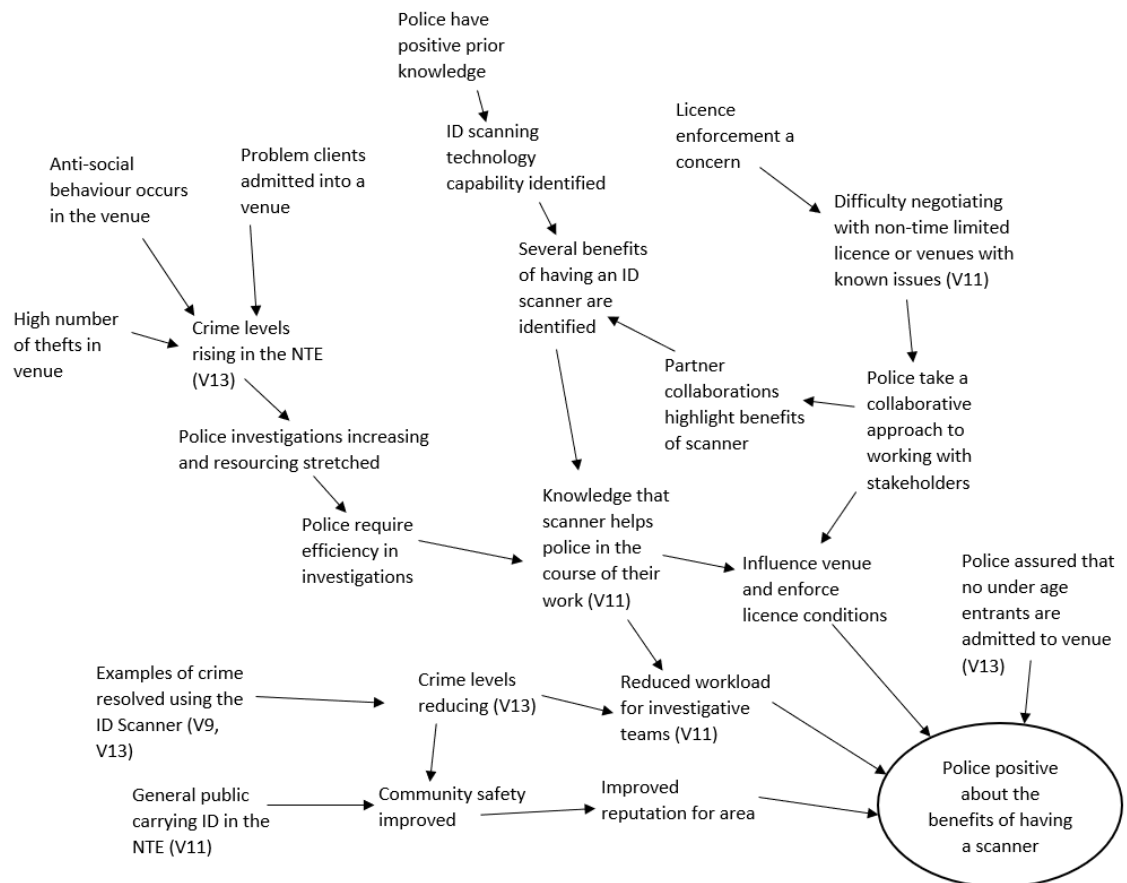
The diagram shows there are many impacts leading to police positivity about premises adopting ID scanners and, of course, this would have major influence on the adoption system. The police work to influence the adoption much in the way Rogers (2003) suggests an innovation champion assists adoption. The energy put into the partnership and the efforts where there is reluctance from a premises to adopt can be extensive and the time and ability to manage partnerships must be considered as a resource impact on the police. This could be countered with the extent of operational resourcing needed from the police if the ID scanner was not in place. There were also indirect consequences identified such as a rise in report of counterfeit ID also impacting police resource. The police reported an increase in the number of overseas students adhering to visa requirements by presenting their real ID in the police station. However, what this diagram does not demonstrate is the collaborative interaction the police have with other stakeholders such as the premises and/or the local authority and which can be addressed later in the analysis.

Referring back to the adoption decision in the research being mostly a voluntary decision, this analysis provides the ability to look conversely at a mandatory decision where a requirement is made formally on a premises' licence which would of course mean there was a decision to implement an ID scanner as the licence would not be agreed without it. Indeed, this had been the case in one of the other geographical areas where data was collected in this study. The choice would be to adhere to the requirement or lose the licence and potentially the business. The causes of events leading up to that point are closely related, if not the same, as the causes which led to a voluntary take up of the technology. This is very insightful and it is these interlinked factors that have been drawn out into understanding about the situation through the use of systems thinking. All these points are very interesting but they do not ensure adoption occurs so, conversely, there is also the need to look at the causes of the lack of adoption. A multiple cause diagram exploring the negative adoption decision is show in Figure 9.4.

Figure 9.4: Multiple cause diagram exploring the negative adoption decision
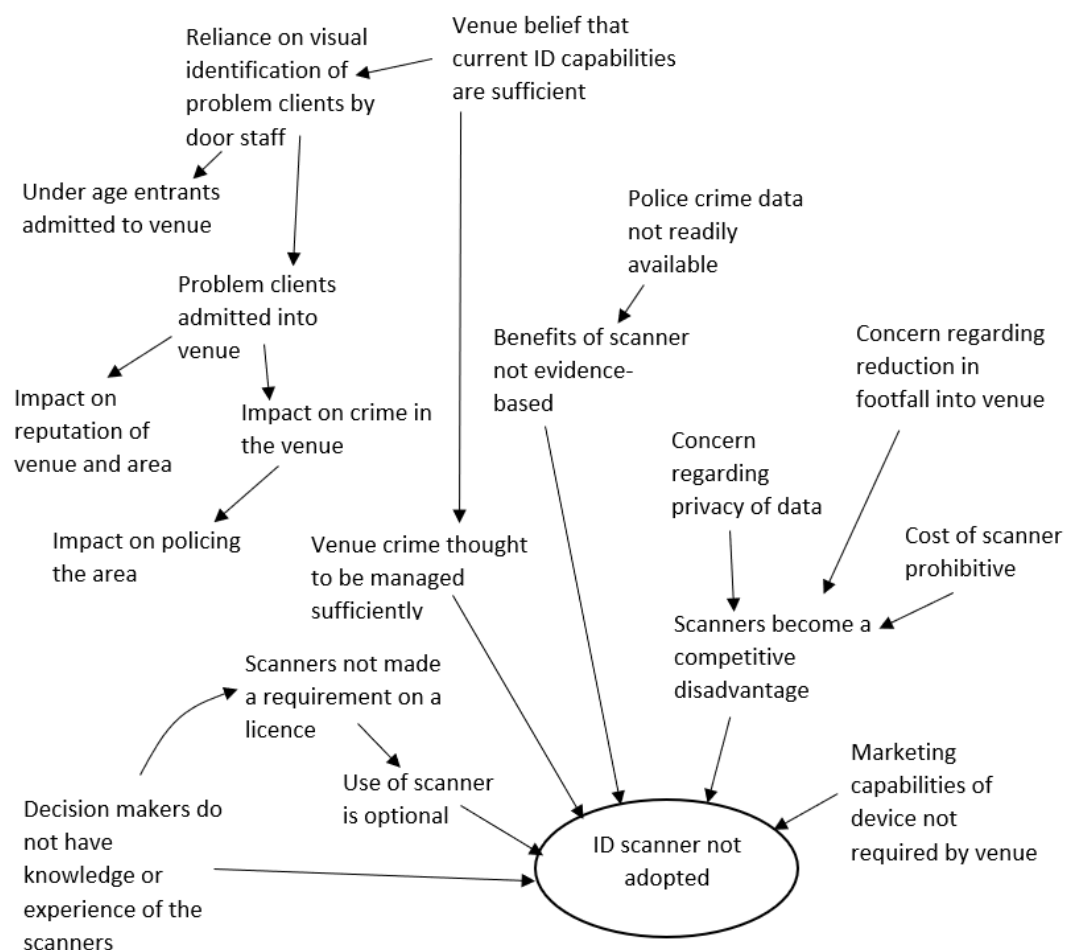
Multiple factors leading to a decision not to adopt were found. These are the issues for which possible solutions should be explored so that a negative adoption decision can be converted into a positive one.

Common interests and objectives amongst stakeholders could be an issue but the diagram does not give the motivations behind those elements. Adoption of the ID scanner is optional in most cases in the geographical area of the main study. The police motivation is to prevent crime but also to investigate and solve crime. The premises, in common with police, wish to prevent crime but for different reasons such as to ensure their reputations remain good and they retain their licences to operate. As the premises have several other considerations such as financial sustainability, they may wish it not to be a licensing requirement. Although this is not the case in all parts of the country, the governance process in the main geographical area of this study means that enforcing premises to use an ID scanner is considered on a case-by-case basis. This has not been without issue. One participant described a situation when the premises approached the local authority for an extension of its licence (a usual process in the case of a change such as a request to extend opening hours) but the police used that application for an extension as an opportunity to request the use of an ID scanner be added to the licence. The police's request was met with an objection. Negotiations were opened up but it meant that the application process became protracted.

Lack of ID verification has an impact on the premises, on crime, and on the police. Much of the content of the multiple cause diagrams point to the premises as the decision maker on whether adopt the ID scanner. The analysis so far has surfaced a wide variety of factors and their causes. This variety suggests that the nature of the decision making in multi-agency adoption is more multifaceted and complex because of the multi-agency context. Even though the multiple cause diagrams have provided an indication of what may need to change and why, they do not show linkages in the situation. The next section takes the analysis further by modelling the adoption through systems maps.

9.3   Modelling the adoption system through systems maps

Using data from the earlier spray diagramming exercises, and information from the multiple cause diagrams, a systems map has been developed to show the structure of the adoption system. This map is shown in Figure 9.5. ID scanners are a technology whose successful adoption and use requires stakeholders to work together in a multi-organisational way. However, the adoption system is in the control of the premises; neither the subsystems associated with the police nor those associated with the local authority can be perceived to be part of the system. The police and local authority can exert strong influence but they are not the decision makers.

Figure 9.5: A systems map of the adoption system

Systems boundary

The adoption system is surrounded by a complex environment. This interpretation of the system helps with an initial stakeholder analysis. In addition to the police and local authority, there are several other groups as well as the general public affecting the adoption or are affected by it. There are reasons why the boundary could be widened. For example, if the funding to purchase the ID scanner came from the police, local authority or, indeed from another source, the funder

would become part of the adoption system. In relation to options for funding ID scanners, one

participant said:

> 'Venues paid for these scanners themselves, there wasn't any funding available to
>
> support the introduction. We tried to push for a late night levy, some of which would be
>
> used to help…venues get a scanner but it didn't get voted in.' (W12).

Taking another geographical area as an example of where ID scanners were adopted as a result of

being a mandatory requirement on a licence, an alternative adoption system is shown in Figure

9.6.

Figure 9.6: A systems map of an alternative adoption system
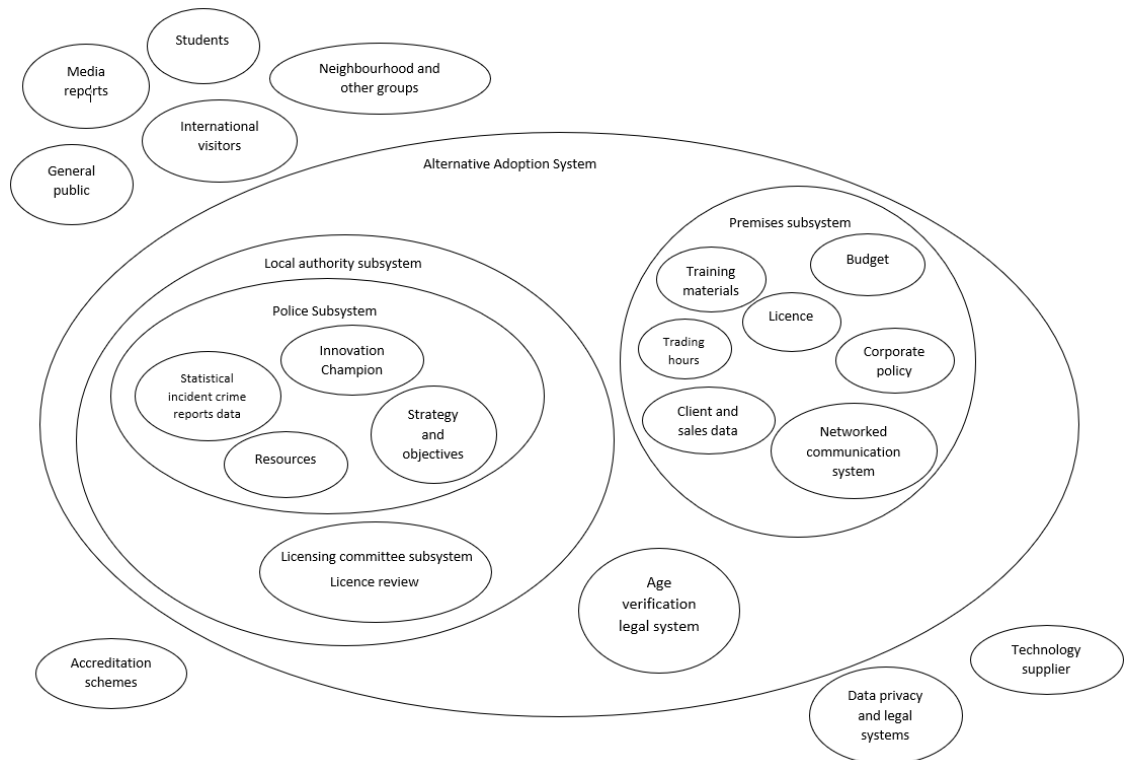
In this case, the local authority lies at the heart of the system. This is because of the approach

taken to proactively specify in the licence arrangement that an ID scanner should be used. It

should be noted however that take-up of the ID scanner was received in a much less positive way

in those places where it was mandated by the licence arrangement. To explore this further, the

interactions between subsystems need to be considered. These subsystems will be discussed in

the next section.

Subsystems

The systems map includes some nested subsystems, awareness of which is important to the understanding of the adoption of the ID scanner.

The purpose of the intervention (the ID scanner) is to address the issues of crime. The crime subsystem contains the components that contribute to the issue and focus an appropriate need for intervention. Often the police exert pressure to address issues but there can also be pressures from other agencies leading to conflicting demands on the adoption system. It can be the case that the regulation system (local authority subsystem) exerts the pressure first, especially where they make the ID scanner a mandatory requirement on the premises licence. The premises subsystem may be stretched in terms of finding the resources needed to fund the purchase and operation of an ID scanner but the impact of its external environment almost demands adoption. The next section looks more closely at what is happening within the subsystems.

The police subsystem

In the adoption system shown in Figure 9.5 the police subsystem influences the adoption system by adopting a role that can be described as the innovation champion. To delve into the police subsystem further and explore relationships the systems map shown in Figure 9.7 has been developed.

Figure 9.7: The police subsystem
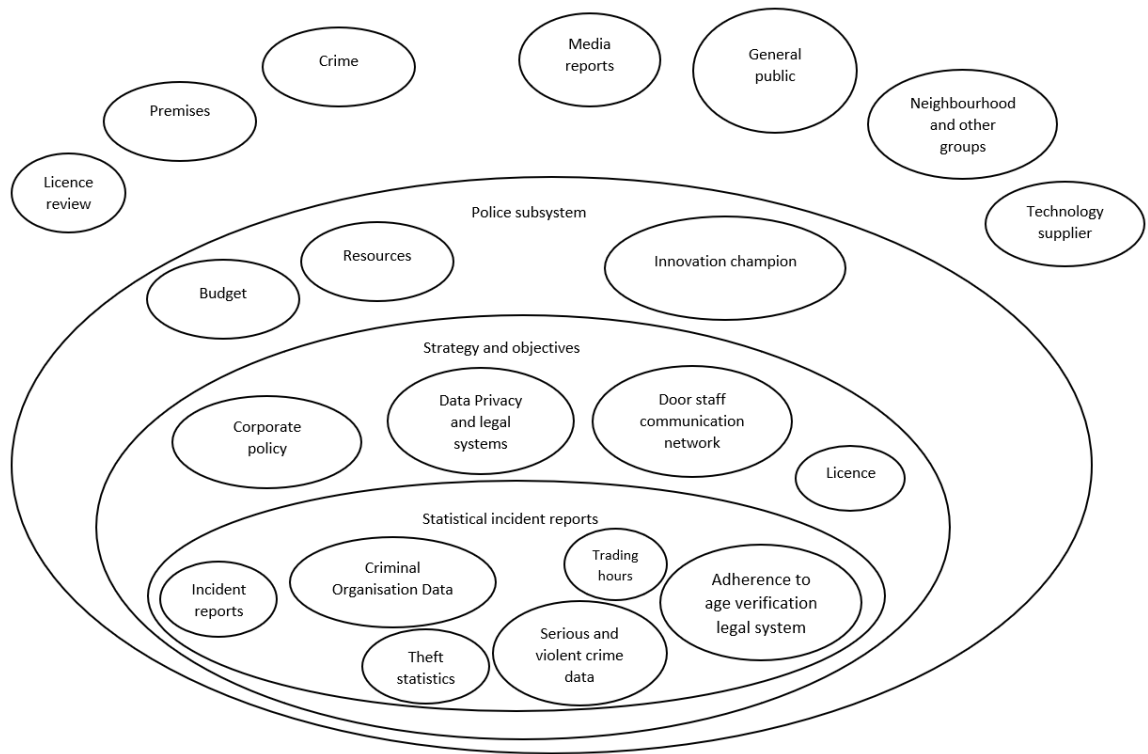
By providing another level of detail, this map of the police subsystem gives further understanding of the complexity the police face in dealing with other agencies both within and external to the system. The police have a complex balance to manage. There is an absence of responsibility for budget or funding yet there is high concern for the impact of crime on the general public.   In this main study where the need for adoption was given high priority so that crime could be reduced, the police operated collaboratively to ensure premises functioned responsibly and that good and strong relationships were built with them. Often having known about the scanner already, they were keen to influence the adoption system to take up the innovation. In this area the police had noticed the value of the ID scanner and took a highly collaborative approach with other bodies to ensure take up of the innovation.

This police subsystem is an area of the adoption system that can be contrasted with the data collected from the different geographical area.

Figure 9.8: The alternative police subsystem
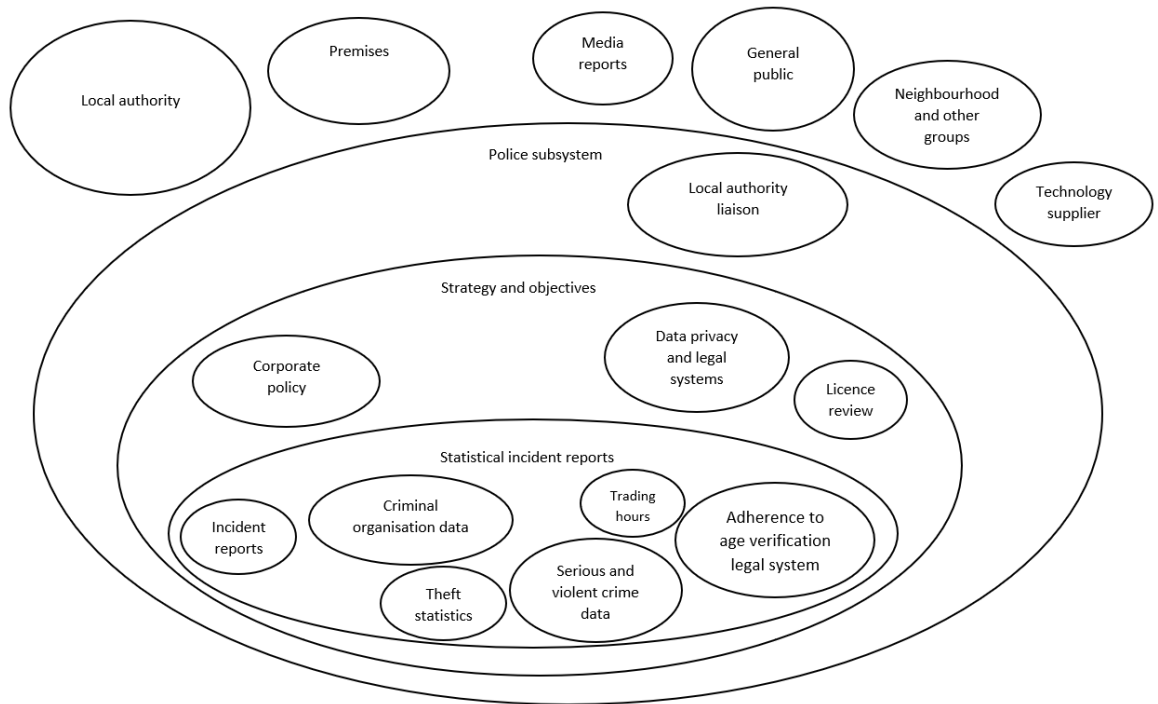
In this different geographical area the police were found to take a very different approach in the way they operated in the system. One police participant said 'we started to ask premises to use the ID scanner…the police tried to talk people into having one…they were told if they didn't sort it out they would be taken to a [licensing] review.' (W11).

The police worked only with the local authority and saw approached adoption through regulation and enforcement as the means with which to compel premises to adopt the ID scanner. Even from the outset the governance route to have the ID scanner added as a licence was less successful than taking a multi-agency collaborative approach and resulted in a limited amount of diffusion. It also caused breakdown of relationships between stakeholders that could have negative consequences.

However, in terms of diffusion and adoption, the adoption system has some commonalities between the two versions. For example, the police still had to hear about the ID scanner themselves before going down the route of adoption through regulation. Not only is the systems thinking approach enabling the situation to be delved into in a deeper way, it is also enabling comparison between geographical areas through looking at different systems and from the

placement of different boundaries. It is also a mechanism that helps to assess the importance of

different aspects of the situation to the police that might be helpful to practitioners. Clearly a

difference was the approach taken in the main study, a strong collaborative approach with the

use of a champion would have had an impact on the premises who are ultimately responsible for

purchasing and implementing the technology. There are of course other roles the police have

such as enforcing the law. They build relationships and get to know the licensees. They belong to

bodies and attend relevant meetings. In the police subsystem, the strategy and objectives for

addressing crime and making the streets safer for everyone but also doing things in an efficient

way. Resources are stretched and the budget features in that system. In the main study of this

research, the police allocated resource to have someone act as that key contact point and

influences of that champion can be seen. This is in keeping with existing frameworks/models such

as the DOI theory by Rogers (*Op. cit.*) but the frameworks/models lacked clarity on how that role

was enacted. As seen in the diagram of the adoption system, the crime subsystem influences the

police. Although the influence from crime could be shown to go directly to the incident reporting,

it has an influence on the police subsystem overall. The crime subsystem also includes many

social factors such as preloading. What still is not shown in this diagram is the relationships

between the police subsystem and that of the local authority. The police work closely with the

local authority. The police participate in the rules, regulations and processes associated with

licensing premises and both are shown in Figure 9.8 to influence the adoption system. Another

example is the local authority subsystem containing the licensing committee where licence

decisions are made. This subsystem is responsible for licence review and has a key influence on

the adoption system via the licence. It has no influence over the technology but has an interest in

the social factors and other factors in the environment, for example ensuring city accreditations

are met or held in high regard. It has less of a role in influencing but as a governing role. Of

course the adoption system must work in tandem with the local authority subsystem. Influence

may become stronger by the local authority when incidents occur or a licence is at risk.

Though when testing the setting in another authority, the police approach was quite different and the local authority was the strongest influence because an ID scanner was made a requirement on a licence. The crime subsystem has a link in to the local authority's incident reporting/stats area. However, both are influenced by crime. What is not found in this analysis is any management of the crime subsystem. The crime is an emphasis on the police, the local authority and on the adoption system itself. One of the reasons for the adoption is to address crime.

In order to undertake the adoption, the premises are faced with a multiplicity of complexity that is revealed through the variety of subsystems. This is in stark contrast to what has been found using existing frameworks/models. Using systems thinking mapping techniques has helped to look at the situation in a critical way as it has enabled analysis and evaluation before judgement is made. The observations presented in this chapter so far all offer insight to the adoption system and therefore impact on diffusion too. This analysis shows there are much broader aspects influencing the system but more investigation is needed. The next section explores some of those influences on the adoption system most commonly discussed by participants in this study.

9.4 Exploring the situation using influence diagramming

By considering the adoption system explicitly as a system, the influences from its wider system and the environment can be better understood. Figure 9.9 builds upon the systems map in Figure 9.5 to make clear the important influences from the wider context and within the system boundary.

Figure 9.9: An influence diagram of the adoption system
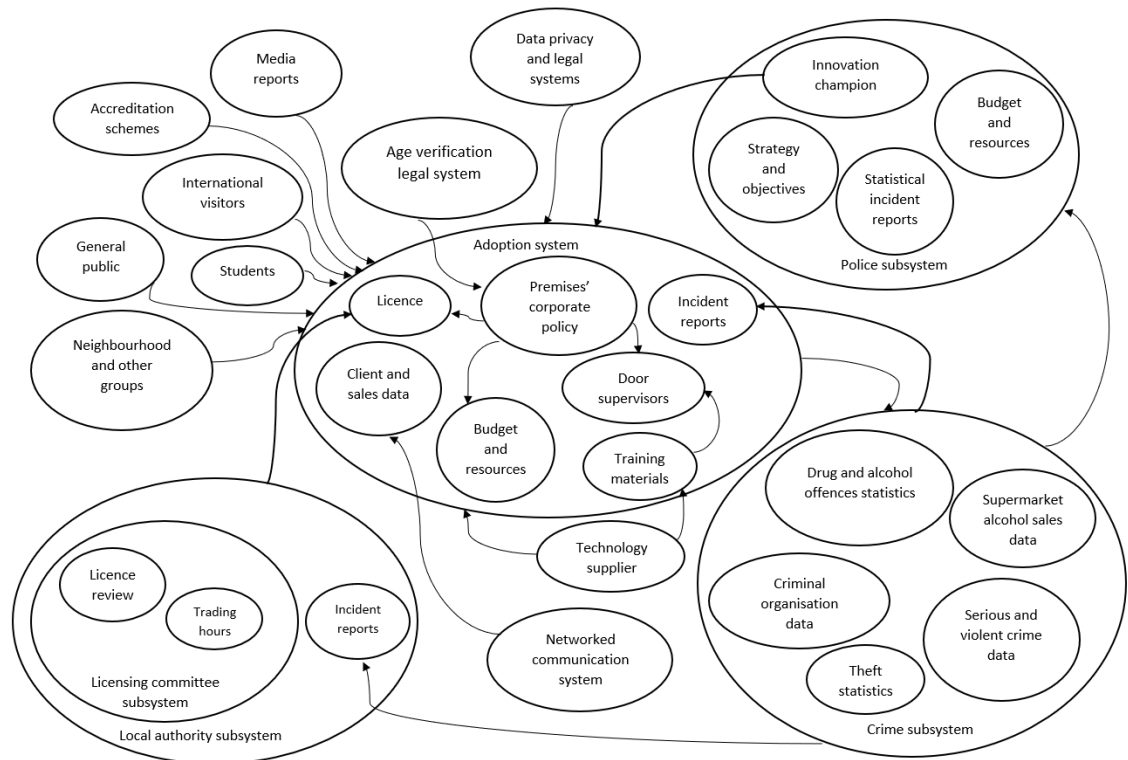
In essence, the premises 'own' the adoption system and, as the interview data made clear, they have prime responsibility for the adoption decision. As the primary adopters, they manage the elements they have control over in the system and have to respond or adapt to influence exerted by the subsystems and elements in their environment. This depiction of the situation in systems terms makes explicit the three major influences on the adoption system that will be discussed in more detail stem from the police, the local authority and the crime subsystems.

The first two of those major influences on the adoption system (influences from the police and the local authority) have already been analysed in some depth in this study but the influence diagram does still provide further insight. It shows that the police subsystem and the local authority subsystem are both comparable in terms of the influence they have over the adoption system but there are differences in how that influence is exerted. The main police subsystem influence on the adoption system arises from the innovation champion whilst the local authority generally exerts its influence via the premise's licence. This is interesting as it provides an

indication about the nature of these relationships. The police rely on individuals to influence the adoption and the local authority influences as a regulatory body.

The third major set of influences is between the crime subsystem and the adoption system. It is interesting because the crime subsystem is not one body or agency - it is formed from multiple components - and it also influences both the police and the local authority subsystems. Where influences of the adoption system on the crime subsystem are concerned, the effects could be significant, as the following quotation from a police interviewee makes clear:

> [the premises] did have an issue with a high number of thefts...and statistics showed the peak number of thefts tended to be in the night-time economy so a way to address the problem was needed. One club was really proactive in adopting the technology…this club saw an 80 per cent reduction in offences in the first 3 months of using the scanner. (V1)

Further reflections can be made using the diagram, for example, there are influences pointing to the adoption system from its external environment but that end at the system rather than at specific components in the adoption system. These are: media reports; accreditation schemes; visitors, students and the public as users of the premises; and neighbourhood and other groups. These groups have views on the operation of the premises and different types of influence that can affect the adoption. An influence diagram of the alternative adoption system is found in Figure 9.10.

Figure 9.10: An influence diagram of the alternative adoption system
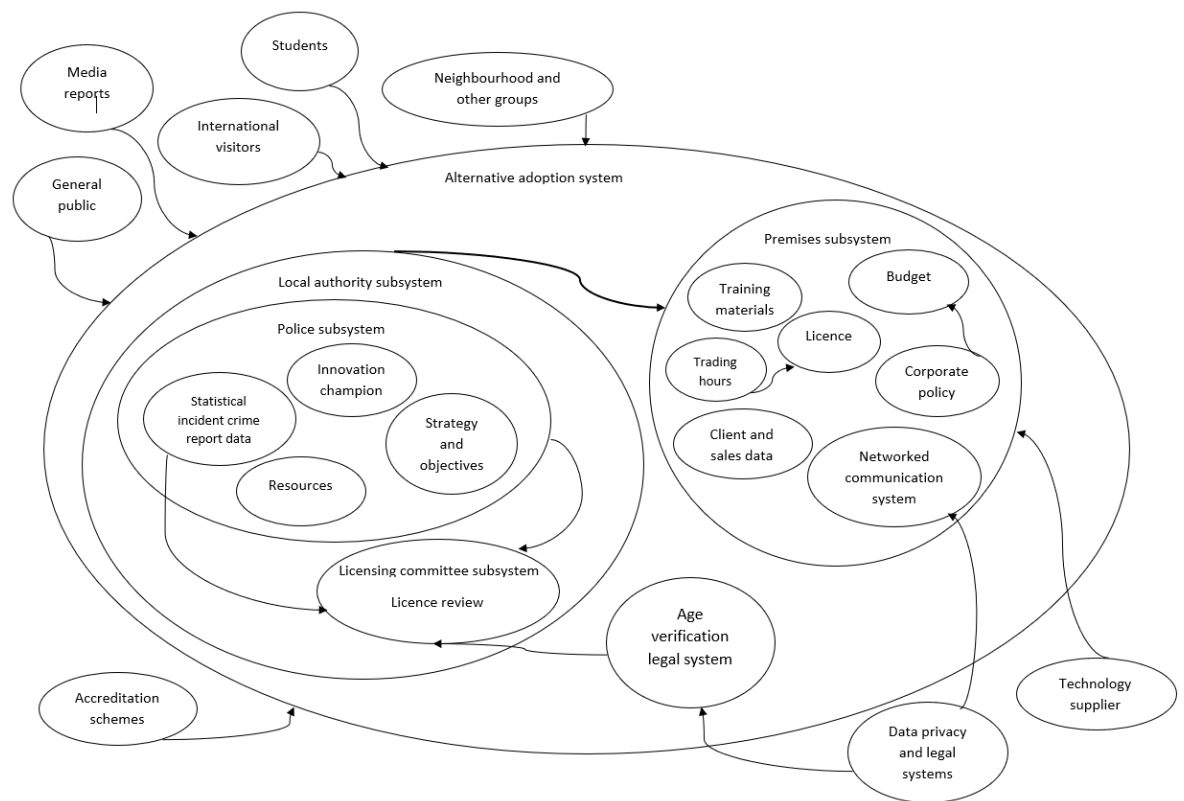
In the alternative system, the main influence is between the local authority and the premises. The police relationships feed in and out of the governance process (the licensing review) and data systems also feed into this. It would be because of the need for a strong case using crime and other data to have the ID scanner mandated on the premises' licence. This also makes the data and privacy factors more prevalent. Resources for the police become less important as they are not spending the time managing the collaboration and with the assumption that the mandatory approach meant a positive adoption of the ID scanner.

Exploring the influences on the adoption system has provided further insights on the interactions and relationships in the system. The influence diagramming has been shown to be a useful tool as part of applying systems thinking. This analysis could be extended further if a system was redefined and if, for example, addressing the crime subsystem became the primary focus of the research rather than the adoption of the ID scanner.

The Formal System Model is used in the next section to further conceptualise the adoption system.

9.5   Evaluation using the Formal System Model

The Formal System Model (FSM), introduced in Chapter 6, is a model that unites many systems concepts and is used here to conceptualise a system, wider system and environment and therefore help structure understanding of relationships amongst them. Building on Figure 9.5, representation in the format of the FSM, Figure 9.11 presents a simplified version of the ways in which factors in the environment disturb the wider system.

Figure 9.11: A simplified version of the ways in which factors in the environment disturb the wider system
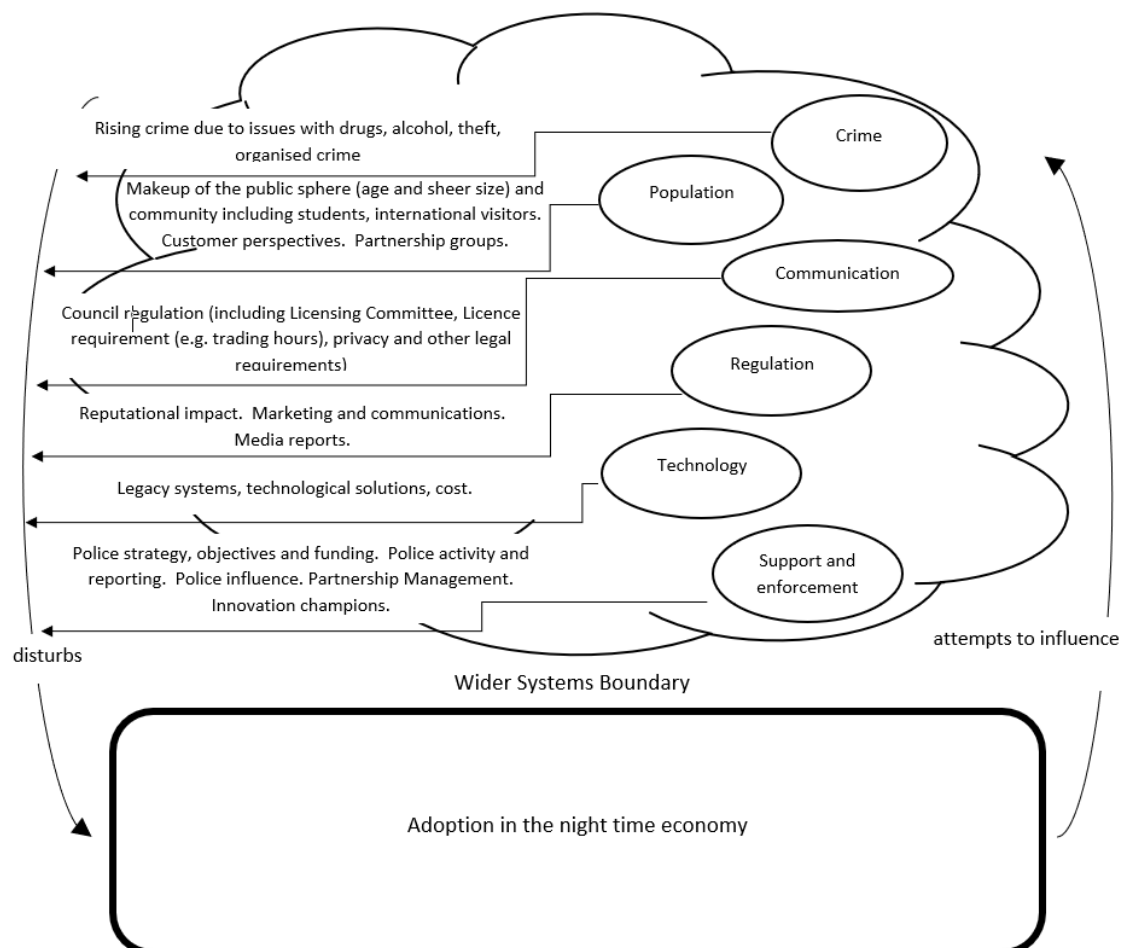
Figure 9.12: Model of the adoption of an ID scanner in the night-time economy using the Formal System Model format
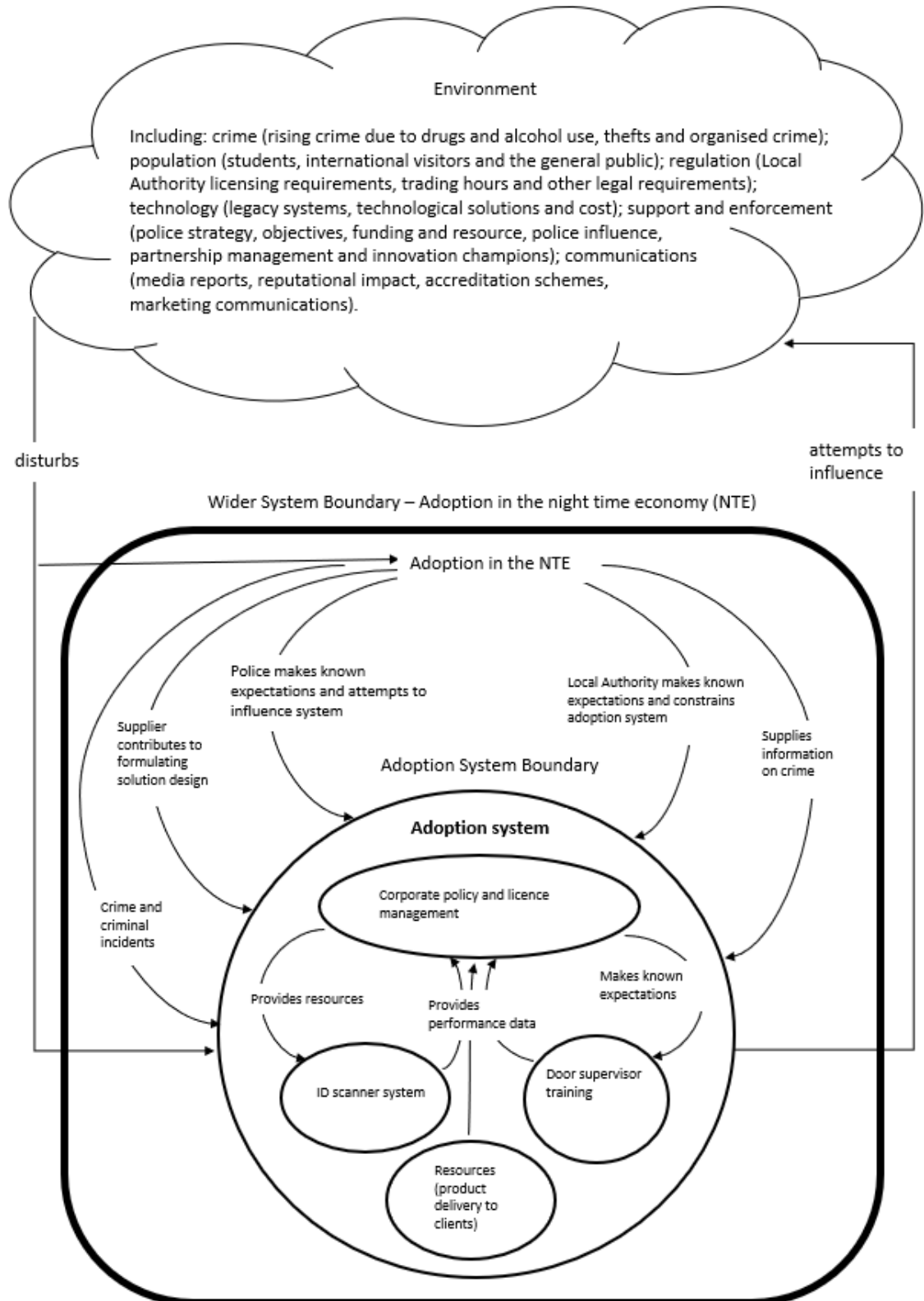
Figure 9.12 shows the adoption of an ID scanner in the night-time economy using the Formal

System Model format. Within the adoption system, the decision-making subsystem (corporate

policy and licence management) decides what problems need to be addressed (for example,

reduce unruly behaviour), which transformations are to be carried out (including use of the ID scanner) and provides the resources, mainly in the form of funding, to enable this to happen. The premises as the primary adopter and some of those working for them may still disagree with, or be unenthusiastic about, the adoption but it is the influence and pressure from the police and the local authority that contributes to a positive adoption decision by the premises.

Although the structure of the adoption system is relatively simple and its mission to adopt the ID scanner is apparently straightforward, its relationships with the wider system and the environment, are neither simple not straightforward and it is those that lead to the complexity and potentially fragile nature of successful adoption. Consideration of the wider system, which in systems terms would be expected to set the agenda for the operation of the system, highlights that whilst the decision to adopt (or not) is technically within the licensed premises' remit, the police and local authority seek to have a significant impact on that decision. The expectations from the police and local authority are made known within the wider system and once the decision to adopt is made known to the transformation subsystem comprising the premises' staff (door supervisors) who will use the new ID scanner, the ID scanner system itself and the resources needed to deliver the products to clients would be implemented. The police do not have direct control and instead were found, in the main data collection area for this study, to use 'collaboration' (a clear sense of collaboration was found in the analysis in Chapter 8) to encourage use of the ID scanner. As the following quotation from an interview with a police source illustrates, the police were often particularly aware of the potential benefits of scanners and have a strong direct influence on the decision by venues to consider and adopt:

> It was a colleague's idea that the ID scanner for clubs could be introduced to deal with violent crime in the night-time economy and support the work of the Night Safe Teams…Relationships with the club managers and owners have been built up and communication with them regularly takes place. The relationships helped the process of 'selling' it to every club. (V11)

The police also work through the local licensing committee when an ID scanner is made a condition of a premises' licence but in this example, their influence over the licencing body would be more subtle. In terms of the FSM, such a requirement would constitute 'making known expectations' and could be viewed as 'legitimising operations'. An example can be seen in this quote from a police source:

> If a club has problems or needs an extension to its licence, such as one that had issues with its door staff, it was negotiated that they introduce the scanner as a measure for tackling its issues instead of being taken to a licence review. (V11)

The nature of the potentially weak links between the wider system and the system in terms of setting expectations is revealing, as is the lack of performance management/monitoring and control functions. The absence of a single organisation or body responsible for performance monitoring makes control by the wider system at best less straightforward.

Both the system and the wider system are operating in a complex and changing environment, for example, because of rising crime (e.g., theft, drug use, serious and violent crime and even organised crime), changes in the population (its demography and culture such as 'pre-loading' which is the practice of obtaining cheaper alcohol to drink before attending a venue) and the falling attendances at clubs. All these changes potentially influence the decision about whether or not to adopt ID scanners. This analysis suggests that main influence the premises has is over the crime subsystem. As decision makers, they can choose to adopt an ID scanner, or implement other measures to counter rising crime. Their influence over other agencies is negligible.

The use of the FSM has helped generalise from a specific example to a general understanding of the relationships involved in multi-agency technology adoption and highlight the mechanisms available to bodies like the police in situations where they do not have explicit direct responsibility for decisions. Comparison between the model shown in Figure 9.12 and the idealised FSM model (Figure 6.1) reveals a number of areas of discrepancy.

The aspects of the FSM provide a set of factors that can be used to ensure there is a key

foundation for successful adoption. These factors are set out in Table 9.1 below.

Aspect of the Formal System Model	Discrepancy and comment
Environment	The influences in the environment are numerous and a significant level of complexity is apparent (See Figure 9.11). There was evidence to suggest that that the Wider System responded to disturbances from the environment. For example, the need to reduce crime influenced the police setting their expectations of adopting an ID scanner. The police prior knowledge of the technology (e.g., where it had been used successfully elsewhere in the UK and that information had been shared with the force in question) and of its benefits, made them highly positive about the technology and they in turn set their expectations to the system. However, the Wider System failed to fully consider environmental influences adequately. In the Adoption System, attempts are made to influence the environment. Adopting an ID scanner directly influences crime but any other influences over the environment were unsuccessful or not apparent.
Formulates initial design/decides on transformation	There was no evidence that the Wider System set out a plan or measures of performance for adoption. There are no formal processes to keep the Adoption System informed and no central partnerships management or coordinating point that would share plans, successes or issues and risks. There was significant emphasis on collaboration and goodwill in keeping other stakeholders informed and networking between agencies. In the Adoption System, the decision making subsystem had corporate policy, plans and had control of the funding.
Provides resources	At the Wider System level the provision of the necessary funds to adopt the ID scanner was inadequate. Resourcing the adoption of an ID scanner was left to the Adoption System to identify the source of funding yet, this was difficult in an industry already in economic difficulty. Also in the Adoption System, the skills and resources of door supervisors were also the responsibility of the licensed premises. However, participants reported that the technology was easy to use and little training was required and this aspect was in little need of analysis.
Makes known expectations	The Wider System has set the need for an ID scanner. There were some unsuccessful attempts to gain commitment voluntarily but pressures from the police and the local authority usually resulted in a positive adoption. In another location (the alternative adoption) a mandatory approach had been taken but that had been met with some resistance and led to broken relationships between stakeholders. Having joint, sound objectives through working together would be beneficial.
Supplies performance information	There is an absence of performance information in the Wider System and the Adoption System. There appears to be no evidence of feedback from the subsystems that carried out the transformations. Some participants discussed performance data on crime incidents but most were designed and used locally in the premises for their own purposes. Some participants reported success in reducing crime but the pockets of information were not strategically gathered and it did not operate as a system.
Decision-making subsystem	There is no consistent decision-making. The police and local authority rely on 'collaboration' and negotiation. Unless premises do not engage or in the case of very serious crime incidents, the local authority can then enact the ID scanner onto the formal premises licence and forcing the adoption decision.
Subsystems that carry out transformations	The Adoption System carried out the all the transformations (the adoption of the ID scanner).
Performance monitoring subsystem	There was no evidence of a formal performance monitoring system. Some evidence exists of informal mechanisms for feedback between subsystems. For example, feedback into the corporate management system came from: door supervisors; data from the ID scanner; and client and sales data. These types of data would be useful combined into information useful for a performance monitoring system.

Aspect of the Formal System Model	Discrepancy and comment
Change Agent	There is evidence to suggest that individuals were acting as 'Change Agents' in the Wider System and evidence suggests the police generally performed that role to promote and influence adoption. There was no post-adoption reviews that had taken place. Indeed, participants explained the difficulty to uninstall once an ID scanner had been adopted so perhaps there was little need to post-review.
Viewpoints	Multiple perspectives were evident in the environment, the Wider System, the Adoption System and subsystems. Many participants described the collaborative nature of the multi-agency working as crucial to the adoption of the ID scanner and that it worked really well. In the Wider System, it became the responsibility of the police to negotiate the adoption by discussing the benefits with the premises and liaising appropriately with the local authority. These views were taken account of by the Adoption System as the ID scanner was adopted. Users did not form part of the Adoption System though would play a key part in carrying and presenting their ID.

Table 9.1: Discrepancies revealed by comparison with the Formal System Model

The discrepancies identified in Table 9.1 illustrate the fragile nature of the situation when compared with the Formal System Model. The FSM was originally devised to understand failures that had already happened. Here the FSM-based analysis shows the absence of a coordinated approach to the planning, and adoption of the ID scanner and hence its potential for failure.

Although the nature of the potentially weak links between the wider system and the system in terms of setting expectations are a major finding of this study, there are other significant areas of interest such as the lack of performance management/monitoring and control functions. The absence of a single organisation or body responsible for performance monitoring makes control by the wider system more difficult. Despite the absence of a coordinating body, there were effective means of communication. The evidence collected showed that collaboration and communication between agencies was very positive.

The use of the FSM has helped structure understanding of the relationships involved in a multi-agency technology adoption and help explain the mechanisms available to bodies like the police in general rather than case-specific terms. The FSM helps take account of all the components, factors and variables identified in this research that are important to technological diffusion and adoption. This analysis therefore demonstrates the effectiveness of the FSM having been used as a research tool to conceptualise a system, wider system and environment and has helped structure understanding of relationships in this new context. This study suggests that if the

Formal System Model was used very early in the adoption process it could act as a framework on which to build the model for diffusion and adoption of an innovation.

The next section summarises this chapter.

9.6   Summary of chapter

This chapter showed the use of the data to apply systems thinking as an analytical framework to explore the adoption of an ID scanner in the night-time economy and which of the many systems that could be identified and constructed to advance understanding. First, multiple causes and effects were looked at. The diagramming techniques allowed originating influences affecting the adoption system and any associated complexity to be analysed. The information led to the adoption system being identified as a system of interest. Next, the subsystems were examined and influences were explored. The analysis enabled a deeper level of thinking about diffusion and adoption and not just focussed on a set of elements as the existing frameworks/models had set out.   The Formal System Model was then used as a way to be comprehensive in considering a situation in systems terms. A summary of the findings in this chapter is found in Table 9.2 below.

Systems analysis technique	Insights gained
Multiple cause diagrams	Influences were found to affect the adoption system (Figure 9.2). Examples are the two main influences of different routes into a positive adoption: voluntary or mandatory. The analysis of the complexity surrounding those causes highlighted: whether there was prior knowledge of the innovation; perceived benefits of the innovation; reputational factors affecting the premises and the wider area; impacts on staff (door supervisors); impacts and causes from crime; the role of the police and other stakeholders; and communication and awareness between stakeholders. The role of the police was examined in further detail (Figure 9.3). Factors identified and explored from this diagram included: activity and impact by the police on the premises; police resourcing; addressing crime; and indirect consequences. An alternative adoption system was also examined to understand the negative adoption (Figure 9.4). Analysis of the complexity included understanding: barriers to adoption; police motivations; economic factors; and governance processes. A wide variety of factors were surfaced and insights discussed. They have provided an indication of what needs to change and why.
Modelling systems	Neither the police nor the local authority are perceived as part of the system (Figure 9.5). The modelling re-enforced the view that the police were not part of the adoption system. However, the police and local authority subsystems both can exert strong influence and affect adoption. The nature of linkages between stakeholders was identified in particular

Systems analysis technique	Insights gained
	the significance of the link between the police and the premises over matters such concern for the public; the reduction in crime; and sharing knowledge about innovations. (Figure 9.8). The alternative adoption system (Figure 9.6) showed a heavy reliance on the crime subsystem, for data to prove the case needed to adopt. However, this caused a breakdown of relationships between stakeholders that could have negative consequences. The police subsystem (Figure 9.7) showed a highly collaborative approach by the police and alternative police system (Figures 9.8) highlighted the complex management of relationships between stakeholders. The stakeholders at times working together in a multi-organisational way. For example: building relationships; 'getting to know' the licensees; belong to relevant bodies and attend meetings; and participate in the rules, regulations and processes associated with the licensing premises. The premises, as the primary adopter, are found to face a multiplicity of complexity.
Influences	The notion of innovation champions was highlighted but this analysis made explicit that were not just one individual but arose out of the systemic nature of the situation and through networks and partnerships. A sense of the very strong influences exerted by different stakeholders over the adoption was gained (Figure 9.9). The alternative adoption system was also analysed (Figure 9.10). For the premises, insights into the strength of influence they face from the environment were gained. The analysis found no management of the crime system but it comprised of multiple elements indicate the importance in adoption.
Formal System Model	The Adoption System, its Wider System and environment was conceptualised (Figures 9.11 and 9.12). The FSM illustrated the significant level of complexity in the environment and all factors that were potentially influencing the Wider System were analysed. The links between the environment and the Wider System where the police and local authority would set their expectations on the Adoption System were revealing and the extent of the wider system and environment revealed the potential fragile nature of successful adoption. The Adoption System was found to make attempts to influence the environment but its own real strength and power was within the Adoption System. There was an absence of performance planning or measure of control usually set by the Wider System. There was also no central partnerships management or coordinating point. There was significant emphasis of collaboration between all stakeholders. There were several findings relating to resources. The Adoption System as the primary adopter provides the funding and resources to adopt and maintain the ID scanner. Other weaknesses were identified including: inconsistent decision-making and a reliance on relationships; no consistent policy or process for capturing, sharing or monitoring crime data; no post-adoption reviews had been evidenced; no performance monitoring system; and the key part played by users of the ID scanner and clients of the premises but who were not part of the Adoption System. The learning from the application of this model and the findings suggest that the FSM could be used as an analysis tool for complex diffusion and adoption.

Table 9.2: Summary overview by type of diagram

The understanding of the situation is vastly improved by the use of systems thinking tools and techniques which incorporated the views of all pertinent stakeholders and those views enhance knowledge and understanding about the adoption of the ID scanner in this context.

The FSM proved a very useful tool in this new context. It took account of all the factors and variables important to diffusion and adoption and went beyond the findings from the analysis using three existing diffusion and adoption frameworks/models. By comparing the model in this research to the FSM, it has helped explain the roles and influences taking place in multi-agency diffusion and adoption. The learning from this chapter has resulted in a full picture of adoption being made and the FSM acting as a framework on which to build the model for diffusion and adoption. It shows that all the necessary factors critical to success of the adoption or, indeed accounting for the decision not to adopt, could be taken into account and combined into a holistic understanding.

These findings will be further discussed in Chapter 10.

Chapter Ten: Discussion

10.1   Introduction to Chapter 10

This chapter draws together research with an emphasis on new understanding that has the potential to aid successful diffusion and adoption of an innovation in a multi-agency setting. First, in order to consider whether systems thinking enhances or replaces the existing frameworks/models, the framework set out in Chapter 5 (Table 5.5) is used for further analysis. The extent to which systems thinking matched or went beyond those criteria is assessed. Next, the results of the earlier analysis of the field study together with the further analysis is used to develop a systems-based approach to diffusion of a technology. Lastly, the potential for practice stemming from the thesis is summarised. Finally, a summary of the chapter is made.

10.2   Further analysis and findings

In Chapter 4 an extensive literature review established several gaps relating to research on diffusion and adoption. Indeed, the literature suggests there were several ways diffusion and adoption research could be improved. A systematic and structured approach to further analysis that set out the aims, processes and anticipated outcomes of this study was presented as a framework in Chapter 5 (Table 5.5). (As a reminder, the framework is repeated here as Table 10.1).

Stage	Aims	Process	Output of the process	Criteria
1	To ascertain the extent to which each framework/model and systems thinking improved the approach to learning about diffusion and adoption in a multi-agency setting, including consideration.	Review of literature. Application of data to each selected framework/model (three in this research.) Application of systems thinking to data.	Report on extent of systemic elements in the existing frameworks/models. Data mapped to the selected frameworks/models using relevant tables and diagrams and a report made. Systems thinking applied to the data and multiple cause diagrams, systems maps and influence diagrams used. The FSM also applied. A report is made.	Ease of application of the four approaches. Commonalities and gaps derived from each of the four applications.

Stage	Aims	Process	Output of the process	Criteria
2	Understand the factors and variables affecting successful diffusion and adoption by demonstrating the ability of each framework/model and systems thinking to identify, consider and understand factors and variables involved.	Application of data to each selected framework/model (three in this research.) Application of systems thinking to data.	Relevant diagrams and tables used to examine the extent to which factors and variables can be identified, analysed and understood. A report is made.	Identification of the pre-specified factors and variables from each framework/model (and the extent to which systems thinking was able to address the same factors and variables). Assessment of strengths and weaknesses of each application. Identification of any further factors and variables that may have been found by using systems thinking and understanding gained.
3	Understand the framing of adoption decisions for decision makers in a multi-agency situation.	Application of data to each selected framework/model (three in this research.) Application of systems thinking to data.	A series of spray diagrams. Report on the application of existing frameworks/models and the extent to which the adoption decision could be understood. A series of diagrams using systems thinking tools and techniques.	Understanding the framing of the adoption decision for each of the four applications. Extent to which each application considered influences and multi-agency diffusion and adoption and the understanding gained.
4	To identify any insights provided by systems thinking beyond those found by applying the existing frameworks/models.	Application of data to each selected framework/model (three in this research) Application of systems thinking to data.	A series of spray diagrams Report on the application of existing frameworks/models and the extent to which the adoption decision could be understood. A series of diagrams using systems thinking tools and techniques.	Any new insights (beyond those provided by the factors and variables in Stage 2) provided by each of the four applications.

Table 10.1: Framework for further analysis

Table 10.2 summarises the findings of the research in the format of the framework. The table

also specifies the chapters, tables and diagrams where evidence of the findings can be found in

this thesis.

Stage	Aims	Process of analysis	Output of the process	Findings
1	To ascertain the extent to which each framework/model and systems thinking improved the approach to learning about diffusion and adoption in a multi-agency setting,	Review of literature to also consider the systemic nature of existing frameworks/models. Apply three selected frameworks/models and analyse.	The absence of systemic elements in existing frameworks/models was reported in Chapter 4. Chapter 8 reported on application and analysis of three existing frameworks/models.	Systems thinking was found easier to apply especially due to the flexible and organic approach to using tools and techniques. It was possible to identify stakeholders using existing frameworks/models but absences were also found.

Stage	Aims	Process of analysis	Output of the process	Findings
	including consideration.	Apply systems thinking and analyse.	Chapter 9 reported on application of systems thinking. Table 8.2, Fig. 8.1 and Fig. 8.2 revealed a gap in taking account of interrelationships that could be crucial to understand complexity and multi-agency working. Table 9.2 provides a summary of the outputs of each of the types of systems diagrams used in the analysis and demonstrates the enhanced understanding gained from their use.	Systems thinking provided an improved way to examine all stakeholders in this context. Systems thinking was not limited to consideration of one organisation and took account of the stakeholders' very different goals and objectives. This wider consideration enhanced the understanding gained. Systems thinking also added value by providing the opportunity for stakeholders to be participants in the research thus supporting an iterative and reflexive approach to understanding diffusion and adoption. Further, there was potential for group learning using systems thinking and the Formal System Model.
2	Understand the factors and variables affecting successful diffusion and adoption by demonstrating the ability of each framework/model and systems thinking to identify, consider and understand factors and variables involved.	Identify codes and themes found in the data in this study. Apply three selected frameworks/models and analyse. Apply systems thinking and analyse.	Tables 7.2 and 7.3 show the factors, variables and linkages found in the data. Chapter 8 reported on application and analysis of three existing frameworks/models. Chapter 9 reported on application of systems thinking.	From the outset the initial data analysis led to the identification of many additional factors and variables that might have not been found using the existing frameworks/models. Clear benefits were derived from the application of systems thinking which made explicit the wide range of factors and variables that could be identified, considered and understood.
3	Understand the framing of adoption decisions for decision makers in a multi-agency situation.	Get to 'know' the data by using a series of spray diagrams. Apply three selected frameworks/models and analyse. Apply systems thinking and analyse.	Chapter 7 reported on pre-analysis. Fig. 7.1 shows a spray diagram that explores the adoption decision and a further series of spray diagrams delve into the decision in more depth (Figs. 7.2 to 7.7.) Chapter 8 reported on application and analysis of three existing frameworks/models. Chapter 9 reported on application of systems thinking. Table 9.1 summarises findings after using FSM to unite all factors that can be used as a foundation for successful diffusion and adoption.	The multi-agency collaborative elements were found to be examined in more depth using systems thinking. Applying the FSM revealed the complex nature of the environment of the Adoption System and provided a way to make it explicit. Therefore, understanding diffusion and adoption was enhanced using systems thinking. Whilst it was possible to map data to the existing frameworks/models, uncertainty remained and conclusions about the success of the adoption could not be drawn. The application of systems thinking was able to provide a deep understanding of diffusion and adoption in this context.

Stage	Aims	Process of analysis	Output of the process	Findings
4	To identify any insights provided by systems thinking beyond those found by applying the existing frameworks/models.	Apply three selected frameworks/models and analyse. Apply systems thinking and analyse.	Chapter 8 reported on application and analysis of three existing frameworks/models. Table 8.2 shows the data mapped data to Rogers' (2003) five characteristics for successful innovation. Chapter 9 reported on application of systems thinking.	New insights found by applying systems thinking included: • Consideration of data and privacy. • Using the ID scanner to tackle the important crime of violence against women and girls. • An argument for a network approach to diffusion and adoption. These insights were not found using existing frameworks/models.

Table 10.2: Summary findings of framework of analysis

The next section discusses findings from each of the stage of the framework in turn.

10.2.1 Approach to learning about diffusion and adoption

Using those outputs and the criteria set out in the framework, a comparison between existing frameworks/models and systems thinking has been made. In all stages of this work, systems thinking has been found to provide greater understanding of diffusion and adoption in a multi-agency setting. For example, it was reported in Chapter 8 that Rogers' diffusion of innovations (2003) theory was not found to enable sufficient depth of understanding of the adoption system. In Tornatzky and Fleisher's Technology Organisation Environment (1990), there were similarities with systems thinking, for example, that the context did serve to constrain or facilitate the adoption decision. In the Technology Acceptance Model by Davis (1986), there were differences in emphasis of application, for example, perceived usefulness and ease of use were factors expected to have very positive outcomes yet were found to have very little influence on the outcome of the adoption of the ID scanner. These differences in findings arise from the absence of consideration of the systemic nature of this complex multi-agency situation by those frameworks/models. Being able to take account of the stakeholders' very different goals and objectives and interactions was an important requirement to understanding multi-agency adoption. The findings in Chapter 9 (the application of systems thinking) were that the knowledge and understanding gained from using systems thinking went beyond that provided by the analysis using existing frameworks/models.

Systems thinking allowed a move away from just a presumption of what constitutes successful diffusion and adoption (e.g., by using pre-defined factors and variables) to exploring as many underlying factors as possible. The stakeholders' different perspectives were examined in depth. Using systems thinking revealed the very strong influence the police have on the adoption of ID scanners and allowed multiple influences to be explored. Whilst some frameworks/models indicated that improving communication channels would allow the technology to be 'rolled out', the application of systems thinking showed this was not the case. A collaborative approach to diffusion (where the police were supported by other agencies such as the premises as the primary adopter) was an important factor contributing to successful adoption (See Section 9.4). This finding meant that choices of how to act, influence and ultimately support adoption are better understood because of the deeper examination of diffusion and adoption that can be undertaken using systems thinking. Therefore, in practice, it is likely more successful solutions to adoption can be found using this approach.

A variety of insights were provided by participants in this study about the partnerships and networks and the multitude of organisations operating alongside policing (Chapters 7, 8 and 9). Often it was the efforts by the police that drove successful adoption. Some of the time it was because they had known it to work from information they had been passed from other police forces. They had been convinced of its benefits as a crime detection and prevention tool and they purposely built relationships with the aim of facilitating the adoption of a technological innovation. These interconnections and the examination of the potential benefit of the police efforts were only captured when systems thinking was used. Allocating resource for partnership management to enable technological adoption may not always be seen as a priority but the benefits can be vast (Al-Tabbaa et al., 2019). These insights show enhanced understanding to the adoption decision was offered and, in practical terms, by using FSM, the extent of the options and impacts can be assessed earlier in the process therefore removing barriers and improving diffusion and adoption.

Amongst the insights arising from the use of systems thinking was a general belief that adopting the ID scanner secured an improvement in crime reduction and prevention and as a result there was as an apparent common purpose. However, the stakeholders voiced quite different goals and objectives. Some took up the ID scanner because of their previous positive knowledge and others because of influence from the police and/or the local authority. Taking Roger's Diffusion of Innovations theory (2003) as an example, the focus on stakeholders was mainly on a population categorised by their propensity to adopt. This level of analysis could still be useful once early work using systems thinking had been conducted. As there had been no formal infrastructure set up to implement the adoption, there was no one central team or source of support for defining, designing or making the transformation (the adoption). The premises were left to their own devices to fund and implement the ID scanner. The police and other stakeholders were expected to carry out their normal duties whilst putting resource into the collaborative partnership management and build and develop relationships. The police, with their wider remit to address crime amongst other priorities, and with their knowledge and partnership links were suitable for such a role. The role of partnership manager and relationship development was not strategically agreed or formalised but was one the police mainly carried out. The collaborative approach taken by police in this study clearly showed there was benefit to all parties by engaging in this way of working and there were many channels of communication inherent in the situation often ad-hoc but more often than not led by the police. This level of collaboration connects and influences the understanding of the adoption. During the application of the Formal System Model (FSM) (Bignell and Fortune, 1984) (Section 9.5), it was found a central partnership and coordination point to manage the adoption process would strengthen the outcomes. Through that central coordinating point, group application of systems techniques could be managed. Using the FSM to identify, illustrate and examine the variety of stakeholders, their goals and objectives and the influences of the variety of impacts on the adoption of the ID scanner provided evidence of iteration in the analysis process (See Figure 9.12). Systems thinking, more generally, enabled earlier influences prior to the adoption decision to be explored.

The FSM took account of all the components, factors and variables identified in this research that are important to technological diffusion and adoption. More than the existing frameworks/models (Chapter 8), the FSM incorporated the varied components, factors and variables of importance to technological diffusion and adoption. This analysis, therefore, demonstrates the effectiveness of the FSM as a tool to conceptualise a system, wider system and environment and here has helped structure understanding of relationships in this new context. When used for analysis, the FSM provided a coherent learning framework, with structured approaches to incorporate iteration. It seems reasonable to assume that when used collaboratively, the FSM also has the potential to provide a participative approach to adoption initiatives. Increasing involvement by stakeholders in the wider decision processes has the potential to create a more iterative and reflexive approach. Such a participatory process would allow stakeholders to articulate their perspectives and to consider the perspectives of others that also have a role in adoption and diffusion. As with all sound participatory processes, this realisation may in turn lead to their own perspectives changing and different decisions being made. Given the involvement with the participants interviewed in this research, it is likely they would have been open to a systems-based participatory action research initiative had one been available and, therefore, there is potential to advance theory further (Chevalier et al. 2019).

10.2.2 Factors and variables affecting diffusion and adoption

The review of the literature reported in Chapter 4 identified an important problem with the identification and consideration of factors and variables affecting diffusion and adoption. It appeared that no definitive set of factors and variables had been established. Indeed, the literature suggested the need to consider if there were other factors to be discovered beyond that specified in a framework/model or to combine existing frameworks/models with one or more of those frameworks/models. The analysis of the field study (Chapters 7, 8 and 9) found the understanding gained by using pre-defined characteristics such as those found in the existing frameworks/models was limited. For successful diffusion and adoption in a multi-agency situation there needs to be an ability to examine the situation fully and to use the understanding to

generate a strategy. Table 10.3 shows the factors and variables that were commonly found in the

existing frameworks/models and those identified from the findings of this research.

Common factors/variables found used in existing frameworks/models	Diffusion of Innovations (Rogers, 2003) (Chapter 8)	Technology Organisation Environment (Tornatzky and Fleischer, 1990) (Chapter 8)	Technology Acceptance Model (Davis, 1986) (Chapter 8)	Systems thinking (Chapter 9)
Actual use of the innovation	The ID scanner was found compatible and easy to use (Table 8.2.)	Not identified.	It was possible to confirm the ID scanner was easy to use but this did not provide insight into understanding the nature of its adoption (Section 8.4.3.)	It was also confirmed that the scanner was easy to use and systems thinking was also used to explore causes of that thinking (Fig. 9.2.)
Use of the technology (attitude and behavioural)	Not identified.	Not identified.	Not identified.	Previous knowledge and influences on perceptions were reasons impacting adoption (Fig. 9.2.)
Availability (of the technology)	Not identified.	Not identified.	Not identified.	Previous knowledge and influences on perceptions were reasons impacting adoption (Fig. 9.2.)
Characteristics (of the technology)	The ID scanner has good relative advantage and was found compatible and easy to use. Trialability and observability were not found in this study (Table 8.2.)	The ID scanner was found to be discontinuous in a departure from existing equipment (Section 8.3.1.)	It was possible to confirm the ID scanner was easy to use but this did not provide insight into understanding the nature of its adoption (Section 8.4.3.)	In addition to characteristics being identified, important perspectives on the technology were explored including perceptions of its potential to improve safety in the night-time economy (Fig. 9.2.)
Communication processes	Impersonal marketing was the main process identified (Section 8.2.2.)	It did not provide much insight into linkages and potential impacts on adoption through communication (Section 8.3.2.)	Not identified.	The FSM provided the ability to explore several aspects of communication finding that collaboration was used to encourage use of the ID scanner (Fig. 9.12.)
Complexity	Complexity surrounding the influences and relationships affecting adoption was identified (Section 8.2.1).	Not identified.	Not identified.	Multiple causes influencing the system were explored (Fig. 9.2, Fig. 9.3, Fig. 9.4) and the adoption system modelled (Fig. 9.5, Fig. 9.6, Fig. 9.7, Fig. 9.8) unravelling complexity in the situation.
Formal and informal linking structures (interconnections)	Not identified.	Formal and informal linking structures were identified (Table 8.4.)	Not identified.	Many linkages were identified and explored using multiple cause diagramming (Fig. 9.2). Additionally, the

Common factors/variables found used in existing frameworks/models	Diffusion of Innovations (Rogers, 2003) (Chapter 8)	Technology Organisation Environment (Tornatzky and Fleischer, 1990) (Chapter 8)	Technology Acceptance Model (Davis, 1986) (Chapter 8)	Systems thinking (Chapter 9)
				adoption system was modelled identifying a wide range of linkages in the situation (Fig. 9.5.)
Individual (leader) characteristics: attitude toward change	It was identified that individual knowledge led to persuasion and that influenced decision making though adopters did not have a particular view or stance on the innovation (Section 8.2.3).	Not identified.	Not identified.	Specific influences by the police were identified and explored (Figs. 9.2 and 9.3.)
Characteristics (industry and market structure)	Not identified.	Crime and the changing night-time economy was identified (Section 8.3.3.)	Limited understanding was drawn as the model focuses on one organisation (Section 8.4.1.)	The extensive environment impacting the adoption system was fully explored (Fig. 9.11.)
Organisational slack	Not identified.	Although a factor in the model, no issue with availability of resources was found in the data (Section 8.3.3.)	Not identified.	Resources were explored using the FSM (Fig. 9.12, Table 9.1.)
Regulation	Not identified.	Regulation through licensing was identified but no further understanding gained (Fig. 8.1.)	Not identified.	The local authority subsystem was modelled (Fig. 9.9.)
Size (organisational)	Not identified.	The variable 'size' did not neatly map as a discrete factor. The ID scanner had been implemented by a variety of large and small organisations (Section 8.3.2.)	Not identified.	Multiple agencies involved in diffusion and adoption of the ID scanner were explored thoroughly and the overall size of multi-agency adoption dealt with using the FSM (Fig. 9.12, Table 9.1.)
Technology support infrastructure	Not identified.	ID scanner technology was mature and there was little change to technologies used (p. Fig. 8.1.)	Factor was not of concern to participants in this study (Section 8.4.1.)	Factor was not of concern to participants in this study (p. 173) yet infrastructure was still considered as part of the FSM (Fig. 9.12, Table 9.1.)

Table 10.3: Summary overview of factors and variables in existing frameworks/models

Table 10.3 shows that the existing frameworks/models led to a partial view whilst systems

thinking did indeed deliver more understanding and provided additional helpful insight against

each of the common factors and variables culled from the literature. (See Chapter 8). As was shown in Tables 7.2 and 7.3, additional factors and variables that are very relevant in this research context were revealed.

The FSM was found to be particularly helpful in uniting the concepts identified in Chapter 6 and structure understanding of the relationships involved in this multi-agency technology adoption context (See Section 9.5). The FSM helps explain the mechanisms available to bodies like the police in general rather than case-specific terms. The FSM was found to take account of all the components, factors and variables identified in this research that are important to technological diffusion and adoption.

The next section discusses the findings in terms of framing the adoption decision.

10.2.3 Framing the adoption decision

Whilst it was possible to map data to the existing three frameworks/models (Chapter 8) there were issues understanding the environment within which diffusion and adoption took place. Roger's (2003) diffusion of innovations theory, for example, suggested there would be important stakeholders, but little was said about how to identify, define and analyse their roles or impacts on diffusion and adoption. Whilst the Technology Acceptance Model by Davis (1986) included a consideration of external factors, it was a model focused on use of the technology. Tornatzky and Fleischer's (1990) Technology Organisation Environment framework/model however showed some utility especially when used for analysis; it encouraged thinking about the industry and other aspects affecting the adoption system but did not go so far as to thoroughly consider linkage between elements and influences. Some of its critics also identified environmental factors as important but understanding of external pressures was absent (Schwarz and Schwarz, 2013). In this research, systems thinking diagrams (Chapter 9) and ultimately from the application of the Formal System Model (See Figure 9.11) made defining the environment explicit. The FSM illustrated the extensive nature of the environment in this study and made the important environmental influences clear, it enhanced understanding during of adoption initiative.

Put simply, the premises was the primary adopter of the ID scanner yet systems thinking enabled a deep dive into the adoption system and its surrounding influences. This finding (Section 9.5) showed up the potentially fragile nature of successful adoption. If using the existing frameworks/models in isolation (Chapter 8), there is an apparent strong case for adoption of the ID scanner and using the criteria from existing frameworks/models alone, there was a lack of support for how the police and other agencies might initiate, build or enhance those relationships and influence diffusion and adoption. Systems thinking on the other hand provided insights to how knowledge and persuasion, for example, impacted the adoption (Chapter 9). Based on existing frameworks/models alone, it would be expected that a decision maker be present to decide what problem needs to be addressed, allocates appropriate resources and enables the transformation to go ahead. As found using systems thinking, there is not always agreement between stakeholders. A premises may not wish to adopt but pressure from the police and the wider system means a positive adoption decision is taken. So, where adoption is not within a stakeholders' remit, strong influences can have direct impact on adoption and that may be from one main source or from several. Also seen by using the FSM (See Figure 9.12), there was a clear boundary relating to the adoption decision. That decision belonged to the premises. However, their authority could be severely restricted depending on the influence from outside the system whether that be changing pressure from increased crime or by influence from another agency in the environment. Yet roles and responsibilities for other stakeholders were also found to be unclear. Adding clarity in future could improve adoption. Also, it is worthy to mention whether compulsion can improve adoption rates in this multi-agency context. Premises would face the choice to take up the ID scanner voluntarily or in some cases have it mandated as part of the licence. Premises were found to face many obstacles in the face of adoption, some of which were not fully understood by police or by the local authority. It is the interactions between stakeholders and agencies that were crucial to the adoption of the ID scanner. The evidence from the empirical research is that compulsion could well lead to an unsuccessful adoption because of lack of collaboration and will to work in partnership with the police and others. In other words,

the ID scanner was found to be received in a much less positive way in the places where it was mandated, leading to a lack of buy-in and willingness to recognise the wider benefits of the technology. In practical terms, for agencies taking up an innovation it means that this variety could be investigated early in the process and barriers taken account of to overcome opposition and lead to a successful adoption. The negative consequences revealed aspects which are those that would require attention to improve adoption in the future. Therefore, systems thinking can be used to improve framing of the adoption decision.

The next section provides the new insights found from the field study.

10.2.4 New insights from the field study

This section discusses new insights identified by the analysis and the findings are discussed in terms of: data; Violence Against Women and Girls (VAWG)[4] and safety in the night-time economy; and network management of diffusion and adoption.

All participants in this study expressed a good understanding, and care for, preventing and reducing crime in the night-time economy yet some unease was evident. Participants in this research often discussed the ID scanner in terms of its data, collection, storage and use or removal of data. Some had concerns because of the ID scanners' ability for data sharing and data networks. One participant said '…a ban set with an unreasonable enforcement can mean a person is refused entry from other venues linked to the system.' (W1) and another described risks to the misuse of data. Whilst other participants viewed the capability as positive 'the machine does have linked data and we did have an instance where someone was subject to a nationwide ban that we were able to pick up.' (V5). There was also debate relating to the ability of people out late at night, who may have had a lot of alcohol, to provide informed consent. (The process for data management was set out in guidelines by the Information Commissioners Office (2009) for this type of technology). These mixed reviews are interesting and indicates a need for more

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[4] The term violence against women and girls refers to acts of violence or abuse that disproportionately affect women and girls. Crimes and behaviour covered by this term include rape and other sexual offences, domestic abuse, stalking, 'honour'-based abuse (including female genital mutilation, forced marriage, and 'honour' killings), as well as many others, including offences committed online. While the term 'violence against women and girls' is used this refers to all victims of any of these offences. (The Home Office, 2023).

understanding about data management. Especially as the ID scanner, as will other technologies,

be enhanced over time, to include new capabilities such as facial and biometric data. However,

and despite some unease about data, society has seen a shift toward prevention, protection and

safety of vulnerable people being raised up the political agenda which may change the perception

in some cases. For example, with the launch of the Operation Soteria Bluestone programme in

2021 (National Police Chiefs' Council, 2023). The programme is a collaboration with Higher

Education Institutions, the police and other agencies to improve the handling of rape and serious

sexual offences (RASSO) investigations (National Police Chiefs' Council, 2023) which highlights the

very important need for the police to improve models of investigation and use of data. At the

same time, there have been several concerns by the public about police professional standards in

policing (BBC, 2021; Quinn, 2022). These changes may well make ID scanners or other

technologies more acceptable. Insights from this study is that adoption initiatives need very

effective communications (e.g., marketing) (and especially social media) effort to help create the

situation where adoption is seen as positive.

The opportunities to use the ID scanner for tackling serious and organised crime, vulnerability and

violence against women and girls (VAWG) emerged in many interviews. Participants provided

stories of disruption to the business of crime gangs, the protection of vulnerable people from use

of the ID scanner. Premises in the night-time economy have opportunity to contribute to this

agenda. A review of literature by McGuire et al. (2021) suggests that police have worked in

collaboration with other agencies on a range of measures to address violence in the night-time

economy. The use of ID scanners can help police investigations. As one participant put it, there

would be significant 'resource impact should the police have to investigate all the people in a club

at a particular time' (W21). Another said 'data from an ID scanner could significantly reduce the

workload for officers when having to investigate an incident…' (V11) and '…it [the ID scanner]

provided an example of where a serious incident had taken place and the investigation had been

helped by making identification using the scanner.' (V1). Several participants provided examples

of when serious crime had taken place outside of a venue but had been resolved quickly because

the perpetrator had earlier been in a premises with an ID scanner and they were able to be identified. Having more effective and visible outcomes contributes directly to improving public confidence in the police. This raises two wider questions on whether adoption should remain the responsibility of the premises and, indeed, whether diffusion and adoption are best undertaken in a multi-agency way.

There is an argument for a network of organisations that contribute to the definition of problems, formulation of solutions, formulation of policy and bringing together of stakeholders. The night-time economy is an industry in need of a collaborative approach. Literature exists on moves towards the involvement and engagement of actors to collaboratively address alcohol-related harm (Ure et al., 2021) but more needs to be known. The way the police facilitated the approach to adoption came through strongly and positively in this research. Collaboration was talked about a lot between stakeholders and in relation to other organisations operating in the night-time economy so could diffusion and adoption initiatives be better managed through organisational networks rather than single organisations. In this research, local authority leadership in terms of knowledge and input of ID scanners was found to be irregular and, sometimes, there was a sense of little interest in police technology which may call for a national approach rather than local and more engagement between private and public sector organisations.

The next section proposes a systems-based framework that would allow other diffusion and adoption frameworks/models to be combined into the analysis and practice of diffusion and adoption.

10.3   Towards a systems-based framework for understanding diffusion

This section builds on the approach to this research and its findings to propose a framework for incorporating existing frameworks/models into a systems thinking approach and a collaborative specific Formal System Model that can be used for multi-agency diffusion and adoption research.

10.3.1 A learning cycle framework

Figure 10.1 illustrates how systems thinking can be used with other frameworks/models to form a learning cycle. The illustration shows the steps taken in this examination of diffusion and adoption and how existing frameworks/models and systems thinking can be fitted together.

Figure 10.1: A learning cycle framework for inquiry into diffusion and adoption
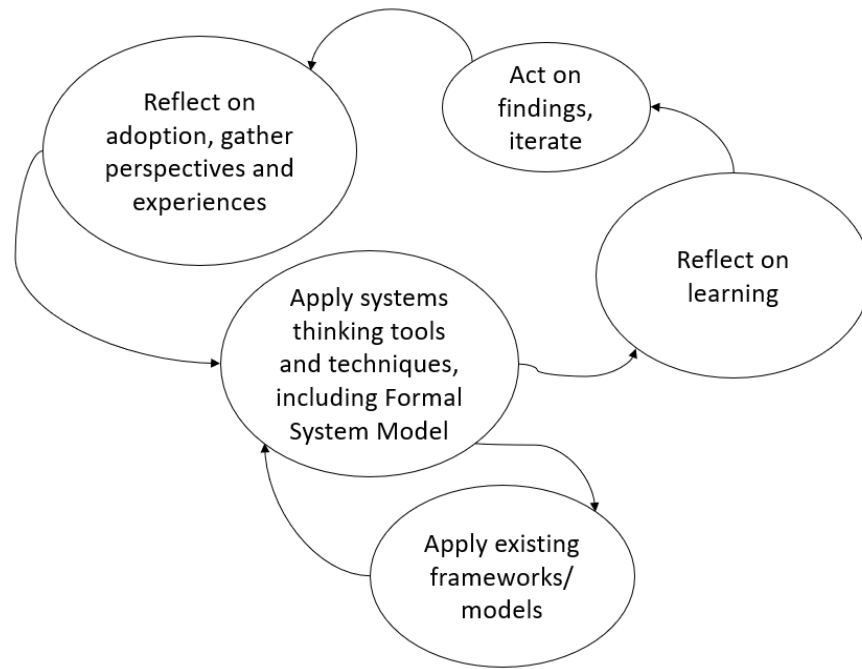
The concept of a learning cycle is well-known and can be applied in many situations. (See, for example, Kolb, 1984). This use of frameworks/models with systems thinking provides a much more comprehensive understanding of diffusion and adoption. The cycle can be followed through the stages illustrated. Specifically referring to existing frameworks/models by considering the most appropriate (or a specific area of an existing framework/model) that is applied, as it has in this research, alongside systems thinking. Following that application of systems thinking alongside existing frameworks/models the learning gathered is reflected upon Findings from that learning can be acted upon and further perspectives and experiences can be gathered and taken account of.

This framework demonstrates how the idea that systems thinking can usefully be combined and used to extend understanding of diffusion and adoption of innovation in a multi-agency setting can be applied.

The next section looks specifically at the proposed collaborative specific version of the Formal System Model within the systems thinking stage of the framework.

10.3.2 A collaborative specific version of the Formal System Model

Applying systems thinking showed how systems methods can be utilised to enhance understanding in an inquiry into diffusion and adoption in a multi-agency setting (Chapter 9). In particular, the Formal System Model (FSM) was found in this research to be the most useful way of representing the situation in systems terms.

Building upon these processes can improve diffusion and adoption initiatives in multi-agency situations. Using a collaborative adoption specific version of the FSM early in the process as a framework to understand diffusion and adoption in a multi-agency situation ensures that all the necessary components of the situation including the wider context are identified, examined and relevant action is taken. It also provides a mechanism by which the likelihood of future success can be enhanced by systemic learning and increased stakeholder participation. In a situation of where stakeholders from multiple organisations with great interest in an adoption decision are not the owners of the decision, there is no recognisable system that reflects all their interests. Using a collaborative specific framework, organisations like the police and local authorities can work to make explicit their common interests and share mechanisms they have available to them. However, this research had set out to understand whether systems thinking could enhance or replace existing diffusion and adoption frameworks/models. As a result of all that work, there have been sufficient findings to enable an indicative collaborative-specific FSM to be developed. Ideally, and given further development and testing, in a similar and highly complex context, a model for collaborative adoption would provide increased insight for practitioners.

The shortcomings and strengths found from applying the analysis in this study can be generalised as:

- The Wider System failed to fully consider the environmental influences adequately.

- There are no formal processes for initial design or planning.

- There was significant goodwill, collaboration and networking between stakeholders.

- Though the Adoption System had control of direct funding, but other shared routes for funding were absent.

- The strength of influence and making known expectations between stakeholders was inconsistent.

- There was no formal or coordinated performance monitoring system.

- Change Agent(s) were present, but review and evaluation was absent.

If these findings are likely to regularly occur in a collaborative setting, then a collaborative-specific FSM might be more likely to surface them. Figure 10.2 shows an indicative collaborative-specific FSM that includes the following changes when compared to the original FSM:

- A collaborative and networked focussed Wider System.

- A collaborative stakeholder board to include representative from all stakeholders and Chaired by a lead collaborator.

- New inputs to the system to coordinate: resource identification; shared experiences; planning; collaborative evaluation of technology (or other) solutions; and high level planning.

- The [Adoption] System to be formalised in terms of performance monitoring, transformation implementation and collaborative team working.

Figure 10.2: Indicative collaborative-specific Formal System Model
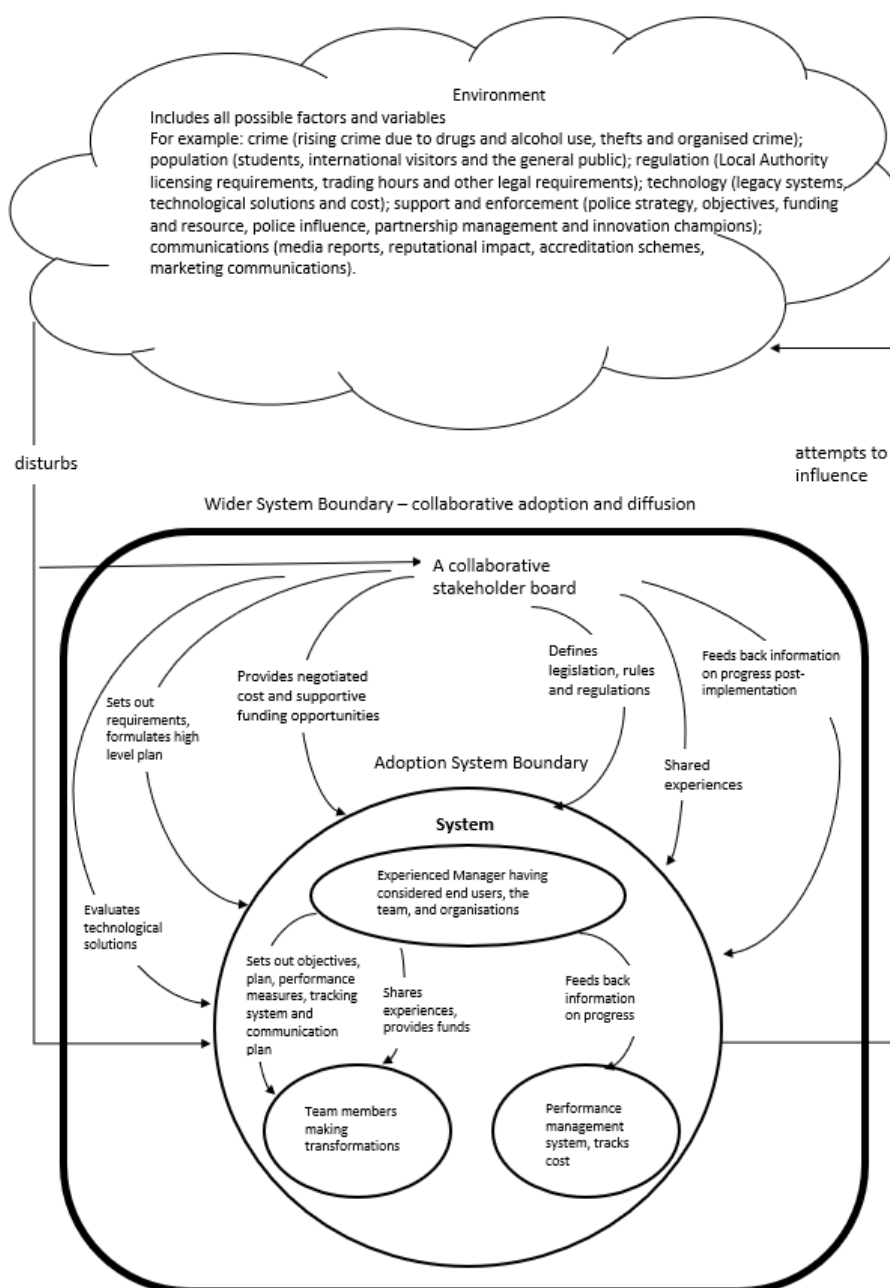
This section has provided a suggested approach to multi-agency diffusion and adoption research utilising systems thinking and other relevant frameworks/models. It has provided an indicative collaborative-specific FSM that will help individuals and organisations working on adoption initiatives in turn, improving successful diffusion and adoption.

The next section summarises the findings for practitioners.

10.4   Summary of findings for practice

This research revealed that approaching multi-agency diffusion and adoption by using systems thinking creatively alongside focused theory, frameworks or models, a purposeful but structured inquiry can be undertaken. The inquiry returned a deep and detailed understanding of multi-agency diffusion and adoption. For practitioners, a set of twelve specific recommendations and guidance is made as a result of this research (See Appendix H).

There are several recommendations for practice that would help successful multi-agency diffusion and adoption by being able to identify, and take account of, all the stakeholders' very different goals and objectives and interactions. Systems thinking has been shown in this research to be an ideal vehicle for identifying and linking the various factors and variables present in multi-agency diffusion and adoption initiatives and the Formal System Model can be explained to practitioners as an available mechanism. If practitioners incorporated systems thinking as a lead approach to understanding and delivering diffusion and adoption and incorporated existing frameworks/models as needed, then practice can be improved. However, practitioners may, have context-related barriers to overcome. For example, practitioners may be required to respond in a context where collaboration was not seen so positively (e.g., in the other geographical area in this study). In that context, participation may need more emphasis and encouragement so the benefit of adoption can be realised. To help implementation by practitioners, this thesis has provided an explanation of the diagrams and provides sources to learn more about systems thinking and to replicate a similar work (Chapter 6). One important recommendation is to have a central coordinating point to manage the diffusion and adoption network. This coordination may not always be possible in terms of resource and one way to overcome this barrier would be for one of the stakeholders to lead the adoption with the network and use the collaborative Formal System Model as a mechanism by which to gain insight and identify action during that process.

The next section provides a summary of this chapter.

10.5   Summary of chapter

This chapter brought together the results of the research described in this thesis. The chapter discussed the findings that showed systems thinking could enhance learning about diffusion and adoption in a multi-agency situation in several ways. The framework for further analysis (Table 10.1) was used to organise the findings and showed the shortfalls of using existing frameworks/models in isolation and how systems thinking enhanced understanding of diffusion and adoption. The chapter then summarised the findings that systems thinking significantly improved the recognition and understanding of the factors and variables affecting successful diffusion and adoption in a multi-agency situation. In addition, systems thinking was found to have benefits increasing stakeholder participation and providing better framing of the adoption decision for those leading diffusion and adoption. The chapter also covered several new insights found from the field study in relation to data, Violence Against Women and Girls and safety in the night-time economy and how a managed network of organisations could improve adoption initiatives. A proposal is made for a systems-based framework for understanding the diffusion of a technology and a set of recommendations for practice are made. The next chapter concludes this thesis.

Chapter Eleven: Conclusion

11.1   Introduction to Chapter 11

This final chapter summarises the thesis and the major contributions made. Limitations are then

identified followed by suggestions for future research.

11.2   Thesis summary

Chapter 1 set out why this research was undertaken. The challenging nature of a large public

service like policing in the UK means that technological innovation is often seen as way to address

the impacts of economic austerity and a changing environment. Although some very large

innovation projects or programmes have been the subject of academic investigations, the study of

smaller day-to-day innovations are uncommon. Furthermore, studies of technological diffusion

and adoption in policing contexts that require collaboration with a wide range of stakeholders are

rarer still. The ID scanner was identified as one of those novel multi-agency applications of

technology. Moreover, the existing theoretical diffusion and adoption frameworks/models

available, appeared to be too specific or restricted to a particular phase of the innovation process.

Systems thinking however, potentially provided an alternative way of examining complex

diffusion and adoption.

Chapter 2 reported on the history of innovation and specifically diffusion and adoption in policing.

Even from early times, there was a drive to utilise technologies to improve policing, for example,

through communication technologies and increasing mobility and flexibility. Whilst there was

evidence of partnership with technology suppliers, relatively little research attention had been

given to collaborations between the police and other stakeholders or agencies. Although the

police had a long history of working in multi-agency settings, cross-force and multi-agency

collaboration had proved difficult and more needed to be discovered about not only adopting

innovations but also about the wider environment in which the police operate.

Chapter 3 described the research setting. A setting novel in itself because of the complex characteristics, the contextual features of the night-time economy and the potential for multi-agency working. The diffusion of ID scanners and the exploitation of their full potential in a specific setting involved the police and many other stakeholders including the local authority, licensees, and premises owners as well as voluntary and other organisations operating at night. Consequently, the actors in a setting displayed a variety of purposes, interests, perspectives and considerations to be examined.

In Chapter 4, a comprehensive literature review examined academic literature on diffusion and adoption with emphasis on that which could inform the specific situation. The review first looked at innovation where despite a large field of literature, there was still much reported uncertainty and complexity in the innovation process. The strengths and weaknesses of a variety of existing diffusion and adoption frameworks/models were identified. Several potential shortcomings in these frameworks were found especially in multi-agency settings which displayed multiple perspectives with many influencing interactions between them. None of the existing frameworks/models were found to explain sufficiently the influence of such factors and the impact on diffusion and adoption. Taking a lead from the literature, three frameworks/models were selected and pursued in this research: one with general applicability (Rogers', 2003, Diffusion of Innovations theory); one designed to generate understanding (Tornatzky and Fleischer's, 1990, Technology Organisation Environment); and one predictive (Technology Acceptance Model by Davis, 1986). All were closely aligned to diffusion and adoption but differed from each other in their approach. Studies of the adoption of devices such as the ID scanner in the context of policing confirmed that there was not sufficient detail surrounding the multi-agency aspects of diffusion and adoption and further research was needed. Overall, this review also found there where gaps existed, there was potential for systems thinking to supplement and advance understanding.

Chapter 5 set out the methodology for the study and the means for acquiring new knowledge including: the research question, the underpinning research philosophy, and the rationale for choice of approach. The chapter outlined the case for qualitative research and set out how the empirical research would be conducted through data collection as well as the approach to analysis. The methodology was designed to maintain a level of flexibility that was practical and suitable for the context. The qualitative approach would begin with coding and thematic analysis of the data before an initial or pre-analysis and then the application of existing frameworks/models and finally the application of systems thinking.

Chapter 6 covered systems thinking including its history and academic background. The language of systems thinking, its main concepts and the routes to tailoring systems thinking using tools and techniques suitable for the topic were also explained.

The initial analysis is set out in Chapter 7. Following coding and thematic analysis, data are explored further using spray diagramming. Through several sets of spray diagrams, it became apparent even at this early stage that there were many factors, different viewpoints and perspectives being uncovered and new insights being gained. This pre-analysis led to a rich illustration of the situation and a view of what was going on in the diffusion and adoption setting.

Chapter 8 reported on the application of the selected three existing diffusion and adoption frameworks/models. Rogers' (2003) Diffusion of Innovations theory proved insightful although despite its sound academic background several critical studies were referenced. In the context of this study, some aspects of the framework/model proved valuable to diffusion and adoption research but appeared to have less utility in multi-agency settings. Reviewing the application of two other frameworks/models: Tornatzky and Fleischer's (1990) Technology Organisation Environment and the Technology Acceptance Model by Davis (1986) proved less rewarding. Areas of commonality were found, such as ease of use and perceived usefulness, but analysis did not yield additional insight about partnerships, interactions, attitudes or influence of the variety of

external variables. Indeed, it was not clear whether all possible factors or variables had been identified.

In Chapter 9, the analysis using systems thinking tools and techniques is set out. Benefits found included reducing uncertainty and the ability to make better sense of the complexity. The analysis utilized multiple cause diagrams, systems maps and influence diagramming. As a way of combining the elements into a systemic understanding, the Formal System Model (FSM) was used. Furthermore, it was proposed that, if applied early in the adoption process, it could potentially act as a framework on which to build a model for diffusion and adoption of an innovation. The FSM increased the likelihood that the factors critical to success of the adoption (or the decision not to adopt) could be considered and a more holistic picture of the adoption process made.

Findings of the preceding chapters were discussed in Chapter 10. This research concluded that systems thinking was found to be a valuable approach to understanding innovation, diffusion and adoption in a complex, multi-agency setting. As an approach it was found to have more mileage than the existing diffusion and adoption frameworks/models.

This thesis has shown how systems thinking tools and techniques can assist those implementing technology projects and provided evidence that it can be applied readily to take account of contextual and environmental influences by investigating communication links, different viewpoints and contemplating emerging properties. As a result of all the findings, a set of recommendations for practitioners are provided (See Appendix H).

The next section summarises the findings in terms of the research questions.

11.3   Summary of answers to the research questions

This section summarises how the research questions have been addressed by this thesis.

1: How does systems thinking improve the approach to learning about diffusion and adoption in a multi-agency situation?

The review of literature as reported in Chapter 4 identified many problems with existing frameworks/models for diffusion and adoption. They were found to have been poor at dealing

with uncertainty and complexity. However, systems thinking provided addition traction when applied to the understanding of diffusion and adoption in a complex multi-agency context. In other words, applying systems thinking in addition to the existing frameworks and models enabled further analysis to be undertaken in a considered and detailed way. The analysis using existing frameworks/models such as Rogers' diffusion of innovations (2003) theory, Tornatzky and Fleisher's Technology Organisation Environment (1990) and the Technology Acceptance Model by Davis (1986) were not found to enable sufficient depth of understanding of the adoption system. The findings in Chapter 10 were that the use of systems thinking provided enhanced understanding of the multi-agency and collaborative elements of diffusion and adoption (of the ID scanner).

Another challenge in this context was the ability to identify stakeholders involved. Existing frameworks/models were potentially problematic because of their underlying assumption that there was one organisation responsible for, and leading, the adoption. Nevertheless, although gaps were apparent, this study found it was still possible to identify, and give thought to, stakeholders by using those existing frameworks/models. The wide variety of participants in this research were given space to voice their understanding of what they considered a successful adoption. Their perspectives were captured in this research through various stages of adoption of the technology whereas the existing frameworks/models are normally used before adoption occurs and were found to be based on assumptions. Using systems thinking allowed a general awareness and sensitivity to all those involved in the adoption of an ID scanner with the recognition that there are a range of consequences to diffusion and adoption for all stakeholders. In previous research, the existing frameworks/models were found to be difficult to apply. Systems thinking provided a quite different approach and was more easily applied than the existing frameworks/models (see Chapter 10). This ease of application appeared to be due to its flexibility in use of tools and techniques which aided design of a purposeful and structured inquiry and allowed it to be applied in a creative way. By being more participatory there is more chance of multiple perspectives on a situation being brought to the surface. Participation increases

engagement and input from all stakeholders as opposed to an 'expert' analysing the system on behalf of stakeholders. This study has demonstrated the benefit of using systems thinking to increase the participatory involvement of stakeholders in the process of analysing and ultimately, improving diffusion and adoption.

Further analysis yielded findings that had not been found by applying the existing frameworks/models. This unique provided by systems thinking provided an opportunity to explore the views across multi-agencies reflects on some wider issues. For example, in relation to data there was an important need to improve investigation in policing and use of data leading to an insight that adoption requires effective communication efforts. Another insight was that the adoption of the ID scanner was described by participants as supporting disruption to crime and protection of vulnerable people. This understanding of improving safety in the night-time economy leading contributes to the discussion on whether diffusion and adoption is best undertaken in a multi-agency way.

2: How does systems thinking improve the recognition and understanding of the factors and variables affecting successful diffusion and adoption in a multi-agency situation?

The literature review in Chapter 4 identified an important problem with the identification and consideration of factors and variables affecting diffusion and adoption. It appeared that no definitive set of factors and variables had been established in any of the existing frameworks/models. The analysis of the field study (See Chapters 7, 8 and 9) found the understanding gained by using those pre-defined characteristics found in the existing frameworks/models in this context to be limited. The analysis using spray diagrams, multiple cause diagrams and the Formal System Model resulted in a thorough understanding of some important influences. Systems thinking has, therefore, been shown in this research to be an ideal vehicle for identifying and linking the various factors and variables present in multi-agency adoption initiatives by looking at the whole situation. The analysis using systems thinking allowed the many interrelationships affecting diffusion and adoption to be identified and understood. The specific elements analysed by using the FSM enhanced understanding of the adoption initiative

and highlighted areas that can be strengthened, thus ultimately improving the likely success of adoption.

3: Does systems thinking lead to a better framing of adoption decisions for decision makers within a multi-agency situation?

It was apparent early in the research that the context surrounding the adoption of the ID scanner was complex and that external factors could have many possible impacts on the diffusion and adoption process. The research found that whilst it was possible to map the data gathered on to the existing three frameworks/models (See Chapter 8), this provided very little understanding of the wider context within which diffusion and adoption took place. Of the three existing frameworks/models, the most useful was Tornatzky and Fleischer's (1990) Technology Organisation Environment framework/model. It encouraged thinking about the industry and other aspects affecting the adoption system but it did not go so far as to allow thorough consideration of the linkages between elements and influences. The existing frameworks/models identified some aspects of the context but not all and their specific influences on the adoption were not fully exposed, sometimes because of a lack of clarity over what constituted the 'environment'. The differences between the external environment and context required unpicking. In this research, systems thinking diagrams (See Chapter 9) and, ultimately, the application of the Formal System Model (See Figure 9.11) made defining the environment explicit. The FSM brought to light the importance of looking at the influences on that adoption decision and indeed, systems thinking revealed strong influences preceding the decision. The FSM also made the boundary relating to the adoption decision clear. The decision to adopt an ID scanner belonged to the premises. However, and as discussed in Chapter 10, their authority could be restricted because of the influences in the environment. Pressure of changing or increasing crime or influence from another agency such as the local authority.

Based on this research there is strong evidence that systems thinking can be used for improved framing of the adoption decision.

4: How does the addition of a systems thinking perspective to existing diffusion and adoption frameworks/models improve the ability to describe, explain or even predict the outcome of diffusion and adoption initiatives in multi-agency situations?

As well as enabling a more holistic analysis of diffusion and adoption practice, this research highlights how systems thinking can assist the practice of diffusion and adoption in a multi-agency context. As this research has shown, policing and crime reduction in the night-time economy is inherently a multi-agency activity; collaboration and facilitation came through strongly and positively throughout. It follows therefore that the night-time economy is an industry that benefits from a collaborative approach. Although literature exists on moves towards the involvement and engagement of actors to collaboratively address alcohol-related harm (Ure et al. 2021) it is undoubtably the case that more needs to be known. The way the police facilitated the approach to adoption came through strongly and positively in this research.

By taking a multiple perspectives approach, systems thinking tools were able to capture how collaboration was a recurring aspect raised by stakeholders both amongst each other and in relation to other organisations operating in the night-time economy. However, the research also showed that local authority leadership in terms of knowledge and input of technologies such as ID scanners was found to be patchy and, sometimes, there was a sense of little interest in policing -related technologies. These findings in turn raise the issue of whether diffusion and adoption initiatives might at times be better managed locally through organisational networks rather than single organisations and in other circumstances call for a national approach rather than local approach and more engagement between private and public sector organisations.

Overall, the results of this research confirm the hypothesis that systems thinking can enhance existing diffusion and adoption frameworks/models. This thesis, therefore, proposes a systems-based framework for diffusion and adoption (See Figure 10.1) that allows other diffusion and adoption frameworks/models to be integrated into the analysis and practice of diffusion and adoption. This systems-based framework provides a way to improve the ability to describe, explain and ultimately improve the outcome of diffusion and adoption. A key part of that process was analysis using the FSM. The findings have contributed to developing a collaborative-specific

FSM that could be used in multi-agency adoption. The FSM was found to be a useful way of representing the situation in systems terms. Its application highlighted how, in a situation where stakeholders from multiple organisations with great interest in diffusion and adoption are not the owners of the decision, there was no recognisable system that reflects all their interests. Using a collaborative-specific framework such as the one proposed in this research (See Figure 10.2), organisations like the police and local authorities can work to make explicit their common interests and share mechanisms they have available to them. However, this research had set out to understand whether systems thinking could enhance or replace existing diffusion and adoption frameworks/models. There have been sufficient findings to enable an indicative collaborative-specific FSM to be developed. Ideally, and given further development and testing, in a similar and highly complex context, a model for collaborative adoption would also provide increased insight for practitioners.

Using these approaches improved understanding of diffusion and adoption in this multi-agency context. An enhanced understanding of the diffusion and adoption situation was presented in this thesis. Ultimately this thesis provided strong evidence that systems thinking can, indeed, enhance existing diffusion and adoption frameworks/models. The next section reports on contributions to theory and practice resulting from this study.

11.4 Contributions to theory and practice

This research contributes to academic theory and to practice in several ways.

First, it addresses the gaps identified in the literature, especially in relation to the restricted understanding of diffusion and adoption that is generated by only using the existing frameworks/models.

Secondly, through the empirical research it provided unique insight into the perspectives of various stakeholders in a technology adoption in which many stakeholders including the police have influence but not a decision-making role. This is an important contribution given there were few studies looking at this type of situation and technology and as evidence-based practice in

policing is given more and more emphasis. This thesis has contributed an important body of knowledge by advancing a guide to research that can lead to an increased awareness amongst stakeholders of the need for wider thinking when adopting a technology such as an ID scanner.

Then, this research contributes a framework/model for analysis using systems thinking that highlights the wide range of factors and connections between stakeholders and agencies. Importantly it showed that factors and variables do not have to be pre-specified and can be collected through research, analysed and new knowledge and understanding gained. The convergence of existing frameworks/models together with systems thinking demonstrates there are useful ways to be inquisitive about new approaches to understanding diffusion and adoption.

Next, this study has provided further research in the field of policing and therefore contributes to building that knowledge base. It provides a model that practitioners can use in diffusion and adoption and has contributed insights to a previously under-researched context of innovative and day to day technology by capturing the very complex nature of the ID scanner adoption and application.

By exposing and addressing gaps uncovered in this study, this research contributes to existing knowledge by providing an enhanced understanding of innovation, diffusion and adoption in a multi-agency setting.

The next section outlines the limitations of this study and makes suggestions for future research.

11.5   Limitations and future research

This research produced useful results but, like all research it does have some limitations. First, a background including many years studying and now teaching systems may have pre-disposed the author to the identification of advantages in using those ideas. With this in mind, there has been a self-awareness and openness in evidencing the findings of this study. Secondly, the investigation started from the perspective of examining technologies that might enhance policing. Though a range of stakeholders were interviewed, the starting point was policing; a study from different perspective, say that of venue users, might have revealed different insights. Thirdly,

different theoretical perspectives could have been deployed e.g., an alternative focus might have looked at how the police exercise leadership in collaborative settings.

Moving on to look at future research, there are opportunities to extend research where working collaboratively in a multi-agency way is important. The approach taken in this research can be extended to many other collaborative settings. For example, many innovative solutions to addressing the United Nation's sustainable development goals (United Nations, 2023) are likely to require collaborative working across many organisations and cultures. Taking just two of those goals, for example, Goal 9 (industry, innovation and infrastructure) encourages innovation especially as industry recovers from the global coronavirus pandemic but creating diverse and more sustainable infrastructure such as improving information and communication technologies at affordable cost in least developed countries cannot be delivered by a single organisation. Similarly, Goal 13 on climate action suggests there are big changes to society needed to ensure climate change is integrated into polices, strategy and plans all over the world and in all levels of public and private sector as well as action by individuals. Lastly, and in terms of method, the collaborative-specific FSM has been proposed in general terms and is potentially applicable in many settings.

Next the final remarks of this thesis are made.

11.6   Final remarks

In this final chapter, a summary of the thesis has been made and several areas for future research have been suggested. This study comprised a qualitative study of significant size with participation from police, local authorities and with owners and managers of licenced premises. The study provided in depth and wide-ranging insight into diffusion and adoption of a novel every day innovation in the night-time economy. This thesis provides evidence of new knowledge having been generated about the adoption of an ID scanner in a multi-agency context. It is hoped that this research will encourage further studies in this emerging research area that offers an exciting perspective on researching diffusion and adoption. The research aims were achieved and

the research question addressed. This study established that systems thinking could, indeed, enhance existing diffusion and adoption frameworks/models. The results reported in this thesis show how the study uncovered and addressed several gaps in the literature on understanding diffusion and adoption in a complex multi-agency situation.

It is hoped that this research will benefit the academic community who will be able to use the outputs of systems thinking when applied to innovation, diffusion and adoption. It also has the potential to benefit the police, local authorities and those managing licensed premises to understand the adoption of new innovations. To support dissemination, providers will be able to use the outputs to discuss its applicability and further research on other innovations. Consequently, it is hoped that both academic communities and practitioners will benefit from this research.

References

Ackoff, R. L. (1971) 'Towards a system of systems concepts', *Management Science*, vol. 17, no. 11, pp. 661-671.

Ackoff, R. L. (1995) '"Whole-ing" the parts and righting the wrongs', *Systems Research*, vol. 12, no. 1, pp. 43-46.

Ackroyd, S., Soothill, K., Harper, R., Hughes, J. A. and Shapiro, D. (1992) *New technology and practical police work: The social context of technical innovation,* Taylor & Francis Inc.

Alam, I. and Perry, C. (2002) 'A customer-oriented new service development process', Journal *of Services Marketing*, vol. 16, no. 6, pp. 515-534.

Alcohol Change UK (2021) 'Alcohol statistics' [Online]. Available at: https://alcoholchange.org.uk/alcohol-facts/fact-sheets/alcohol-statistics (Accessed 22 January 2021).

Allen, D. and Wilson, T. D. (2004) 'Action, interaction and the role of ambiguity in the introduction of mobile information systems in a UK police force', IFIP International Federation for Information Processing Working Conference on Mobile Information Systems, Boston, MA, Springer, vol. 158, pp. 15–36.

Al-Tabbaa, O., Leach, D. and Khan, Z. (2019) 'Examining alliance management capabilities in cross-sector collaborative partnerships.', Journal *of Business Research*, vol. 101, pp. 268-284.

Anderson, E. (2015) 'Why are Britain's nightclubs in such a desperate situation?', *The Telegraph*, 10 August 2015, [Online]. Available at: https://www.telegraph.co.uk/finance/newsbysector/retailandconsumer/leisure/11794792/Why-are-Britains-nightclubs-in-such-a-desperate-situation.html (Accessed 27 October 2020).

de Andrade, D., Puljević, C., Miller, P. G., Taylor, N., Curtis, A. and Ferris, J. (2021) 'The value of identification scanner technology in monitoring and detecting banned patrons in entertainment precincts', *Drug and Alcohol Review*, vol. 40, no. 7, pp. 1219-1227.

Association of Chief Police Officers (2012) 'Policing in the UK: A brief guide', [Online]. Available at: https://news.npcc.police.uk/releases/acpo-publishes-policing-in-the-uk-a-brief-guide (Accessed 3 June 2022).

The Association of Town and City Management (2016) 'The Association of Town Management' [Online]. Available at: https://www.atcm.org/ (Accessed 1 December 2020).

Aucamp, J. and Swart, J. (2015) 'Extending the technology acceptance model to evaluate discussion forum adoption in a learning management system', *Interim: Interdisciplinary Journal*, vol. 14, no. 1, pp. 124–138.

Audit Commission. (1998) *A fruitful partnership; effective partnership working*., Audit Commission Publications, London.

Bharadwaj, S. and Deka, S. (2021) 'Behavioural intention towards investment in cryptocurrency: an integration of Rogers' diffusion of innovation theory and the technology acceptance model', *Forum Scientiae Oeconomia*, vol. 9, no. 4, pp. 137-159.

Bansal, P., and Corley, K. (2011) 'The coming of age for qualitative research: Embracing the diversity of qualitative methods', *Academy of Management Journal*, vol. 54, no. 2, pp. 233–237.

BBC (2008) 'Police on patrol get Blackberries', 18 August 2008 [Online]. Available at: http://news.bbc.co.uk/1/hi/england/northamptonshire/7568990.stm (Accessed 19 March 2023).

BBC (2020) 'Senior police voice concern over failed IT systems', 28 October 2020 [Online]. Available at: https://www.bbc.co.uk/news/technology-54718670 (Accessed 6 June 2022).

BBC (2021) 'Sarah Everard: How a woman's death sparked a nation's soul-searching', 14 March 2021 [Online]. Available at: https://www.bbc.co.uk/news/uk-56384600 (Accessed 30 March 2023).

BBC (2023) 'Vanity Soho strip club shut by council after alleged spikings', 10 January 2023 [Online]. Available at: https://www.bbc.co.uk/news/uk-england-london-64222281.amp (Accessed 20 January 2023).

Beer, S. (1981) *The brain of the firm*, Chichester, John Wiley.

Beer, S. (1984) 'The viable system model: Its provenance, development, methodology and pathology', *Journal of Operational Research Society*, vol. 35, no. 1, pp. 7–26.

Bendassolli, P. F. (2013) 'Theory building in qualitative research: reconsidering the problem of induction', *Forum: Qualitative Social Research*, vol. 14, no. 1, pp. 15–36.

Bichard, M. (2004) *The Bichard inquiry report*, The Stationery Office, London.

Biernacki, P. and Waldorf, D. (1981) 'Snowball sampling: problems, techniques and chain-referral sampling', *Sociological methods and research*, vol. 10, no. 2, pp. 141–163.

Bigliardi, B., Ferraro, G., Filippelli, S. and Galati, F. (2021) 'The past, present and future of open innovation', *European Journal of Innovation Management*, vol. 24, no. 4, pp. 1130–1161.

Bignell, V. and Fortune, J. (1984) *Understanding Systems Failure*, Manchester University Press.

Black, L, J. (2013) 'When visuals are boundary objects in system dynamics work', *System Dynamics Review*, vol. 29, no. 2, pp. 70-86.

Bouwman, H., van de Wijngaert, L. and de Vos, H. (2008) 'Context-sensitive mobile services for police officers: a re-assessment of TAM', *Proceedings of the 7th International Conference on Mobile Business (ICMB 2008) Creativity and Convergence*, no. 1, pp. 191–200.

Burrell, G. and Morgan, G. (1979) *Sociological Paradigms and Organisational Analysis, Sociological Paradigms and Organisational Analysis*, London, Heineman.

Buzan, A. (1974) 'Use Your Head', London, BBC Publications.

Byrne, J. and Marx, G. (2011) 'Technological innovations in crime prevention and policing. A review of the research on implementation and impact', *Journal of Police Studies*, vol. 3, no. 20, pp. 17–40.

Carlsson, C., Carlsson, J., Hyvönen, K., Puhakainen, J. and Walden, P. (2006) 'Adoption of mobile devices/services - searching for answers with the UTAUT', *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)*, vol. 6, p. 132a.

Chan, J. (2001) 'The technological game: how information technology is transforming police practice', *Criminology and Criminal Justice*, vol. 1, no. 2, pp. 139–159.

Chapman, J. (2004) *Systems failure: Why governments must learn to think differently,* London, Demos.

Chau, P. Y. K. (1996) 'An empirical assessment of a modified technology acceptance model', *Journal of Management Information Systems*, vol. 13, no. 2, pp. 185–204.

Chau, P. Y. K. and Tam, K. Y. (1997) 'Factors affecting the adoption of open systems: an exploratory study', *MIS Quarterly: Management Information Systems*, vol. 21, no. 1, pp. 1–24.

Checkland, P. (1972) 'Towards a systems-based methodology for real-world problem solving', *Journal of systems engineering*, vol. 3, no. 2, pp. 87–116.

Checkland, P. (1981) *Systems Thinking Systems Practice*, Chichester, John Wiley.

Checkland, P. (1988) 'Information systems and systems thinking: time to unite?.', *International Journal of Information Management*, vol. 8, no. 4, pp. 239–248.

Checkland, P. (1999) *Systems thinking, Rethinking management information systems: An Interdisciplinary Perspective*, Oxford University Press, pp. 45-56.

Checkland, P., Scholes, J. (1990). *Soft systems methodology in action*. Chichester, GB: John Wiley and Sons Ltd.

Checkland, P. (2000) 'Soft Systems Methodology: A Thirty Year Retrospective', *Systems Research and Behavioral Science*, vol. 17, pp. 11–58.

Checkland, P., and Poulter, J. (2006) *Learning for action: A short definitive account of soft systems methodology and its use practitioners, teachers and students,* Chichester, GB, John Wiley and Sons Ltd.

Chesbrough, H. (2003) *Open Innovation: The new imperative for creating and profiting from technology.* Boston, Massachusetts, U.S., Harvard Business School Press.

Chesbrough, H. (2020) '*To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective.*', Industrial Marketing Management, vol. 88*,* pp. 410-413.

Chevalier, J.M. and Buckles, D.J. (2019) *Participatory action research: Theory and methods for engaged inquiry*. Routledge.

Christensen, C. M. and Bower, J. L. (1996) 'Customer power, strategic investment, and the failure of leading firms', *Strategic management journal*, vol. 17, no. 3, pp. 197-218.

Churchman, C.W., Ackoff, R.L. and Arnoff, E. L. (1957) Introduction to operations research.

Churchman, C. W. (1971) *Design of inquiring systems: basic concepts of systems and organization*, Basic Books, New York.

Cleary, M., Horsfall, J. and Hayter, M. (2014) 'Data collection and sampling in qualitative research: does size matter?', *Journal of advanced nursing*, pp. 473-475.

Club Angels (2015) [Online]. Available at: http://www.clubangels.org.uk/ (Accessed 6 November 2016).

Colvin, C. A. and Goh, A. (2005) 'Validation of the technology acceptance model for police', *Journal of Criminal Justice*, vol. 33, no. 1, pp. 89–95.

Corbin, J. M. and Strauss, A. (1990) 'Grounded theory research: procedures, canons, and evaluative criteria', *Qualitative Sociology*, vol. 13, no. 1, pp. 3–21.

Cox, D. J. (2010) *A certain share of low cunning: a history of the bow street runners*, 1792-1839, Routledge.

Cummings, D. (2010) *How constant age checks are infantilising adults*, A Manifesto Club Report.

Cupchik, G. (2001) 'Constructivist realism: an ontology that encompasses positivist and constructivist approaches to the Social Sciences', *Forum: Qualitative Social Research*, vol. 2, no. 1.

Custers, B. (2012) 'Technology in policing: Experiences, obstacles and police needs', *Computer Law and Security Review*, Elsevier Ltd, vol. 28, no. 1, pp. 62–68.

Dragons Den (2016) BBC Two Television, series 3, episode 5, 31 August 2016.

Danermark, B., Ekström, M., and Karlsson, J, C. (2019) *Explaining society: Critical realism in the social sciences,* London, Routledge.

Darroch, S. and Mazerolle, L. (2013) 'Intelligence-led policing: a comparative analysis of organizational factors influencing innovation uptake', *Police Quarterly*, vol. 16, no. 1, pp. 3–37.

Davidson, J. (2017) ''No single reason' why Police Scotland i6 IT project failed, Audit Scotland concludes' *Holyrood*, 9 March 2017 [Online]. Available at: https://www.holyrood.com/news/view,no-single-reason-why-police-scotland-i6-it-project-failed-audit-scotland-concludes_13221.htm (Accessed 4 June 2022).

Davis, F. (1986) *A technology acceptance model for empirically testing new end-user information systems: theory and results*, Massachusetts Institute of Management.

Davis, F. D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly: Management Information Systems*, vol. 13, no. 3, pp. 319–340.

Dearing, J. W. and Cox, J. G. (2018) 'Diffusion of innovations theory, principles, and practice', *Health Affairs*, vol. 37, no. 2, pp. 183–190.

Department for Media Culture and Sport (2008) *Evaluation of the impact of the Licensing Act 2003*, March 2008 [Online]. Available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/04_03_08_Licensingevaluation.pdf (Accessed: 17 December 2016).

Dewson-Smyth, N. (2015) 'Buy it yourself', *The Custody Record*, 7 February 2015 [Online]. Available at: https://thecustodyrecord.wordpress.com/2015/02/07/buy-it-yourself/ (Accessed 31 July 2015).

DiCicco-Bloom, B. and Crabtree, B. F. (2006) 'The qualitative research interview', *Medical Education*, vol. 40, no. 4, pp. 314–321.

Dodd, V. (2022) 'UK police use of live facial recognition unlawful and unethical, report finds', *The Guardian,* 27 October 2022 [Online]. Available at: https://www.theguardian.com/technology/2022/oct/27/live-facial-recognition-police-study-uk. (Accessed: January 2023).

Downs Jr., G. W. and Mohr, L. B. (1976) 'Conceptual issues in the study of innovation', *Administrative Science Quarterly*, vol. 21, no. 4, pp. 700–714.

Doyle, G. J., Garrett, B. and Currie, L. M. (2014) 'Integrating mobile devices into nursing curricula: Opportunities for implementation using Rogers' Diffusion of Innovation model', *Nurse Education Today*, vol. 34, no. 5, pp. 775–782.

Drummond-Smith, I. (2014) *Evaluation of Plymouth ID scanner pilot*.

Du Preez, N, D., and Louw, L. (2008) A framework for managing the innovation process. *PICMET'08-2008 Portland International Conference on Management of Engineering & Technology,* IEEE, pp. 546-558.

Fagerberg, J. (2003) 'Schumpeter and the revival of evolutionary economics: An appraisal of the literature', *Journal of Evolutionary Economics*, vol. 13, no. 2, pp. 125–159.

Fagerberg, J. (2018) 'Mobilizing innovation for sustainability transitions: A comment on transformative innovation policy', *Research Policy*, Elsevier, vol. 47, no. 9, pp. 1568–1576.

Farrell, C. (2022) 'Policing & partnership working – why this is important', *Careers in Blue,* 18 September 2022 [Online]. Available at: https://careersinblue.co.uk/partnership-working-why-is-this-important/. (Accessed 24 December 2022).

Farrell, J. and Saloner, G. (1985) Standardization, compatibility, and innovation. *the RAND Journal of Economics*, vol. 16, no. 1, pp. 70-83.

Faúndez-Zanuy, M. (2004). 'Are inkless fingerprint sensors suitable for mobile use?'. *IEEE Aerospace and Electronic Systems Magazine*, vol. *19, no.* 4, pp. 17-21.

Fisher, J. C. and Pry, R. H. (1971) 'A simple substitution model of technological change', *Technological Forecasting and Social Change*, vol. 3, pp. 75–88.

Fleming, J. and Rhodes, R. (2018) 'Can experience be evidence? Craft knowledge and evidence-based policing', *Policy and Politics*, vol. 46, no. 1, pp. 3–26.

Forrester, J.W. (1961) *Industrial dynamics*, Cambridge, Massachusetts (MA), MIT Press.

Forrester, J.W. (1971) *World dynamics*, Cambridge, Massachusetts (MA), MIT Press.

Foster, R. N. (1985) 'Timing technological transitions', *Technology in Society*, vol. 7, pp. 127–141.

Fortune, J. (1993) *Systems Paradigms*, Milton Keynes, Open University Press.

Fortune, J, Peters, G. (2005) *Information systems: achieving success by avoiding failure*, Chichester, Wiley and Sons Ltd.

Füller, J., Hutter, K., Wahl, J., Bilgram, V. and Tekic, Z. (2022) 'How AI revolutionizes innovation management–perceptions and implementation preferences of AI-based innovators.', *Technological Forecasting and Social Change*, vol. 178, p. 121598.

García-Avilés, J.A. (2020) Diffusion of innovation. *The international Encyclopedia of media psychology*, pp. 1-8.

Gayadeen, S. M. and Phillips, S. W. (2014) 'The innovation of community policing and the COPS office: does diffusion of innovation theory hold in a manipulated environment?', *International Journal of Police Science & Management*, vol. 16, no. 3, pp. 228–242.

Gelder, S. (2015) 'Romford nightclub thug in first ID scanner conviction', *Romford Recorder,* 15 July 2015 [Online]. Available at: https://www.romfordrecorder.co.uk/news/crime/21537233.romford-nightclub-thug-first-id-scanner-conviction/ (Accessed 29 March 2023).

Gioia, D. A., Corley, K. G. and Hamilton, A. L. (2013) 'Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology', *Organizational Research Methods*, vol. 16, no. 1, pp. 15–31.

Glaser, B. G. (1978) *Theoretical sensitivity*, Mill Valley, CA: Sociology Press.

Goffin, K. and Pfeiffer, R. (2002) 'Competing in the innovation pentathlon.', *Innovation*, vol. 4, no. 1–3, pp. 143–146.

Hartley, J. (2005) 'Innovation in governance and public services: Past and present', *Public Money and Management*, vol. 25, no. 1, pp. 27–34.

Henderson, M., Barnett, R. and Barrett, H. (2017) 'New developments in transnational education and the challenges for higher education professional staff', *Perspectives: Policy and Practice in Higher Education*, vol. 21*,* no. 1, pp. 11-19.

Her Majesty's Inspectorate of Constabulary (2011) *Demanding Times*.

Heylighen, F., and Joslyn, C. (2001) Cybernetics and second-order cybernetics. *Encyclopedia of physical science and technology*, vol. 4, pp. 155-170.

His Majesty's Inspectorate of Constabulary and Fire & Rescue Services (HMICFRS) (2021) *Policing in the pandemic – the police response to the coronavirus pandemic during 2020* [Online]. Available at: https://www.justiceinspectorates.gov.uk/hmicfrs/publication-html/the-police-response-to-the-coronavirus-pandemic-during-2020/ (Accessed 12 March 2023).

The Home Office (2012) *False ID Guidance,* July 2012, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/183495/False ID guidance.pdf (Accessed 19 June 2023).

The Home Office (2012) *Strategic Policing Requirement,* July 2012.

The Home Office (2014) *Reducing Mobile Phone Theft and Improving Security*, September 2014, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/390901/HO_Mobile_theft_paper_Dec_14_WEB.PDF (Accessed 29 March 2013).

The Home Office (2015) *Revised guidance issued under Section 182 of the Licensing Act 2003*, October 2015, [Online]. Available at: http://www.homeoffice.gov.uk/publications/alcohol-drugs/alcohol/guidance-section-182-licensing/ (Accessed 3 June 2022).

The Home Office (2018) *Serious violence strategy*, April, [Online]. Available at: https://www.gov.uk/government/publications/serious-violence-strategy (Accessed 3 June 2022).

The Home Office (2019a) *Police Workforce, England and Wales, 31 March 2019*, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831726/police-workforce-mar19-hosb1119.pdf (Accessed 3 June 2022).

The Home Office (2019b) *Home Office funds innovative policing technology to prevent crime* [Online]. Available at: https://www.gov.uk/government/news/home-office-funds-innovative-policing-technology-to-prevent-crime (Accessed 7 November 2020).

The Home Office (2023) *The Strategic Policing Requirement,* February 2023, [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1138740/20230223_Strategic_Policing_Requirement__V1.2__-_OS.pdf (Accessed 29 March 2023).

Hoppe, H. C. (2002) 'The timing of new technology adoption: theoretical models and empirical evidence', *The Manchester School*, vol. 70, no. 1, pp. 56–76.

House of Commons Committee of Public Accounts (2012) *Mobile Technology in Policing: Second Report of Session 2012-13*, January, [Online]. Available at: https://publications.parliament.uk/pa/cm201213/cmselect/cmpubacc/129/12906.htm (Accessed 3 June 2022).

Ikumoro, A, O., and Jawad, M, S. (2019) 'Intention to use intelligent conversational agents in e-commerce among Malaysian SMEs: an integrated conceptual framework based on tri-theories including unified theory of acceptance, use of technology (UTAUT), and TOE.', *International Journal of Academic Research in Business and Social Sciences*, vol. 9, no. 11, pp.205-235.

Independent Police Commission (2013) *Policing for a Better Britain*.

Information Commissioners Office (2009) *Data Protection Good Practice Note: Use of ID scanning devices in pubs and clubs*, [Online]. Available at: https://ico.org.uk/media/for-organisations/documents/1593/scanning_devices_in_pubs_and_clubs.pdf (Accessed 6 March 2022).

Irvine, A., Drew, P. and Sainsbury, R. (2012) '"Am I not answering your questions properly?" Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews', *Qualitative Research*, vol. 13, no. 1, pp. 87–106.

Jenkins, G.M. (1969) 'A Systems Study of a Petrochemical Plant', *Journal of Systems Engineering*, vol. 1, no. 1, pp. 90-101 reproduced in Wilson, B. (1984) *Systems: concepts, methodologies, and applications*. John Wiley and Sons, Ltd. Chichester pp. 277-294.

Jones, L. (2020) 'Coronavirus: What's behind the great toilet roll grab?', *BBC*, 26 March 2020 [Online]. Available at: https://www.bbc.co.uk/news/business-52040532 (Accessed 22 March 2023).

Joubert, J. and Van Belle, J. (2012) 'Success Factors for Product and Service Innovation: A Critical Literature Review and Proposed Integrative Framework', *Management Dynamics*, vol. 12, no. 2, pp. 1–22.

Katebi, A., Homami, P. and Najmeddin, M. (2022). 'Acceptance model of precast concrete components in building construction based on Technology Acceptance Model (TAM) and Technology, Organisation, and Environment (TOE) framework.', *Journal of Building Engineering*, vol. 45, p. 103518.

Kolb, D, A. (1984) *Experiential learning: Experience as the source of learning and development,* Englewood Cliffs, NJ, Prentice-Hall.

Koper, C. S., Lum, C. and Willis, J. J. (2014) 'Optimizing the use of technology in policing: Results and implications from a multi-site study of the social, organizational, and behavioural aspects of implementing police technologies', *Policing (Oxford)*, vol. 8, no. 2, pp. 212–221.

Kotsemir, M. N. and Meissner, D. (2013) 'Conceptualizing the Innovation Process – Trends and Outlook', *SSRN Electronic Journal*, no. 46504.

Lambri, T. (2014) *Modelling the implementation and acceptance of the Police National Database in UK police forces*, Loughborough University.

Lane, A., Armson, R., Farmer, E., Hamwee, J., Martin, J., Fisher, W., Hudson, J., Paton, G., Roberts, P. (2000) *T552 Systems thinking and practice: diagramming*, Milton Keynes, UK, The Open University.

Lane, A. (2002) *Systems thinking and practice: diagramming,* Milton Keynes, UK, The Open University.

Lane, D, C. (2008) 'The emergence and use of diagramming in system dynamics: a critical account.', *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research* vol. 25, no. 1, pp. 3-23.

Lane, A. (2013) 'A review of diagramming in systems practice and how technologies have supported the teaching and learning of diagramming for systems thinking in practice', *Systemic practice and action research,* vol. 26, pp. 319-329.

Laszlo, A. and Krippner, S. (1998) 'Systems theories: their origins, foundations, and development', *Advances in Psychology*, vol. 126, no. C, pp. 47–74.

Legris, P., Ingham, J. and Collerette, P. (2003) 'Why do people use information technology? A critical review of the technology acceptance model', *Information and Management*, vol. 40, no. 3, pp. 191–204.

Lin, C., Hu, P. J. H. and Chen, H. (2004) 'Technology implementation management in law enforcement: COPLINK system usability and user acceptance evaluations', *Social Science Computer Review*, vol. 22, no. 1, pp. 24–36.

Lindsay, R., Cooke, L. and Jackson, T. (2009) 'The impact of mobile technology on a UK police force and their knowledge sharing', *Journal of Information and Knowledge Management*, vol. 8, no. 2, pp. 101–112.

Lindsay, R., Jackson, T. W. and Cooke, L. (2011) 'Adapted technology acceptance model for mobile policing', *Journal of Systems and Information Technology*, vol. 13, no. 4, pp. 389–407.

Lippert, S. K. and Forman, H. (2005) 'Utilization of information technology: examining cognitive and experiential factors of post-adoption behavior', *IEEE Transactions on Engineering Management*, vol. 52, no. 3, pp. 363–381.

Lippert, S. K. and Ph, D. (2006) 'Technological, organizational, and environmental antecedents to web services adoption', *Communications of the IIMA*, vol. 6, no. 1, pp. 146–158.

Lipsey, M.W., Wilson, D.B., Cohen, M.A. and Derzon, J. H. (2002) 'Is there a causal relationship between alcohol use and violence?', *Recent developments in alcoholism*, pp. 245–282.

London Assembly (2013) *Smart policing*, August 2013 [Online]. Available at: https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Police%20technology%20report%20-%20Final%20version.pdf (Accessed 29 March 2023).

Low, C., Chen, Y. and Wu, M. (2011) 'Understanding the determinants of cloud computing adoption', *Industrial Management and Data Systems*, vol. 111, no. 7, pp. 1006–1023.

Mann, P., Aczel, J., Scanlon, E. and Cooper, M. (2007) 'Sketch-based interfaces to support collaborative conceptual design learning', *Computer Assisted Learning (CAL '07)*, Trinity College, Dublin, Ireland.

Manning, P. K. (1992) 'Information technologies and the police', *Crime and Justice*, vol. 15, pp. 349–398.

McCabe, A., Skelcher, C. and Lowndes, V. (1997) '*Partnerships and networks: an evaluation and development manual.*' York Publishing Services.

McCloskey, J. F. (1987) 'OR Forum—The Beginnings of Operations Research: 1934–1941', *Operations Research*, vol. 35, no. 1, pp. 143–152.

McGuire, J., Evans, E., Kane, E., McGuire, J., Evans, E. and Kane, E. (2021) 'Policing the Night-Time Economy: A Systematic Review of Evidence-Based Practice.' *Evidence-Based Policing and Community Crime Prevention*, pp.27-60.

Mead, M. (1961) 'Anthropology among the sciences', *American Anthropologist*, vol. 63, no. 3, pp. 475–482.

Metcalfe, W. (2014) 'Newcastle clubs introduce state of the art ID scanners to help pinpoint trouble makers' *Chronicle Live North West,* 6 December 2914 [Online] Available at: https://www.chroniclelive.co.uk/news/north-east-news/newcastle-clubs-introduce-state-art-8236731 (Accessed 6 June 2022).

Metropolitan Police Service (2014) *ONE MET: Total Technology,* London.

Min, S., So, K.K.F. and Jeong, M. (2019) 'Consumer adoption of the Uber mobile application: Insights from diffusion of innovation theory and technology acceptance model.', *Journal of Travel and Tourism Marketing*, vol. 36, no. 7, pp.770-783.

Mohammad, A, B., Al-Okaily, M. and Al-Majali, M. (2022) 'Business intelligence and analytics (BIA) usage in the banking industry sector: an application of the TOE framework.', *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 8, no. 4, p. 189.

Motorola Solutions (2021) 'Lancashire Constabulary is the first police force in the UK to deploy a Motorola Solutions integrated Body-Worn Camera and Pronto digital policing solution.' [Online]. Available at: https://www.motorolasolutions.com/content/dam/msi/docs/en-xu/public-safety/Pronto_VB400_Lancashire_Constabulary_Case_Study.pdf (Accessed 19 March 2023).

Murdoch, D. and Ross, D. (1990) 'Alcohol and crimes of violence: Present issues', *International Journal of the Addictions*, vol. 25, no. 9, pp. 1065–1081.

The National Archives (1829) *Metropolitan Police Act*.

The National Archives (1964) *Police Act of 1964*, [Online]. Available at: https://www.legislation.gov.uk/ukpga/1964/48/contents (Accessed 3 June 2022).

National Audit Office (2012) *Mobile technology in policing*. The Stationery Office.

National Audit Office (2018) *Financial sustainability of police forces in England and Wales 2018*, [Online]. Available at: https://www.nao.org.uk/wp-content/uploads/2018/09/Financial-sustainability-of-police-forces-in-England-and-Wales-2018.pdf#:~:text=4%20Key%20facts%20Financial%20sustainability%20of%20police%20forces,%28from%20central%20government%20and%20local%20funding%29%20to%20police (Accessed 3 June 2022).

National Police Chiefs' Council (2016) *Policing Vision 2025*, [Online]. Available at: https://www.npcc.police.uk/documents/Policing Vision.pdf (Accessed 3 June 2022).

National Police Chiefs' Council (2023) [Online]. 'Operation Soteria – Transforming the Investigation of Rape.' https://www.npcc.police.uk/our-work/violence-against-women-and-girls/operation-soteria/ (Accessed: 23 March 2023).

Nelson, K, M. (2022) 'Body worn cameras and ID scanners must be used at Casino Rooms in Rochester' *KentOnline*, 14 June 2022 [Online]. Available at: https://www.kentonline.co.uk/medway/news/body-worn-cameras-and-id-scanner-for-troubled-nightclub-268685/ (Accessed 22 December 2022).

Nielsen, J. (1994) *Usability engineering*. Morgan Kaufmann.

OECD (2017) 'Fostering Innovation in the Public Sector', [Online]. Available at: https://oecd-opsi.org/wp-content/uploads/2018/07/Fostering-Innovation-in-the-Public-Sector-254-pages.pdf (Accessed 3 June 2022).

Office for National Statistics (2022) *Crime in England and Wales: year ending September 2022* [Online]. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/bulletins/crimeinengl andandwales/yearendingseptember2022 (Accessed 29 March 2023).

The Open University (2012) 'Diagramming for development 1 - bounding realities' [Online]. Available at: https://www.open.edu/openlearn/science-maths-technology/computing-ict/diagramming-development-1-bounding-realities/content-section-0?active-tab=description-tab (Accessed 7 November 2020).

Oreszczyn, S. (1999) *Participative Approaches to Hedgerow Conservation*, The Open University.

Palmer, D., Warren, I. and Miller, P. (2013) 'ID scanners in the night-time economy: social sorting or social order?', *Trends and Issues in Crime and Criminal Justice*, vol. 466, pp. 1–9.

Pawson, R. and Tilley, N. (1994) 'What works in evaluation research?', *British Journal of Criminology*, vol. 34, no. 3, pp. 291–306.

Pearce, T. and Fortune, J. (1995) 'Command and control in policing: A systems assessment of the gold, silver and bronze structure', *Journal of Contingencies and Crisis Management*, vol. 3, pp. 181–187.

Pennington, P. (2020) 'Police using technology riddled with controversy overseas' *Stuff*, 7 December 2020 [Online]. Available at: https://www.stuff.co.nz/national/crime/300176755/police-using-technology-riddled-with-controversy-overseas (Accessed 3 June 2022).

Peters, G. and Fortune, J. (1992) 'Systemic methods for the analysis of failure', *Systems practice*, vol. 5, no. 5, pp. 529-542.

Pica, D., Sørensen, C. and Allen, D. (2004) 'On mobility and context of work: exploring mobile police work', *Proceedings of the Hawaii International Conference on System Sciences*, 5-8 January 2004, vol. 37, no. C.

Pidd, H., (2022) 'Nightclub has licence suspended after fatal Birmingham stabbing', *The Guardian*, 20 December 2022 [Online]. Available at: https://www.theguardian.com/uk-news/2022/dec/30/nightclub-has-licence-suspended-after-fatal-birmingham-stabbing (Accessed 20 January 2023).

Plant, M., Plant, M. and Thornton, C. (2002) 'People and places: some factors in the alcohol-violence link', *Journal of substance use*, vol. 7, no. 4, pp. 207–213.

PopplestonAllen (2016) 'Lords review of will be a challenging task', 9 June 2016 [Online]. Available at: http://www.morningadvertiser.co.uk/Legal/Licensing-law/Lords-review-of-Licensing-Act-will-be-a-challenging-task (Accessed 17 December 2016).

PopplestonAllen (2021) *The Licensed Trade Guide* [Online]. Available at: https://www.popall.co.uk/wp-content/uploads/2021/03/Licensed-Trade-Guide-2021.pdf (Accessed 24 March 2023).

Potter, S. ed. (2006) *Doing Postgraduate Research*, vol. 13, Sage publications.

Private Eye (2022) 'Police radios; tender trap', 29 June 2022, vol. 1576, p. 38.

Quinn, B., (2022) 'Met officers guilty of sharing offensive messages with Wayne Couzens', 21 September 2022, The Guardian, Available at: https://www.theguardian.com/uk-news/2022/sep/21/met-officers-guilty-of-sharing-offensive-messages-with-wayne-couzens (Accessed 30 March 2023).

Reform Think Tank (2012) *The future of technology in policing* [Online]. Available at: http://www.reform.co.uk/resources/0000/0477/Police_ICT_Conference_WEB.pdf (Accessed 6 November 2016).

Richard, B., Sivo, S.A., Orlowski, M., Ford, R.C., Murphy, J., Boote, D.N. and Witta, E.L. (2021) 'Qualitative research via focus groups: Will going online affect the diversity of your findings?', *Cornell Hospitality Quarterly*, vol. 62, no. 1, pp. 32-45.

Rogers, E. (2003) *Diffusion of Innovations*, The Free Press, A Division of Simon and Schuster Inc.

Rothwell, R. (1994) 'Towards the fifth-generation innovation process', *International Marketing Review*, vol. 11, no. 1, pp. 7–31.

Russell, S. (2015) 'The high tech gadgets helping to prevent crime in Norwich's clubland', *Eastern Daily Press,* 10 July 2015 [Online]. Available at: https://www.edp24.co.uk/news/20892491.high-tech-gadgets-helping-prevent-crime-norwichs-clubland/ (Accessed 31 July 2015).

Salimon, M.G., Kareem, O., Mokhtar, S.S.M., Aliyu, O.A., Bamgbade, J.A. and Adeleke, A.Q. (2023) 'Malaysian SMEs m-commerce adoption: TAM 3, UTAUT 2 and TOE approach.', *Journal of Science and Technology Policy Management*, vol. 14, no. 1, pp. 98-126.

Schwarz, C. and Schwarz, A. (2014) 'To adopt or not to adopt: a perception-based model of the EMR technology adoption decision utilizing the technology-organization-environment framework', *Journal of Organizational and End User Computing*, vol. 26, no. 4, pp. 57–79.

Senge, P.M. and Sterman, J. D. (1992) 'Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future', *European journal of operational research*, vol. 59, no. 1, pp. 137–150.

Senge, P. (2006) *The Fifth Discipline*, Doubleday, New York.

Sherman, L. W. (2013) 'The rise of evidence-based policing: targeting, testing, and tracking', *Crime and Justice*, vol. 42, no. 1, pp. 377–451.

Slater, R., Frederickson, J., Thomas, C., Wield, D. and Potter, S. (2007) 'A critical evaluation of partnerships in municipal waste management in England.' *Resources, Conservation and Recycling*, vol. 51, no. 3, pp. 643-664.

The Stationery Office (2003) *Licensing Act* [Online]. Available at: http://www.legislation.gov.uk/ukpga/2003/17/contents (Accessed 6 November 2016).

Stewart, R. W. and Fortune, J. (1995) 'Application of systems thinking to the identification, avoidance and prevention of risk', *International Journal of Project Management*, vol. 13, no. 5, pp. 279–286.

Stillman, S. (2006) 'Grounded Theory and Grounded Action: Rooted in Systems Theory', *World Futures*, vol. 62, no. 7, pp. 498–504.

Straub, E. T. (2009) 'Understanding technology adoption: theory and future directions for informal learning', *Review of Educational Research*, vol. 79, no. 2, pp. 625–649.

Street Pastors (2016) [Online]. Available at: http://www.streetpastors.org/ (Accessed 6 November 2016).

Sutton, M. (2008) 'How prolific thieves sell stolen goods: describing, understanding and tackling the local markets in Mansfield and Nottingham, A Market Reduction Approach Study', *Internet Journal of Criminology,* pp. 1–82.

Taherdoost, H. (2022) 'A critical review of blockchain acceptance models—blockchain technology adoption frameworks and applications.', *Computers*, vol. 11, no. 2, p. 24.

Tornatzky, L. G. and Fleischer, M. (1990) *The Processes of Technological Innovation*, Lexington Books.

Travis, A. (2010) 'ID cards scheme to be scrapped within 100 days' *The Guardian* [Online]. Available at: http://www.theguardian.com/politics/2010/may/27/theresa-may-scrapping-id-cards (Accessed 6 November 2016).

Tushman M L, Anderson, P. (1986) 'Technological discontinuities and organizational environments', *Administrative Science Quarterly*, vol. 31, pp. 439–465.

UK Government (2012) *Definition of policing by consent* [Online]. Available at: https://www.gov.uk/government/publications/policing-by-consent/definition-of-policing-by-consent (Accessed 6 June 2022).

United Nations (2023) '*Sustainable development goals*' [Online]. Available at: https://sdgs.un.org/goals (Accessed 31 March 2023).

Urban, M. (2013) 'Concerns grow over the rise of compulsory ID scanning in pubs, clubs and venues' *Brixton Buzz,* 2 April 2013 [Online]. Available at: https://www.brixtonbuzz.com/2013/04/concerns-grow-over-the-rise-of-compulsory-id-scanning-in-venues/ (Accessed 22 December 2022).

Ure, C., Burns, E.J., Hargreaves, S.C., Hidajat, M., Coffey, M., de Vocht, F., Audrey, S., Hare, S., Ardern, K. and Cook, P.A. (2021) 'How can communities influence alcohol licensing at a local level? Licensing officers' perspectives of the barriers and facilitators to sustaining engagement in a volunteer-led alcohol harm reduction approach.' *International Journal of Drug Policy*, vol. 98, p. 103412.

Valente, T.W. and Davis, R. L. (1999) 'Accelerating the diffusion of innovations using opinion leaders.', *The Annals of the American Academy of Political and Social Science*, vol. 566, no. 1, pp. 55–67.

Venkatesh, V. and Davis, F. D. (2000) 'A theoretical extension of the technology acceptance model: four longitudinal field studies', *Management Science*, vol. 46, no. 2, pp. 186–204.

Venkatesh, Morris, Davis and Davis (2003) 'User acceptance of information technology: toward a unified view', *MIS Quarterly*, vol. 27, no. 3, pp. 425–478.

Venkatesh, V. and Zhang, X. (2010) 'Unified theory of acceptance and use of technology: U.S. vs. China', *Journal of Global Information Technology Management*, vol. 13, no. 1, pp. 5–27.

Von Bertalanffy, L. (1950) 'The theory of open systems in physics and biology', *Science*, vol. 111, no. 2872, pp. 23–29.

Von Bertalanffy, L. (1968) *General Systems Theory*, Braziller, New York.

Von Bertalanffy, L. (1972) 'The History and Status of General Systems Theory', *Academy of Management Journal*, vol. 15, no. 4, pp. 407–426.

Walker, A., Flatley, J., Kershaw, C., & Moon, D. (2009) 'Findings from the British Crime Survey and Police recorded crime', *Crime in England and Wales 2008/09*.

Walsham, G. and Sahay, S. (1999) 'GIS for district-level administration in India: problems and opportunities', *MIS quarterly*, vol. 23, no. 1.

Walsham, G. (2006) 'Doing interpretive research', *European Journal of Information Systems*, vol. 15, no. 3, pp. 320–330.

Wastell, D., Kawalek, P., Langmead-Jones, P. and Ormerod, R. (2004) 'Information systems and partnership in multi-agency networks: An action research project in crime reduction', *Information and Organization*, vol. 14, no. 3, pp. 189–210.

Wastell, D. G. (2006) 'Information systems and evidence-based policy in multi-agency networks: The micro-politics of situated innovation', *Journal of Strategic Information Systems*, vol. 15, no. 3, pp. 197–217.

Weber, R. (2004) 'The rhetoric of positivism verses interpretivism', *MIS Quarterly*, vol. 28, no. 1, pp. 3–12.

White, D. and Fortune, J. (2009) 'The project-specific Formal System Model', *International Journal of Managing Projects in Business*, vol. 2, no. 1, pp. 36–52.

Wiener (1948) in Ackoff, R. L. (1974) 'The systems revolution', *Long range planning*, vol. 7, no. 6, pp. 2–20.

Williams, C. (2014) *Police Control Systems in Britain, 1775-1975: From Parish Constable to National Computer*, Manchester University Press.

Wilson, B. (1984) *Systems: concepts, methodologies, and applications*. John Wiley and Sons Ltd, Chichester.

Woodward, S. (2013) 'Russell Kirsch: The man who taught computers to see', *OregonLive,* 11 May 2007 [Online]. Available at:
http://www.oregonlive.com/living/index.ssf/2007/05/russell_kirsch_the_man_who_tau.html (Accessed 6 November 2016).

Wu, P. F. (2009) 'Opening the black boxes of TAM: Towards a mixed methods approach'*, ICIS 2009 Proceedings - Thirtieth International Conference on Information Systems*, pp. 1–10.

Young, O, R. (1964) 'General systems', *Yearbook of the Society for General Systems Research*, vol. 9, p. 61.

Zhang, M., Zhou, Y., Li, L. (2022) 'Manufacturing firms' E-commerce adoption and performance: evidence from a large survey in Jiaxing, China.', *Information and Technology Management,* pp. 1-23.

Appendices

Appendix A: Summary of the proposal to The Open University Human Research Ethics Committee

HUMAN RESEARCH ETHICS COMMITTEE (HREC) PROFORMA

Open University research involving human participants or materials has to be reviewed and where appropriate, approved by the HREC. To apply to HREC, please complete and email this proforma to research-rec-review@open.ac.uk. You will need to attach any related documents such as a consent form or information sheet so that a full application can be considered by the HREC Review Panel. Omitting any documents may result in a delay to the review process.

If you have any queries about completing the proforma please look at the Research Ethics website, in particular the FAQs - http://www.open.ac.uk/research/ethics/human-FAQs.shtml which include a set of Generic Protocols and Templates. You can also contact the HREC Chair or Secretary.

The submission deadline for applications is every Thursday at 5.30pm when they will be assessed for completeness and then sent to the HREC Review Panel. Once an application has been passed for review you should receive a response within 10 working days. All general research ethics queries should be sent to Research-Ethics@open.ac.uk, or call the HREC Secretary on (01908 654858).

PROJECT IDENTIFIATION AND RATIONALE

Title of project: Technology in Modern Policing

Abstract

The research project will explore aspects of the management of technology in the modern Police Service, with particular emphasis on the adoption of new technologies. It will identify the factors that affect the speed and success of technology adoption and examine the extent to which existing models (e.g., the technology acceptance model (Davis, 1989)) are able to account for these factors. This is an under-researched field and an important area for study.

(Davis, F. (1989): Perceived usefulness, perceived ease of use and user acceptance of information technology, MIS Quarterly, (13, 3), September 1989, pp. 319-340).

This proposal, as part of a PhD study, requires cooperation of a gatekeeper for access to participants. The research would be carried out through interviews and may include observation of the technology in use - this paper deals with both those aspects. Interviews would be conducted in accordance with University policies and consistent with existing good practice. Later on in the PhD, it may be appropriate to conduct an online survey but that is out of scope of at this time. If valuable to the PhD, a new proposal would be put forward to this Committee for approval. (193 words)

Project personnel and collaborators

Investigators

The names and institutional attachments of all persons involved in the collection and handling of individual data and the name one person as Principal Investigator (PI) can be found below.

In this proposal, the Research student is named the Principal Investigator and a separate supervisor endorsement is to be sent to Research-Rec-Review@open.ac.uk to support the application.

Principal Investigator is the

Research Student: Heather Barrett

Primary Supervisor: Professor Joyce Fortune

RESEARCH PROTOCOL

Literature review

The indicative brief review of the existing literature is as follows:

Existing literature shows that whilst implementing technology in the police, there is a belief that such innovations save money (Manning, 1992) though it can just be accepted that significant benefits, by way of cost saving and efficiency, are delivered (Cooke et al, 2009). The National Audit Office, 2012 reported that there is a problem especially in relation to a failure to implement effectively. Cooke et al, 2009 carried out a study which was focused on knowledge management yet a number of issues with the technology were recorded in their findings including technical failure, lack of consistency with other devices and that operational protocols were not fit for purpose. Some studies have shown that in order to implement well, the devices must meet the needs of the users (Pica et al, 2004) though other studies suggest strategic management issues exist, such as the London Assembly, reporting for the Metropolitan Police, in 2013 said that forces tend to go straight to a technology solution before working out the problem they are trying to solve.

More widely and as the situation of austerity is set to continue (Independent Police Commission, 2013), the importance of driving efficiency and effectiveness through use of technologies is set to continue. A number of studies cite the need to increase the number of primary studies in this field (Cooke et al, 2009 and 2013). Currently, evidence-based approaches are increasingly important in policing. Therefore this research, as part of a PhD study, is a unique opportunity to carry out research with the police in relation to management of new technology. It is original and does not replicate or duplicate work done elsewhere and the research could be applicable to other sectors also implementing new technology.

ALLEN, D., PICA, D. & CARSTEN SØRENSEN, C. On Mobility and Context of Work: Exploring Mobile Police Work. Proceedings of the 37th Hawaii International Conference on System Sciences, 5-8 January 2004 Hawaii.

INDEPENDENT POLICE COMMISSION 2013. Policing for a Better Britain.

LINDSAY, R., COOKE, L. & JACKSON, T. 2009. The impact of Mobile Technology on a UK police force and their knowledge sharing.

LINDSAY, R., JACKSON, T. W. & COOKE, L. 2013. Empirical evaluation of a technology acceptance model for mobile policing.

LONDON ASSEMBLY 2013. Smart policing How the Metropolitan Police Service can make better use of technology. London Assembly.

THE NATIONAL AUDIT OFFICE 2012. Mobile technology in policing.

Methodology

The research will take a case study approach initially using two key forms of research – interviews and observation. Secondary data may be sought using documentary evidence though this would relate to the technology and not involve individual and personal data.

The case study will look at the introduction of an ID Scanning technology in nightclubs in Oxford and possibly later in Northamptonshire; the Scanner is introduced as a way of increasing safety. It may be appropriate at a later date to make a comparison by studying the introduction of a different technology but in that case, the protocol will be reviewed and the HREC contacted for further advice.

Interviews are proposed for primary data; they would take place with the stakeholders outlined in the next section and an information sheet and consent form applicable to all participants in this study has been designed. All interview data would be anonymised and not attributable to any individual, the steps taken to ensure anonymity are set out in the appropriate sections of this paper.

The semi-structured interviews will explore the story of the project including:
• Why is this project important and for what purpose is it intended;
• How they become involved;
• What their role was and what part they played;
• What activities and actions they have been involved in;
• How has it gone (e.g., what went well / less well);
• Where is it going next.

Observation of an ID Scanner technology may take place in order to identify and/or confirm potential issues and best practice; data collected using this mechanism would be about the use and performance of the technology and would not involve any individual data. The public would pass through an entrance to an entertainment venue where a new ID Scanner has been introduced but the focus of the observation is the technology in practice and individual data will not be collected on observation.

No collection or assessment of any individual criminal data would be involved in this proposed study.

Participants

There are five key sets of stakeholders involved in the study – police officers, technology suppliers, hosts (where applicable – e.g., an entertainment venue that may host a particular technology), public bodies providing regulatory control (e.g., a local authority and licensing) and the general public who may come into contact with the technology.

The main target population for interviews will be serving police officers and administrative staff (e.g., back office police staff). Staff from partner organisations would also be invited to participate in order to form a more rounded view of the introduction and implementation of a new technology. Partner organisations include technology suppliers and other decision makers (e.g., staff in a local public body such as the local authority) that may provide licence, funding or other approval for use of the technology.

However, to enable consideration of all issues and practice in relation to the technology, it would be helpful to also gain the view of the general public. They would be offered the opportunity to volunteer to participate in an interview (the recruitment procedures are explained in the next section).

The observation element relates to overseeing the technology in practice only, although the public may use a particular technology, no data would be collected on that aspect – the performance of the technology only would be of interest in observation (e.g., failures, issue and/or what works well). There is no need to look at or see any personal data from members of the public using the device.

The diversity of the sample will not be monitored; the study relies on participants involved with a particular new policing technology.

Recruitment procedures

For the interviews, potential participants will be identified and approached initially by the gatekeeper (e.g., Detective Chief Inspector / Superintendent and Head of Operational Delivery) who will circulate an invitation from the researcher. The invitation to take part in the study would go to police officers and staff involved in the new technology project and to other partners where there is an existing relationship (e.g., hosts of the technology if not the police and any public body also involved in the project). The invitation from the researcher would ask volunteers to make contact to arrange an interview should they wish to participate. On contact with the researcher, the potential volunteer would be provided with the information sheet and consent form along with communication to agree suitable arrangements for the time, date and location of the interview. They would also be provided with the instructions that two copies of the consent form would be signed at the start of the interview one for them to retain, and that they are able to withdraw from the study by simply letting the researcher know.

Direct observation would be organised by the police gatekeeper, and partner organisation if applicable and the researcher would be accompanied by officers in the interests of safety to the location of the technology but the researcher would not be 'on patrol' as such (e.g., where a static ID Scanner is introduced). As this study is about observation of the police interaction with the technology only, data pertaining to the technology would be collected on observation and not in relation to individuals. Observation would always be in a public place and although police interaction with host staff (e.g., security staff) already operating the technology may be witnessed, it is not expected that the researcher would witness criminal interaction with the police or any arrest by the police. However

In order to offer the opportunity for the general public to volunteer to participate, and to provide a more rounded piece of research, an invitation could be handed out to the general public with the researcher's contact details so the researcher would not know who these people are until the potential participant had made voluntary contact with the researcher. Once an expression of interest had been received by the researcher, an interview would be arranged in the same way as any other participant in the study – they would be provided with more information and the consent sheet to consider, along with instructions for withdrawal and that two copies of the consent form would be signed at the start of the interview. By asking the general public to make contact should they wish to volunteer at a later date, this provides a more robust consent as they may feel obliged if their contact details were exchanged whilst the police were also in attendance.

No part of this study involves recruiting or observing any children or vulnerable adults. The steps taken to eliminate any risk to recruiting an under-age participant in the general public element of this study have been set out in the risks section of this paper.

Consent

Valid consent will be sought in line with the principles set out in the Ethics Principles for Involving Human Participants by informing them in advance and in understandable language of any reasonable factor that may influence their willingness to participate.

For interviews, an information sheet and a signed consent form will be used; the same document will be used for all participants in this study as a matter of consistency. This information and form will be shared with the potential participant giving them at least two weeks to return the consent form ahead of the interview so they have time to consider and digest the information and ask any questions of the researcher. Two copies of the consent form will [be] signed ideally in advance of the interview if possible as email confirmation would be accepted, or before the interview commences and in which case, one for the participant to retain and one the researcher's records. All data will be anonymised in reporting on the outcomes (the arrangements for which are detailed later in this paper).

In the observation element, as this will focus on the technology data (e.g., failure or issues with an ID Scanner) will not be captured about any member of the public. It would not be possible to approach or gain informed consent of people entering a nightclub and there is no need to look at any personal data or discuss the technology at this point with a member of the public.

All participants will be notified that they can withdraw their consent at any time should they wish to do so and in such as case, all personal data would be destroyed and removed from the study. This includes both handwritten notes and any data kept electronically pertaining to that individual.

The information sheet and consent form for all interview participants are [provided].

Location of data collection

Data from interviews will be collated on location at the appropriate police station and/or office (in the case of a council or other public body involved); in order for good working relationships and so not to compromise time pressures on the police, the researcher will travel to their preferred location (usually a police station or Headquarters office building). The approval to do this will be provided by the relevant senior manager of the station/office. Interviews will be recorded via handwritten notes only, no recordings will be made; notes will be written up after the interview and a summary of key points shared electronically directly with the participant in order to facilitate a shared understanding of the interview. Handwritten notes will be stored securely at Walton Hall and all electronic data also stored in Open University systems.

Data from the observation will not be attributable to individuals; observation is of the technology in practice and this will be handwritten notes by the researcher while on-site in a public place and written up electronically at the end of the observation session; the data collected would be in relation to technological issues (e.g., failures or issues with the technology).

Should a member of the general public register an interest as a participant, their data will be stored and destroyed in accordance with the same process for any other individual in the study. These interviews would take place over the telephone and data collected whilst the researcher is at Walton Hall.

Individual data will be anonymised by using a code that only the researcher will have access to (stored electronically only in an OU secure folder).

The researcher is also a full-time member of University staff with experience in advising on data protection, also which provides additional security as the researcher uses an OU optimised laptop for all work related to the research. Data will be stored in a secure Open University shared area to which only the researcher has access (and the Supervisor if required) and accessed via the OU optimised desktop. Handwritten notes and the hard copy consent forms will be stored in a locked drawer at Walton Hall. All hard copies will be shredded by the researcher in line with storage and disposal of data complies with the University Police on Data Protection – this will be a maximum of 5 years on completion of the PhD.

Schedule

The research forms part of a part-time PhD study, the time frame for the research will focus on interviews and observation during 2014 although the interviewing period may extend into 2015. The main data collection phase is expected run until the end of 2015.

Key Ethics considerations

Published ethics and legal guidelines to be followed

The researcher will use the following appropriate guidelines:
• Ethics Principles for Research Involving Human Participants
• Code of Practice for Research at the Open University
• The British Psychological society (BPS)
http://www.bps.org.uk/sites/default/files/documents/code_of_ethics_and_conduct.pdf

• British Society of Criminology http://britsoccrim.org/new/?q=node/22 (some aspects of the Code here are useful to consider when conducting police research).

It may be appropriate for the researcher to have sight of internal police documentation relating to the implementation project and in which case the researcher will take a similar approach to that of the interviews – a summary of points that the researcher would like to use would be shared with the person that owns the information (and senior managers if applicable) and permission to use it requested via email; the owner would have the option to add, amend or delete information they did not want the researcher to use in this study.

Data Protection

The OU Data Protection Code of Practice will be adhered to and data stored in accordance with University policy and storage requirements. As noted earlier in this paper, the researcher is a full-time member of University staff and experienced in advising on data protection; no sensitive data will be collected in this study. Registration with the Data Protection Co-ordinator through a Data Protection Questionnaire has been made and no issues were identified.

All individual personal data collected from the interviews will be anonymised when the researcher writes up each interview by using a coding system that only the researcher will have access to. As the study is mainly capturing qualitative data, care will also be taken to code any particular terms that may also lead to identification (e.g., a street name would be changed to a description of the wider area).

Hardcopy consent forms and notes will be in locked drawers on University premises whilst the laptop on which data will be collected is an optimised desktop provided by the OU and is therefore compliant with University IT Information Security. The optimised desktops have particularly high security. All electronic data will be stored in a secure and private folder on the University shared area.

Data collected on observation relates to the technology and not to any individual.

The detailed project plan will include data storage and destruction activity and all personal data will be destroyed within a maximum of 5 years after publication of the PhD.

Recompense to participants

No recompense will be given to any participant in this study.

Deception

There is no need in this study to withhold any information from participants or misrepresent any information or any other form of deception will not take place.

Risk of harm to participants

The key risks to harm of participants to this research are noted below; risks in this study have been carefully assessed and mitigation strategies considered.

There is a risk to access to interview participants as this study relies initially on a gatekeeper in the police force and changes to the gatekeeper could be a barrier to recruiting participants; this risk will be mitigated through ensuring strong relationships are built with key stakeholders and in the event of the gatekeeper changing roles or responsibilities then the researcher would request a handover to a new contact takes place.

To ensure staff are not coerced into taking part, the researcher will be clear at the point of setting up the interview that it is entirely voluntary and there is option to opt out even after interview has started. Information as to who has or has not participated would only be accessed by the researcher and would not be shared with the gatekeeper.

The observation element is in relation to the technology in use and not observing the public and no personal data will be collected on observation though there may be a need to explain the presence of the researcher so a contact card will be carried along with the details of the project supervisor should someone wish to make an enquiry However the recruitment of the general public is proposed to take place, as described earlier, via a hand-out with the invitation to contact the researcher at a later date to volunteer. The invite can be handed out generally (i.e., it is not identifying someone only who had been stopped by the police); no other communication with the general public would take place until the researcher received an expression of interest from them to take part. This reduces any risk associated with their recruitment.

The research will not record, photograph or video any aspect of the participants. However, it may be appropriate to take a photograph of the technology itself to aid understanding by others not connected with the research; any photograph would not include people and permission of the technology owner would be sought.

More generally, there may be a risk in relation to sharing negative outcomes of the research where the police may believe they are implementing a successful project but the research finds the contrary. In order to mitigate this, stakeholder expectations will be managed and communications will be clear in relation to the purpose of the research. Though negative outcomes may also be helpful to the police as lessons learned.

The proposed study does not involve any contact with children or other vulnerable groups nor will it collect or observe any other personal or criminal data; the study focuses on the way the police implement technology. In relation to general public volunteers, although the researcher will only hand out invitations to those believed to be adults, in order to mitigate any risk of an under-18 participating, general public volunteers will be advised the study is for adults only and will be asked on the consent form to confirm that they are over the age of 18. It is not possible to identify vulnerable adults but the researcher will take care to adhere to University policy and will seek advice from the Supervisory team should any concerns about a participant be evident.

Should, in the unlikely event, a participant disclose unprofessional behaviour or any untoward behaviour is observed by the researcher, the researcher will seek advice from the Supervisor and respond in line with University policy and procedures and in line with Police policy if necessary, as there may also be a relevant police policy that applies.

Debriefing

After data collection of the interviews, an electronic written summary of the notes of an interview will be shared with the relevant participant, this is to inform them of the outcomes of their participation and it will provide them opportunity to add clarifications to the record and to add or withdraw information if necessary. Participants will be asked to confirm that the summary is suitable to be shared in the public domain via outputs of the research (journal papers, PhD publication etc.)

The research more broadly may be written up and shared with the gatekeepers but all data will be anonymous and not attributable to any individual.

PROJECT MANAGEMENT

Research organisation and Funding

The Open University is supporting the cost of study fees as the researcher is full-time member of staff as well as a part-time doctoral researcher, no other sources of funding or external funding applies.

Other project-related risks

The police force is subject to their own code of practice and Ethics policies whilst the researcher is also a member of staff and subject to University codes of practice and ethics.

The risk of harm to the researcher has been assessed as less than that for a member of the public for instance, in the observation element, there may be a small risk to safety but the risk is mitigated by being accompanied by police officers or other security staff (in the case of a technology in an entertainment venue for instance); for the technologies used by the police that this study will focus on there is a very small risk of an altercation taking place whilst the researcher is with the police (i.e., a uniformed officer would be required to do their job should they be called upon). In the unlikely event of the police having to make an arrest whilst the researcher is present, the researcher will stop collecting data about the technology and will be sufficiently removed from the situation. The researcher will inform and seek advice from the supervisors of this project. The researcher is also aware of risk of being called as a witness and having to provide evidence. The police have confirmed that they are used to a variety of observers accompanying them for different reasons (including other PhD researchers).

Risks to the researcher's safety in relation to undertaking interviews is also deemed to be low risk as interviews will take place at police stations or at another place of work (e.g., a local council or local entertainment provider). Interviews with any general public volunteers would take place by telephone.

Standard insurances covered by the University (indemnity and liability) apply.

BENEFITS AND KNOWLEDGE TRANSFER

The research may deliver individual gains as participants are provided the opportunity to talk about the factors affecting them, they may also welcome the opportunity to speak in confidence to a third-party. A contribution to knowledge is gained as lessons learned are helpful in informing future projects and in sharing learning with other forces; contributing to evidence-based policing and to effective and efficient working. This study could benefit wider communities if the police are able to implement projects in a more cost-effective way. Intended forms of dissemination include an examined PhD thesis and relevant journals/publications. (95 words)

DECLARTION

I declare that the research will conform to the above protocol and that any significant changes or new ethics issues will be raised with the HREC before they are implemented.

I declare that I have read and will adhere to the following two OU documents:

•   OU Code Of Practice For Research and at the Open University

•   OU Ethics Principles for Research involving Human Participants

http://www.open.ac.uk/research/ethics/index.shtml

In order to conform with OU governance guidelines, brief information on OU research approved by the HREC will be added to the Research Ethics website. The HREC will assume that you agree that the following data from your research can be made public via the website unless you tick the box below:

HREC reference number   Project title   Faculty   Approval date   Type of HREC approval

o   No, I do not wish for details of my HREC approved research to be publicised.

Name: Heather Barrett

Unit/Faculty: Mathematics, Computing and Technology (MCT)

E-mail: heatherbarrett@hotmail.com

Signature(s) (this can be the typed name(s) of investigator(s) if an electronic copy is submitted (which is preferred)

H.Barrett

Date: 7 May 2014

End of project final report

Once your research has been completed you will need to complete and submit a final report to the HREC. A copy of the template can be found on the Research Ethics website at http://www.open.ac.uk/research/ethics/human.shtml/Final_report.

Appendix B: Information sheet for participants

Information sheet and consent form for participants

**The Open University
The Design Group, Faculty of Mathematics, Computing and Technology
PhD Research Project: Technology in Modern Policing**

What is the aim of this research?
The purpose of this study is to understand the experiences, needs and activities involved in introducing and implementing new technology in modern policing. The study will consider advantages and disadvantages in the way technology is introduced and implemented.

Who is conducting the research and who is it for?
Heather Barrett is carrying out this research as part of a part-time PhD study and is supported by the Design Group in the Open University. Heather is receiving training in carrying out research as part of her study. Further information about the Design Group can be found on the website at:
http://design.open.ac.uk/phd/current_phd.htm

Why am I being invited to participate in this research?
You are being invited as you have been recognised as having a role in the introduction of new technology in policing.

If I take part in this research, what will be involved?
Heather will be conducting interviews during 2014 and 2015. The interview will take approximately 1 hour and it would be held at your place of work, or by telephone, at a date and time that is convenient to you. To ensure your safety, Heather will provide photographic identification.

What will the interview be like?
Before the interview starts, you would be asked to read and sign the attached consent form; there would be two copies of this, one for you and one for Heather's record. The interview would use a semi-structured format, this is where Heather will ask questions from her set of prompts.

Is it confidential and what happens with my data?
Your participation is entirely voluntary and will be treated in the **strictest confidence** and in accordance with the Data Protection Act. All data would be securely handled as data is captured on secure Open University IT facilities that only Heather and her Supervisor has access to. No personal information would be passed to anyone outside of the OU research team.

Following the interview, Heather will write up and share her notes of the interview with you. Heather will be anonymising the data at this time – only Heather and her supervisor will have access to the names of the interviewees. You will be asked to reply with your confirmation if you are happy with the information recorded and that it can be used in the research.

Reports on the findings from this study will be written and may be published publicly (such as a PhD thesis and in relevant journal papers) but no individual will be identifiable in the published results of the research.

You are able to withdraw from the study at any time leading up to publication and you do not have to give a reason - please just let Heather know and she will destroy all data relating to you. All research data would be held up to a maximum of 5 years after the end of the PhD after which time, all personal data will be destroyed.

What happens now?

Over the next few weeks, Heather will contact you to ask if you would like to take part and, if so, ask you a few questions about yourself so she can make sure that a cross-section of people with different experiences are included in the study. It is this reason she cannot guarantee that she will see everyone who volunteers to take part, although she would hope to include most.

If you would prefer not to be contacted about this research, please let Heather know. Your participation is entirely voluntary.

Who will benefit from this research study?

It is hoped that you will find your participation to be helpful as a way of sharing what really happens in project. Heather also hopes to gain a PhD at the end of the research project and more widely, it is hoped that the report will help inform best practice for future policing technology projects.

Are there any hazards to me taking part in this research?

The possible risks to participants have been assessed and no significant harm has been identified. More broadly, there may be a risk that the research finds negative results however, it could be beneficial for those results to become lessons learned to improve future projects. If you have any concerns or identify a risk please do inform Heather so action can be taken.

What if I have other questions?

If you have any other questions about the study then Heather would be very happy to answer them. Please contact Heather Barrett by email to heatherbarrett@hotmail.com

Alternatively, should wish to speak to someone else at the Open University about this research, please contact Professor Joyce Fortune at Open University by email at: j.fortune@open.ac.uk.

Appendix C: Consent form for participants

The Open University
The Design Group, Faculty of Mathematics, Computing and Technology

Consent form for persons participating in the PhD research project: Technology in Modern Policing

Name of participant:

Name of researcher: Heather Barrett

1. I consent to participate in this project and I have been provided with a written Information Sheet that I can keep and I understand the content;

2. I understand that my participation will involve an interview and I agree that the researcher may use the results as described in the Information Sheet;

3. I confirm that I am over the age of 18 years old;

4. I acknowledge that:

   (a) The possible effects of participating in this research have been explained to my satisfaction;

   (b) I understand that I am free to withdraw any time and without giving reason by simply informing the researcher. On withdrawal, any unprocessed data I have provided will be destroyed.

   (c) The project is for the purpose of research;

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded;

   (e) I have been informed that the data generated will be stored securely in facilities provided by the Open University and that all data will be destroyed by a maximum of 5 years after completion of the PhD project;

   (f) Any data from me will not be attributed to me in any publications arising from the research;

   (g) A summary copy of the research findings will be forwarded to me, should I request this by entering my email address here:

   _____

Participant signature: Date:

Heather Barrett   Email: heatherbarrett@hotmail.com
The Open University
Walton Hall, Milton Keynes, MK7 6AA

Appendix D: Semi-structured interview sheet

General interview area	Potential areas of prompt
How they become involved?	How did the participant first hear about it / first become involved Was there any prior experience / anything similar Who else is involved
What their role was and what part they played?	What is the participants role / part in the project What benefits are there for that role What is the impact on current/other work/responsibilities Has there been any signs of conflict/issues What was the effect of what you did
What activities and actions they have been involved in?	What were you asked to do What have you done so far What activities / actions / have they been involved in (intended/unintended?) What are the practical issues expected/happening, what actions have been taken to resolve them Was there anything else that would have helped
Why is the project important?	What is its intended purpose What are the intended benefits What risks / weaknesses were identified What were the uncertainties with the project What were/are the longer term aims and actions for this project
How has the project been set up? (could inquire by stage if appropriate)	Who was involved in setting it up and how was that communicated Was/is there an intended timeframe for implementation Is there a link with overall technology strategies/any commonalities with other technology introduction projects What information was provided and in what format (i.e., guidelines/procedures/training) What opportunities/risks were identified early on/any other issues and challenges the project faced What pressures, motivations, viewpoints were there What is seen as the key aspects of this situation What is important to get it working How would the project be evaluated/technology monitored
How has it gone?	What is known about problems/issues/successes (what went well / less well / barriers / significant issues / if only problems – was there anything that went well) What information is needed to face a similar situation again Things that are working better / not so well The best / worst / typical experiences What would you do differently next time What evaluations of the have been done
Where is it going next?	What were the plans for the future What things are working better / not working as well What else do needs to be done Who else is involved Where is it going next
Possible prompt questions	*That's interesting, could you tell me more* *Can you explain a bit more* *Can you describe that for me* *Can you give an example of an occasion when that happened* *Why do you think that is necessary/in what way* *Is there anything else* *Are there any other reasons* *What was the consequences of that*

Appendix E: Table of data codes

Theme	Category	Code	Indicative quotations from data
Adoption decision	Cost	Cost	…the cost is an issue. It costs around £100 per week, currently on a three-year contract…This high cost is the reason why we would hold off installing it in other venues. (V5)
Adoption decision	Environment/ context	Crime statistics	Statistics showed the peak number of thefts tended to be during the night-time economy so a way to address the problem was needed. (V1)
Adoption decision	Environment/ context	Hearing about the ID scanner	The ID scanner project was first introduced through receipt of an email where an article about ID scanners was shared. It provided an example of where a serious incident had taken place… (V1)
Adoption decision	Environment/ context	Practicalities	Some practical issues with the scanner exist though they are pretty self-explanatory and staff find them easy to use. (W14)
Local authority	Collaboration	Communication with partners	I am a…Local Coordinator, I am interested in ID checking at the entrance to venues as it sometimes comes up in meetings. (W8)
Local authority	Environment/ context	City accreditations	There are mechanisms that support improvements to the city…There are recognition programmes such as the Purple Flag by the ATCM [The Association of Town and City Management] that can award a city as safe, clean with a diverse night-time economy. (V16)
Local authority	Governance	Case by case review	Venues tend to object to things like the ID scanner being on a licence…Ability to control new licences can be limited as, if there are no objectors, there is no further discussion to be had and the proposal passes through. (V4)
Local authority	Governance	Evidence base	[the venue] did have an issue with a high number of thefts...and statistics showed the peak number of thefts tended to be in the night-time economy so a way to address the problem was needed.' 'One club was really proactive in adopting the technology…this club saw an 80 per cent reduction in offences in the first 3 months of using the scanner. (V1)
Local authority	Governance	Governance	When new things are proposed, such as a new technology like the scanner…the [council] are involved, they first come to a [Group] and then it comes to the Scrutiny Committee. …There are many stages where people can speak and issues will be aired and debated. ...proposals can be found in appeals for new licences. (V4)
Local authority	Governance	Licence management	The Licensing Authority…is there to enforce the Licensing Act through a clubs' licence and it is concerned with the management of the licensed premises. The Authority can enforce licences with actions such as closing premises, seeking to review a licence, and by making a prosecution. (V17)
Crime and crime prevention	Environment/ context	Alcohol use and social factors	Cheap booze and pre-loading is an issue for the target audience, youngsters want to be out and about. Also interesting is the growth in fake ID. The ID scanner works. (V3)
Crime and crime prevention	Environment/ context	Crime displacement	I've noticed since [the Venue] has one [an ID scanner], it does seem to have a displacement effect, people go into the [other Venue] instead. (V9)

Theme	Category	Code	Indicative quotations from data
Crime and crime prevention	Environment/ context	Crime enforcement	…the police can…use the system to identify people in the club involved in an incident, for example an assault. (V13) We are focusing on preventative measures as scanners put off organised crime. (W15, W16)
Crime and crime prevention	Environment/ context	Drug and violent crime	There are a range of examples where they have positively supported investigations…someone was raped…but it was possible to trace the offenders' movements using data from the scanner. (W15, W16)
Crime and crime prevention	Environment/ context	Preloading	Culture is a problem, where people are drinking heavily before coming out and may be drunk going into a venue then quickly becoming too drunk and causing problems. (W17)
Police	Business impact	Police resourcing	There are a number of impacts on officers' workloads especially where national information on banned individuals and informal bans from licensed premises are not currently shared making reoffending easier. (W21) There would…be a resource impact should police have to investigate all the people in the club. (W21)
Police	Collaboration	Police influence on stakeholders	...it was a colleague's idea that the ID scanner for clubs could be introduced to deal with violent crime in the night-time economy and support the work of the Night Safe Teams. …Relationships with the club managers and owners have been built up and communication with them regularly takes place. The relationships helped the process of selling it to every club (V11) [Police force] is close by…they come and speak at some monthly and annual events, there is good cooperation. (V4)
Police	Collaboration	Relationship building	The focus is on using information sharing from relationships and networks to discuss new topics. (W20)
Police	Collaboration	Voluntary or forced use	You have to make a decision to operate them voluntarily or be mandated. (W14) Premises are first given the opportunity to volunteer to join the scheme…To address problems in clubs that do not volunteer…the powers of the club's licence were used to encourage or enforce use of the scanners. (W21)
Police	Environment/ context	Crime reduction and prevention	an incident…didn't happen in the club but we knew the person had been in there so we used the data in the ID scanner which helped the case. (V7)
Police	Environment/ context	Hearing about the ID scanner	The ID scanner project came about through promotion by the supplier, word of mouth from other forces… (W21)
Police	Governance	Strategy and objectives	...a scanner should be installed in every club which meets a certain criteria. (W21)
Police	Use	Experience	We get to hear about the technology from being out and about. (V9)
Premises	Business impact	Queues	ID scan causes extra time in the queue…[Venue] has long queues especially when the weather is cold, fights break out in the queue. (W14)

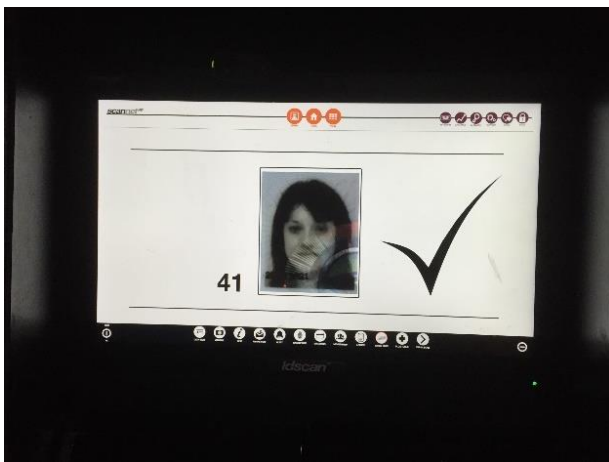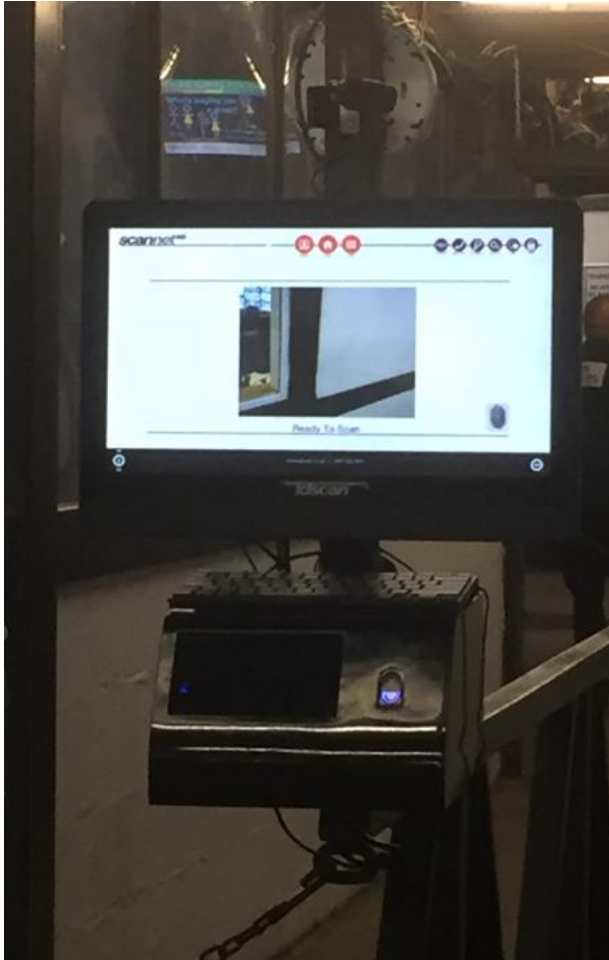| Theme	Category	Code	Indicative quotations from data
Premises	Business impact	Revenue generation	For small independent business, this is a high cost to bear. (V5)
Premises	Business impact	Risks to use the scanner	…the ability to use the scanner seems limited. Only two police requests to use the data have been received. (V5)
Premises	Business impact	Venue reputation	We think getting a scanner will improve business and has safety benefits. (V20)
Premises	Environment/ context	Client welfare	There is a benefit to having a scanner to young vulnerable females [gaining] access to a club and is at risk of exploitation. ID scanning would deter the perpetrator…it was also evident…the only way to identify people would be through visual detection but identification in the dark club or under lights can be difficult to rely on. (V2)
Premises	Environment/ context	Competition	The…main clubs in [City] have an ID scanner. Clubs might have been negatively impacted, for example, due to queueing and causing delays. (W20)
Premises	Environment/ context	Hearing about the ID scanner	I heard about it through my networks… (V19)
Premises	Use	Professionalism of security staff	We have a policy of checking ID every time, door staff work best using their judgement. (W18)
Premises	Use	Reporting	We do keep incident logs for anything involving emergency services otherwise, fights or minor incidents are dealt with on the spot so there isn't much data for analysing any reduction in incidents. (V5)
Technology	Business impact	Technology supply	There is currently only one supplier who mainly makes the sales pitch to police based on the crime prevention benefits. (V14, V15)
Technology	Cost	Risks to use the scanner	We are…liable for any damage we cause to the machine and should anything happen, it would be an additional cost. (V5) Clubs are heavily taxed and therefore finances are tight which can be a reason for not introducing the scanner. (V11)
Technology	Environment/ context	Make up of population (students, visitors etc.)	In the busiest areas…there are an awful lot of students and late night venues which is an issue... (V4)
Technology	Use	Ease of use	…the technology becomes relied upon - door staff just scan the ID and rely on the ID to be accepted or declined by the system which removes the human approach. (V5)
Technology	Use	Job requirements (training on ID scanners)	Having a scanner in place...enable door staff to focus more on customer service and building a rapport with the customers and assessing people as they enter such as identifying those who have already had too much to drink. (V10)

Theme	Category	Code	Indicative quotations from data
Technology	Use	Maintenance	We are…liable for any damage we cause to the machine…(V5) We called the 24-hour service line, it wasn't clear what had been done but it did resolve the problem and the scanner then worked ok. (V5)
Technology	Use	Privacy - client data concerns	Data protection case law suggests [police access to data] could be done. (W21)
Technology	Use	Technical issues	…we had the opportunity to test it [the ID scanner] using fake ID…The range of sophistication in fake ID was variable…we were surprised it accepted some of them. (V5)
Technology	Use	Technology capability	The scanner has a camera that takes pictures of every customer that enters. (V16) Duplicate ID is identified by the scanner and it is retained and handed over to the police. (V12)

Appendix F: Structure of modern policing

Modern police forces in the United Kingdom operate across the four Nations, England, Scotland, Wales and Northern Ireland, with distinct legal frameworks governing each Nation. In England and Wales, a territory approach is taken with 43 separate forces. Although these separate forces run as discrete organisations, they are bound together by common values in line with the Peelian principles mentioned in this thesis. However, radical changes have been made to organisational structures and more are envisaged. Cross-force collaborations are being promoted with increasing vigour and there have been calls to reduce the number of police forces. In Scotland, police forces have already been merged into one - Police Scotland - and in England and Wales there have been suggestions to alter the arrangements governing the Police and Crime Commissioners (PCCs). PCCs were established in November 2012 in both England and Wales, replacing the former Police Authority so the police become more accountable to the public and communities they serve. PCCs are responsible for delivering a Police and Crime Plan to set out the strategy and objectives for policing in their geographical area. A report of the Independent Police Commission (2013) *Policing for a Better Britain* called for a renewed look at integrating police forces to bring the PCCs to an end. Since then, there has been some variation with the inclusion of the fire service to bring about Police, Fire and Crime Commissioner's (PFCC) and in some places, for example Greater Manchester, a directly elected Mayor has replaced the PCC.

Appendix G: Images of the ID scanner

The images below show a desk top style ID scanner installed at the entrance to a venue and the

result on screen after scanning a UK driving licence.

Appendix H: Recommendations for practitioners

Item	Recommendation	Comments
1	Training in systems thinking should include the ability to creatively incorporate existing frameworks/models into analysis.	This research revealed that approaching multi-agency diffusion and adoption by using systems thinking creatively alongside focused theory, frameworks or models, a purposeful but structured inquiry can be undertaken. The inquiry returned a deep and detailed understanding of multi-agency diffusion and adoption. On this basis, future skills development in systems thinking should encourage organic modes of inquiry. However, how training in systems thinking is far-ranging. It is delivered by many providers and through a variety of mechanisms. Education institutions, for example, could include multi-agency adoption initiatives in case studies and encourage students to give some thought the approach to research. For practitioners, they could take current systems thinking training along with the findings of this research and replicate a similar work.
2	For multi-agency adoption initiatives, incorporate a systems thinking element.	In this multi-agency adoption initiative, systems thinking was found provide an understanding beyond that provided by existing adoption/frameworks models. It was found to be important to successful adoption and to be able to identify, and take account of, all the stakeholders' very different goals and objectives and interactions. Using systems thinking alongside existing frameworks/models provided the systemic nature of inquiry missing from the diffusion and adoption frameworks/models and a deeper understanding was provided. However, there may be implications due to the context, type of adoption initiative or, indeed, the variety of organisations and stakeholders involved in adoption. This study reviewed and selected frameworks/models for further analysis that were relevant to the context. A different study, though may follow the same process, may result in different frameworks/models being applicable in that context.
3	Promote a high level of stakeholder participation in the planning and implementation of an adoption initiative.	The ability to uncover all the different aspects affecting adoption was made much simpler because of the stakeholders and their engagement in this study. The identification and analysis of perspectives and influences, for example, meant there was a deeper level of understanding gained. This participation, used early in the process means that the choices of how to act, influence and ultimately improve adoption are more likely to lead to successful initiatives. In practice, there may be context-related barriers to overcome. For example, in a context where collaboration was not seen so positively (e.g., in the other geographical area in this study) then participation may need more emphasis and encouragement so the benefit is realised.
4	To apply the Formal System Model when analysing multi-agency adoption.	Using the Formal System Model to identify, illustrate and examine the variety of stakeholders, their goals and objectives and the influences of the variety of impacts on an adoption initiative that was already in various stages of implementation provided evidence of iteration in the analysis process. However, there is still a level of analysis that may be useful in some adoption initiatives. For example, those that do require a focus on acceptance can incorporate analysis using the Technology Acceptance Model. In practice, for those unfamiliar with the frameworks/models there may be some difficulty in doing so.
5	To include opportunities for reflection and action when exploring and developing adoption initiatives.	This study can be interpreted as providing evidence that reflective inquiry works well as action research. Using the Formal System Model can be explained to practitioners as a mechanisms available in general terms and is not case-specific. However, future research may look more deeply at the similarities with participatory action research and build further empirical studies.
6	Incorporate a process for use of multiple cause diagrams within the overall adoption initiative.	Systems thinking has been shown in this research to be an ideal vehicle for identifying and linking the various factors and variables present in multi-agency adoption initiatives. This was especially present due to the use of multiple cause diagrams. For practitioners, the diagrams can be used to delve deeply and gain understanding into the situation. To help implementation, this thesis has provided an explanation of the diagrams and provides sources to learn more about systems thinking.
7	The environment can be better understood through use of a pre-analysis process and the Formal System Model.	In multi-agency adoption the external environment is particularly complex and unpicking differences between the context and the environment of a system (features of a system that sit outside the main systems boundary and those that can affect the system or be affected by it) was found to be important. By, at least, using spray diagrams for initial analysis and applying structure by using the Formal System Model, the important environmental influences were made clear. In practice, analysis of the specific elements in the FSM enhances understanding of the adoption initiative and highlights areas that can be strengthened ultimately improving the success of adoption.

Item	Recommendation	Comments
8	Use influence diagrams to in multi-agency adoption initiatives.	The research found that if existing frameworks/models were used in isolation, there were some gaps in understanding adoption. For example, a lack of support for how stakeholders initiate, build or enhance the relationships needed for collaborative adoption. These gaps were addressed using systems diagrams to add a clear boundary to the adoption decision (the system of interest in this example). In practice, this recommendation can be implemented using the description of influence diagrams in Chapter 6 and from the sources provided. However, the value of diagramming is not always recognised and some promotion of the benefit to doing so may be required.
9	Ensure multi-agency adoption initiatives have very effective mechanisms for communication.	Further insights from the study related to wider concerns for societal and technological change. For example, aspects of adoption might relate to privacy and data concerns. Or the adoption can uncover additional benefit such as the ability to contribute to addressing Violence Against Women and Girls as in the example of the ID scanner in the night-time economy. Therefore, effective mechanisms for communication are required to help create or promote the positive view of adoption. In practice, this means that there needs to be mechanisms created and available between stakeholders.
10	Consider impact of adoption initiatives on all actors involved in the widest possible sense.	This research found that it was possible that diffusion and adoption could be best undertaken in a multi-agency way. There were important contributions of impact the ID scanner had than actors alone had described. For example, the ability of the technology to address a wider variety of crime than had been expected by some participants and therefore, providing opportunity for organisations to contribute to agendas such as the disruption of criminal gangs and the protection of vulnerable people. However, there are limitations. Technology will not solely be an answer but collaborative working and understanding of situations will go towards improving knowledge and therefore, action.
11	To manage adoption initiatives through a network of organisations.	This study has showed that a network of organisations that contribute to the definition of problems, formulation of solutions and formulation of policy improves the success of an adoption initiative. The collaboration and facilitation came through strongly and positively. For practitioners to implement, a central coordinating point to manage that network. That may not always be possible in terms of resource. One way to overcome this barrier would be to recognise the network and for one of the stakeholders to lead the adoption using the FSM as a mechanism by which to gain insight and identify action during that process. All the results of this research confirm the position that systems thinking can enhance existing diffusion and adoption frameworks/models. A key part of that process was analysis using the FSM. The findings have contributed to developing a collaborative-specific FSM that could be used in multi-agency adoption. However, since there were few studies like this one (complex multi-agency technology diffusion and adoption) to confirm the extent to which any discrepancies are applicable in other settings and in other technological adoptions, further research should take place.
12	Multi-agency diffusion and adoption can be improved through developing the collaborative-specific FSM.	All the results of this research confirm the position that systems thinking can enhance existing diffusion and adoption frameworks/models. A key part of that process was analysis using the FSM. The findings have contributed to developing a collaborative-specific FSM that could be used in multi-agency adoption. However, since there were few studies like this one (complex multi-agency technology diffusion and adoption) to confirm the extent to which any discrepancies are applicable in other settings and in other technological adoptions, further research should take place.