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Abstract

Purpose – Services comprise of socio-technical (human and technological) factors which exchange various resources and competencies. Service networks are used to transfer resources and competencies, yet they remain an underexplored and "invisible" infrastructure. Considering the growth in technological investment in recent years, this research sets out to model the impact of IT-enabled innovation on a service network. In response to the growing importance placed on understanding these complexities, the field of "service science" has emerged to guide the effective design, implementation, and management of service systems. The purpose of this paper is to investigate the impact of introducing an IT-enabled innovation in a public service network.

Design/methodology/approach – This is achieved through a case study of an Exam Administration Service Department (EASD) where an electronic grading system was introduced to improve the EASD grading process. Data are analysed using both actor-network theory (ANT) as a theoretical lens and social network analysis (SNA) for empirical purposes to visualise the impact of IT-enabled innovation on a service environment.

Findings – The research described in this paper makes a useful contribution to the service science and IT innovation community both in terms of its topic (public service networks) and in terms of its theoretical framework and application methods (ANT and SNA).

Originality/value – This paper demonstrates how we can investigate the impact of IT-enabled innovation within a service network. Most notably, the application of SNA enables us to visualise the impact of technology and gain insights on the socio-technical dynamics associated with introducing service innovations.

Keywords Innovation, Public sector, Case study, Service science, Actor network theory, Social network analysis

Paper type Research paper

1. Introduction

Society comprises of an extremely complex groups of people who interact with one another through relationships, often sharing similar cultures, territory, economies, and political systems (Weber, 1978). The interactions which exist between socio-material elements (humans and non-humans) may be described as the relational patterns or the relational infrastructure. The relational infrastructure supports the exchange of resources and competencies, for example, information (Carroll and Helfert, 2015). Therefore, services may be described as the end product of human assemblage, knowledge, innovation, interaction, and consumption. One can examine the "multiple, emergent, and shifting socio-material assemblages" (Orlikowski, 2007) of service dynamics. What is interesting here is the idea that one can map this relational infrastructure to visualise the exchange of resources (Carroll, 2012). However, service networks are used to transfer resources and competencies, yet they remain an underexplored and "invisible" infrastructure (Orlikowski, 2007; Carroll *et al.*, 2010a, b;

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Chesbrough, 2011; Contractor *et al.*, 2011). This is a key issue in service management and a gap which this research addresses. The main objective of this research is to develop an understanding of how a public service network evolves to implement IT-enabled innovation and to report on its impact on the network through the material-semiotic perspective. Based on the literature, the research questions which emerged from the gaps are as follows:

RQ1. How does the introduction of IT-enabled innovation impact on socio-material relationships in the service network?

RQ2. How does a public service network evolve through the introduction of IT-enabled innovation?

RQ3. How does IT impact the relational ties between service actants within a service network?

RQ4. What are the main socio-technical factors which contribute towards service network assemblages within the public sector?

RQ5. How do relational ties between actants within a service network contribute towards service socio-technical dynamics?

2. Literature review

Service networks become increasingly complex when technology is implemented to execute specific processes to deliver a service and meet various new priorities (Ostrom *et al.*, 2015). This ultimately adds to the complexity of a service environment, making it one of the most difficult environments to examine and manage. This is a growing problem as service providers continue to invest in technology without understanding its impact on service dynamics (Benjamin and Blunt, 2012). Although service science calls for more theoretical focus on understanding complex service systems (Voss and Hsuan, 2011), few efforts have surfaced which apply a new theoretical lens on understanding the underlying trajectories of socio-technical dynamics within a service system. Despite the burgeoning number of studies on public service sector information systems, none of these research efforts focus on the dynamic relationship between technology and its impact on the assemblage-like configuration of service relational structures. The author has identified the research gap in the need to visualise and explain (Gregor, 2006) the impact of IT-enabled innovation in a public service setting. While much has been published regarding the bureaucratic nature of IT investments in public sectors, this research describes the impact of IT-enabled innovation on the service relational infrastructure. In essence, the research introduces public service science to explain how public service technological innovations commands control over public sector behaviour and therefore acts as an agent of bureaucracy which alters the relational dynamics of power, risk, responsibility, and accountability.

2.1 Examining service networks

Services comprise of socio-technical (human and technological) factors which exchange various resources and competencies (Carroll, 2012). Thus, the stabilisation of services relies on continuous interaction between actors (human and non-human) to deliver a service. The interaction which exists between actors may be described as the "relational patterns" or the "relational infrastructure" which supports the exchange of resources and competencies (Carroll *et al.*, 2010a, b; Spohrer *et al.*, 2010; Carroll, 2014a).

Therefore, services may be described as the creation of socio-technical assemblage, knowledge, innovation diffusion, socio-material interaction, and resource consumption. A service network is characterised by the actions which stabilises its socio-technical behaviour through the exchange of resources and competencies for a specific service objective. Thus, a service networks comprise of "large numbers of long-running, highly dynamic complex end-to-end service interactions […] [which] […] typically transcend several organisations and span geographical locations" (Mancioppi *et al.*, 2008). However, within service networks, interactions are considered extremely difficult to trace. This is largely due to their intangible nature (Fitzsimmons and Fitzsimmons, 1999). Another problem lies in understanding the "invisible" service network infrastructure and examining how resources may be exchanged or optimised. Thus, we need to introduce new methods to examine service complexity (Harmon, 2015) because "[…] everyday businesses and governments invest billions to transform existing service systems without the benefit of [engineering modelling] tools and methods" (Spohrer and Maglio, 2010, p. 5).

2.2 Exploring the value of IT-enabled service networks

To understand the value of technological innovation, the author shifts the focus away from "traditional" financial metrics. This research attempts to stimulate more discussion on "value" by examining service composition as a source of understanding service phenomena and the dynamics of service evolution. By adopting this view, one can examine the impact of technology in value co-creation. Understanding the complexity of network structures, process patterns, and methods to improve network performance is critical to the success of service eco-systems (Rosemann and vom Brocke, 2015; Eisenberg *et al.*, 2015). This is true for both the service provider and client within a service network (Spohrer *et al.*, 2007). The author has identified a gap in the need to adopt an alternative view of service behaviour. This allows us to provide more insight on how the relational structure stabilises IT-enabled service innovation. For example, when one incorporates network science approaches, the level of dimensional support across the process structures is expressed in several forms including, structural, functional, compositional, and behavioural (Tichy *et al.*, 1979). Often these dimensions are taken for granted and consequently overlooked (Cross and Parker, 2004) although this information provides both tangible and intangible metrics on service network performance (Hassan, 2009; Carroll *et al.*, 2010a, b; Carroll, 2012).

Financial metrics are undoubtedly significant to gain insight of the overall performance of the service network. Bannister (2001) suggests that the interest of service development is often focused on cost savings, quality, and productivity. However, financial metrics are based on past performance (Ostrom *et al.*, 2015; De Keyser and Lariviere, 2014) and offer little insight on how a network is structured or may be structured to achieve the desired financial results. Financial metrics examine "what was" or attempt to project performance as "what ought to be", as opposed to understanding "what is". This is particularly more important in the agile service business model as service actions and transactions vary in timeframes, for example, cloud computing environments (Carroll *et al.*, 2014). Thus, the relational structure allows us to examine the behaviour, health and dynamics of service provision. Understanding service network dynamics is considered problematic due to the continuous changing environment in today's service environment and the need for greater emphasis on developing business models to leverage greater service agility (Oosterhout *et al.*, 2006; Leih *et al.*, 2014). To exacerbate this, researchers (Morabito *et al.*, 1999; Chesbrough, 2011;

Carroll and Helfert, 2015) advocate that is it now time to move from a nineteenth century organisational model towards a twenty-first century model, i.e. one that accommodates for modern service networks.

2.3 Modelling service environments

Service modelling may be defined as (Räisänen, 2008, p. 6) "[…] the representation of relations between what is provided to customers, the technical definition of the services, and the resources needed for operating the service". This definition draws the author's attention towards the nature of the relations which constitute as a service. It also raises questions as to how IT-enabled service innovation might impact on these relations. IT investments are often considered to add value to a service environment. The concept of IT value-creation continues to receive interest in understanding methods to explain the value of technological innovations (Soh and Markus, 1995; Weill *et al.*, 2002; Carr, 2003; Carroll *et al.*, 2010a, b; Chesbrough, 2011; Contractor *et al.*, 2011; Camisón and Villar-López, 2014). Normann and Ramirez (1993) explain that the concept of value constellation focuses on the value-creating system, through the reconfiguration of relationships and roles, the mobilisation of value in new forms, while improving the fit between competencies and the customer. This is fitting since IT often adopts a central role to mobile value in various forms. For example, Spohrer *et al.* (2010) explains that a service system can co-create value if resources are properly organised for value propositions which define the desired outcome. In fact, they argue that the foundations of a service system are (p. 5):

- a dynamic configuration of resources;
- a set of value co-creation mechanisms between suitable entities;
- an application of competencies-skills-knowledge any person(s) in job or stakeholder roles;
- an adaptive internal organisation responding to the dynamic external environment; and
- learning and feedback to ensure mutual benefits or value co-creation outcomes.

Therefore, value is considered to be co-created through a combined effort of two parties or more across all service sectors and value is determined by the beneficiary, i.e. the client (Vargo *et al.*, 2008). What is of immense importance here is to learn how the relational structure assembled to generate service value and how this is impacted by technology particularly in the public sector.

2.4 Theoretical considerations

This section briefly describes some of the most prominent theories within the IS field which were considered to focus this research. For example, the author considered the use of agency theory to view organisations as a relationship of contractual resource exchanges between parties (Eisenhardt, 1989). Complexity theory explains complex phenomenon which are otherwise unexplainable through traditional theoretical developments (Simon, 1996). Complexity theory identifies how complex behaviour emerges from simple rules whereby complex systems are networks of interdependent parts which interact based on the rules. However, it fails to provide the author with a realistic understanding of the socio-technical dynamics of service networks. Institutional theory examines structures of a social environment. Within a social structure (e.g. an organisation), it pays particular attention

towards processes (rules, norms, and routines) which support social behaviour through authoritarian controls. Therefore, institutional theory provides a lens to examine the emergence of a social structure and the variable which influence change (Scott, 2005) but is not considered suitable to study dynamic and complex service system. In addition, social exchange theory was considered as a negotiated process sustained through human relationships and often motivated by profit (Blau, 1964). However, it fails to accommodate for the technical factors within the relational structure of public services. The theory also prescribes an "open" relational environment (i.e. a voluntary exchange of resources) which is not often suitable within a bureaucratic service environment and fails to examine the dynamic factors which sustain service relationships.

The author also examined theoretical development to explain the success of IT. For example, the DeLone and McLean IS success model examines the success of information systems from a number of different perspectives and classifies them into six categories of success (DeLone and McLean, 2003). The model adopts a multidimensional framework which measures independencies between the various categories:

(1) information;

(2) system and service quality;

(3) use (intention to);

(4) user satisfaction; and

(5) net benefits.

These dimensions suggest that there is a clear relationship between them which influences the success of the IS and certain net benefits can be achieved. The net benefits influence user satisfaction and use of the information system. In addition, the technology acceptance model (TAM) is an information systems theory which examines how users accept the use of technology though a number of important influential factors (Davis, 1989). Among these factors are:

- the perceived usefulness of the technology; and
- the perceived ease-of use of the technology.

TAM suggests that these factors determine people's intention to use a technology. While TAM provides an excellent approach to examining people's acceptance of technology, this paper does not focus on the "use" of technology, but rather the factors which contribute to the socio-technical dynamics of a service network. While examining methods to identify the impact of innovation, the diffusion of innovation examines the characteristics of an innovation and its context that correlate with its diffusion (Rogers, 1962). The process examines how innovation is communicated among various interested parties through various channels within a social system. The success of an innovation is largely dependent on decisions made within the social system as they adopt five steps:

(1) knowledge: exposure to an innovation but lacks information about the innovation and seeks to learn more;

(2) persuasion: interested in the innovation and is keen to learn more detail about the innovation;

(3) decision: weights up the advantages and disadvantages of innovation and makes a decision whether to adopt the innovations;

(4) implementation: employs and examines the usefulness of innovations; and

(5) confirmation: finalise decision to continue using the innovation.

Individuals have different levels of enthusiasm towards the adoption of innovations and often the amount of time required depends on certain characteristics of the person or social system. These are innovators, early adopters, early majority, late majority, or laggards. Although this theory provides a useful insight of the implementation of innovation, it fails to address the socio-technical factors which this study sets out to examine.

2.5 Actor-network theory (ANT)

ANT stems from on-going efforts in social studies of science and technology (e.g. Callon, 1986; Law, 1986; Latour, 1987). It has received increasing attention in its ability to examine agency of both human and non-humans subjects (Carroll *et al.*, 2012; Carroll, 2012). ANT is often described as a material-semiotic approach to a research field. This allows researchers to examine and explain the relations which exists between material (i.e. things) and semiotic (i.e. concepts). ANT allows the author to explore the relational ties which stabilise a service network through a various influential factors. ANT provides the author with the ability to examine a heterogeneous network which is suitable when exploring the socio-technical factors (i.e. dissimilar elements) of IT-enabled service networks. While ANT accepts that a network comprises of both social and technical factors and is equally important in a social network, the author has determined that this provides the most suitable research lens for this research.

3. Explaining service formation through ANT

This section offers a brief discussion on ANT – the sociology of technology and science. The literature suggests ANT is viewed as a more radical approach towards understanding technological influences (i.e. a socio-technical view). Carroll *et al.* (2012) presents a more in-depth analysis on ANT within a service science discipline. This work explains how ANT may be used to examine actors' behaviour within a service system since every action leaves a footprint. This provides us with more insight on the underlying infrastructure of service operations. ANT is very influential across IS theory and draws on the "strengths of qualitative research to provide a powerful, but somewhat different framework for understanding IS innovation" (Tatnall and Gilding, 1999, p. 962). It pays particular attention to the concepts of "materiality", "inscription", and "translation" (see Table I). These concepts allow offer a vocabulary to explain how the introduction of a service system impacts the structure of a service network. ANT is often described as a systematic approach to explore the infrastructure which supports the scientific and technological achievements within a network making it a more profound approach to researching and understanding service networks.

The fundamental aim of ANT is to explore how networks are built or assembled and maintained to achieve a specific objective. Identities (networks and actants) are established by their represented or delegated interactions which acknowledge the importance of the inseparable socio-technical factors. ANT rejects "any sundering of human and non-human, social and technical elements" (Hassard *et al.*, 1999). ANT adopts socio-technical symmetry to explore actants' (human and non-human) participation within heterogonous network assemblages through negotiation and translation. ANT provides the ability to uncover the chain of actions or

Concept	Explanation
Actant	"Any element which bends space around itself, makes other elements dependent upon itself and translates their will into the language of its own" (Callon and Latour, 1981, p. 286)
Actor network	A heterogeneous network of aligned interests formed through translation of interests (Walsham and Sahay, 1999)
Assemblages	Built out of social ties rather than physical and explores what is the social made of, e.g. how we act, or who else is acting
Associations	Non-social ties which can be used to trace associations and does not designate a thing among other things
Black box	A snapshot of the network which illustrates its irreversible properties
Translation	The creation process of an actor-network through four main phases (Callon, 1986): (1) Problematisation (2) Interessement (3) Enrolment (4) Mobilisation
Problematisation	Defines identities and interests of other actors which align with its own interests (i.e. obligatory passage point)
Obligatory passage point	A situation that has to occur in order for all the actors to satisfy the interests (Callon, 1986)
Interessement	Convince other actors to agree on and accept the definition of the focal actor (Callon, 1986)
Enrolment	An actor accepts the interests defined by the focal actor and sets out to achieve them through actant allies which align with the actor network (Callon, 1986)
Mobilisation	Ensuring actors represent actors interests (Callon, 1986)
Inscription	Creating technical objects which ensure an actor's interests are protected, e.g. a particular piece of software or regulations to meet organisational objectives (Latour, 1992)
Performativity	"Entities achieve their form as a consequence of the relations in which they are located […] they are performed in, by and through those relations" (Law, 1999)
Irreversibility	The point to which it is impossible to return to a point where alternative opportunities may exist (Walsham and Sahay, 1999)
Immutable mobile	Strong properties within a network which establishes it irreversibility, e.g. software standards (Walsham, 1997)
Speaker/delegate/ representative	An actor that speaks on behalf of (or stands in for) other actors (Callon, 1986; Sarker *et al.*, 2006)
Betrayal	A situation where actors do not abide by the agreements arising from the enrolment of their representatives (Callon, 1986; Sarker *et al.*, 2006)

Table I.
ANT main concepts

influences from various actors which are carried out to deliver a specific action and outcome. Therefore, it breaks away from the social science school of thought since it does not fixate upon any set theory per se, but rather enjoys the uncertainty of human behaviour in which actions are not predetermined. Latour (2005) explains that the ANT approach rejects a social dimension, social order, a social force, frame of reference; actors are not embedded in a social context, and suggest that actors know what they are doing and are connected to many other elements. In this alternative view, "social" is not some glue that could fix everything: it is what is glued together by many other types of connectors (Latour, 2005, p. 5) and the specific associations provided which are of importance. This draws our attention towards the linkage, relations, assemblages, or interactions of service networks. During the interactions, one of the key factors which emerge from the negotiations is the

concept of translation (Callon, 1986). Translation is a complex view of interactions which suggest that actors:

- assemble similar definitions and meanings;
- define network representatives; and
- encourage one another towards the pursuit of self-interest and collective objectives.

After negotiation with certain states of power relations, actants eventually conceive what they want and what they can achieve. Actants have the ability to (re)construct a network which their interactions to stabilise the system. Of course, the reverse is also true, i.e. the lack of interactions can destabilise the network until it eventually dissolves. In addition, ANT identifies objects as boundary objects which foster interconnections (Star and Griesemer, 1989). It provides a vocabulary to examine how powerful networks emerge and pays particular attention to assemblage and the influence of objects and people. Therefore, it establishes networks and determines particular actions or behaviour. Although there are many aspects to ANT, the process of "translation" is fruitful in examining the implementation of service innovation to describe how technology impacts on service network dynamics and impacts the structure of a service network.

3.1 ANT: key concepts and vocabulary

While exploring the underlying mechanics of a service network, ANT presents us with a "vocabulary" to examine and discuss, for example, how the introduction of an IT system impacts the structure of a service network (Carroll, 2012; Carroll *et al.*, 2012). ANT considers that "reality" is dependent, contextual, and emergent and refutes the notion that there may be a "fixed point" of analysis. Rather than suggest that factors such as culture or globalisation impact a certain phenomenon, ANT considers that these factors need explanation and sets out to describe how environments (i.e. networks) come into being. These studies adopt ANT to incorporate a different language and viewpoint to describe the network's operations. There are a number of key concepts (summarised in Table I) which one has to become familiar with while adopting ANT.

In the pursuit of specific interests, networks are formed and aligned through technological innovations. As actors continue to translate (align interests) and enrol additional actors, the network becomes increasingly more stable. Succeeding in alignment is particularly important. This is achieved through inscriptions. Inscriptions are common procedures such as managerial practice, employee contracts, standards, regulations, or software requirements documentation (i.e. indicates how the network should operate). Building on both innovation themes and ANT concepts, Carroll (2014b) identifies the overlap between the diffusion of innovation and ANT (Table II).

The theoretical approach for this work identified the complementary nature of ANT and social network analysis (SNA) to explain and visualise the impact of technology innovation on a traditionally bureaucratic public service network.

4. Conceptual framework

Figure 1 illustrates the authors approach towards understanding the impact of IT-enabled innovation on a public service network. It is divided into six main phases: explore, describe, analyse, record, explain, and contribute representing both ANT and SNA approaches.

Diffusion of innovation	Actor-network theory	Description of overlap
Knowledge	Problemisation	Identifies how innovation will support and align others interests
Persuasion	Interessement	Convince other actors to learn about and agree on a specific innovation to support operations
Decision	Enrolment	Weights up the advantages and disadvantages of innovation and decides to adopt the defined interests represented via the innovation
Implementation	Inscription	Creating technical objects such as a piece of software to demonstrate the usefulness of the innovation
Confirmation	Irreversibility	Making a final decision to implement or continue using an innovation to a point to which it is impossible to return to another point where alternative optional may exist

Source: Carroll (2014b)

Table II.
Diffusion of innovation and ANT

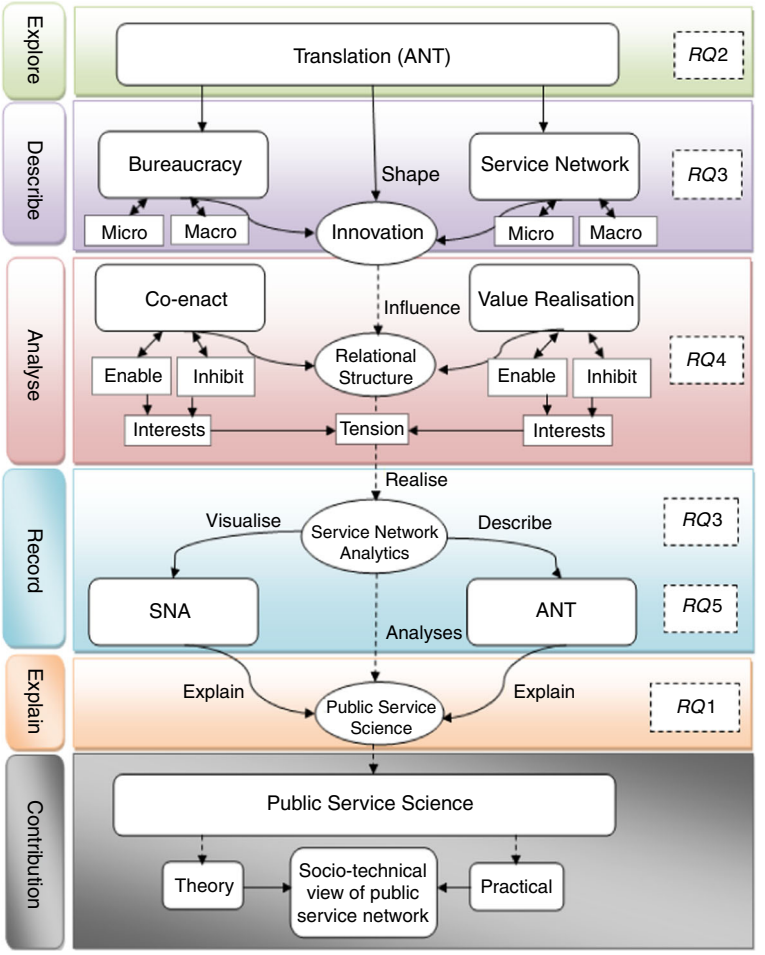


Figure 1.
The public service science conceptual model

The first phase addresses the following research question:

RQ6. How does the introduction of technology impact on socio-material relationships in a service network?

It explores a public service network under the process of translation. The process of translation includes problematisation, interessement, enrolment, and mobilisation of service actors. The second phase examines the environment which divides into "bureaucracy" and the "service network". Through ANT, one can describe the role of service innovation in both a micro and macro environment (i.e. what drives the assemblage of public service network evolution?). The third phase examines how relational structures co-enact to stabilise a service and how value may be realised by identifying what enabled and inhibits service value to serve particular interests which answers how is the nature of power impacted by technology during the reconfiguration of service relational structures?. The fourth phase of the model is concerned with service network analytics and visualisation using SNA followed by a description using ANT. This addresses the following questions: how can we visualise the relational structure change of a public service network relational structure to compare pre- and post-technological implementation; what drives the assemblage of public service network evolution? Explaining how these components interrelate with one another, led to the theoretical development which addressed the main research question (how does the introduction of technology impact on socio-material relationships in the service network?). The final phase illustrates how this work contributes on both a theoretical and practical level to service science by examining the socio-technical nature of a public service network and the impact of IT-enabled innovation on the service structure. This also led to the emergence of the term "servicracy" within the findings (Carroll, 2014b). Servicracy is a term the author coined from this study of bureaucratic powers and socio-technical dynamics of public service innovation. It enabled the author to explore and extend our understanding of the bureaucracy and socio-technical dynamics of public service innovation to protect actor's interests and ultimately led to the development of public service science.

6. Methodology

Figure 2 illustrates the case study model which provides an overview of how the research was conducted.

Exploring the phenomena of service networks and their characteristics through empirical research approaches provides insights on the implications of IT-enabled

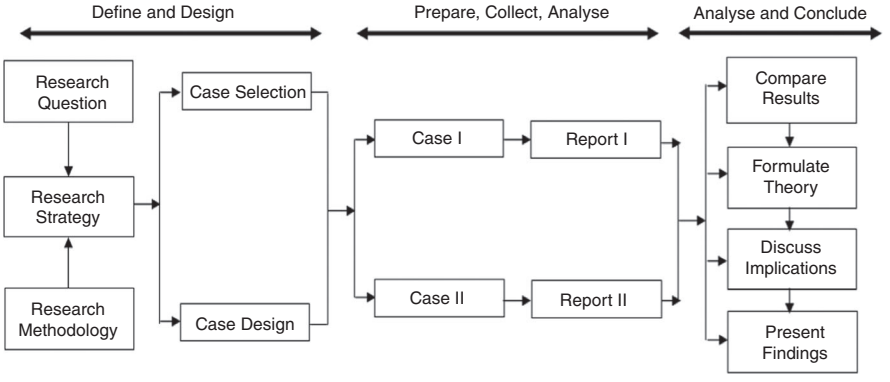


Figure 2.
Case study model

innovation on service relational structure. Service systems embody a massive complexity of interactions and dependencies, with the main source of complexity being people. Digitising all or part of a service system alters service dynamics. SNA provides a way of quantitatively analysing relationships among actors. SNA software (i.e. UCINET (https://sites.google.com/site/ucinetsoftware/home)) calculates quantitative measures of network structure. UCINET also generates a visual representation of networks through various network diagrams. The conceptual design (Figure 3) supports the enquiry and provides a model to which plays a central role in framing this research (guided by Miles and Huberman, 1984).

The framework illustrates which concepts were identified in the initial literature review are used to examine service networks and supported the decisions of the initial inductive process. The adoption of mixed methods approach enabled participants to provide an account for their own "realities" and the meanings they attach to their views (Orlikowski and Baroudi, 1991; Latour, 2005). The research employs several empirical data gathering methods varied from observation, online surveys, semi-structured interviews, reports and regulatory document analysis, and attending departmental board meetings (Table III). The online survey was a key phase of the research methodology. Each respondent (actor) reported who they interacted with in order to deliver a service. This was recorded using SurveyMonkey and later exported into a spread sheet (Microsoft Excel). Each actor was assigned both a column and a row. For every actor represented on a row of the spread sheet, actor used qualitative data to answer the question, "Who do you interact with to successfully complete [process x]?" For each column in the row, the entry of a 1 or 0 indicated the presence or absence of interaction by the actor represented on the row. This resulted in a directed matrix demonstrating connections between actors.

Table III provides an overview of the eight phases involved in this research. These phases formed the research strategy to explore the socio-technical dynamics of a service network and examine the implications of IT-enabled relational structures on service dynamics. To validate the research findings from each method, a process called "triangulation" was employed. Results from each phase of this research were cross-checked to examine the complex issue, events, and actions which emerged within the

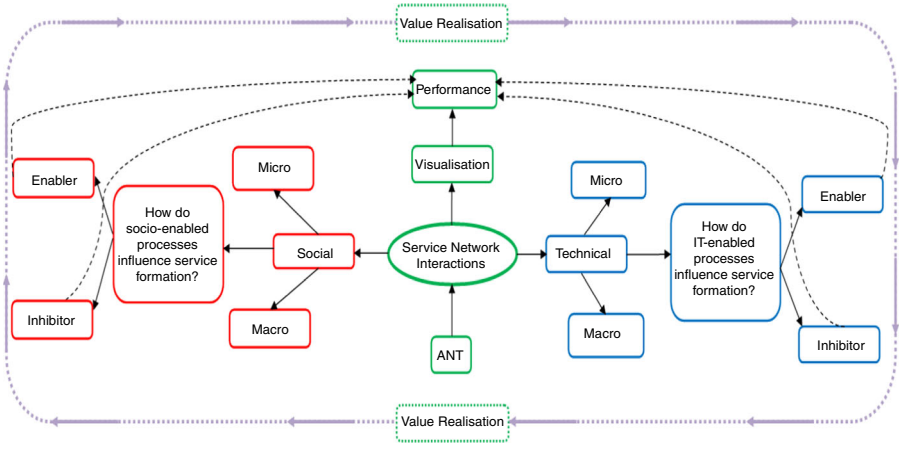


Figure 3.
Conceptual model of the research

Service view	Phase	Description	Objective
Pre-IT Implementation	Phase 1	Observation	Interactions and service environment: observed service activities for two hours per day for the duration of one week to understand how the service was managed and delivered within the service network Archival records: reviewed secondary data, e.g. manuals, reports, or other documentation on student services to minimise any disturbance to staff members
	Phase 2	Online survey I (100 participants)	Free choice and open ended questions: distributed a short online survey to understand how actors interacted to deliver a service under the paper-based system
	Phase 3	Mapping service I (SNA)	UCINET and NetDraw: results from the online survey allowed the researcher to map service interaction using SNA software. The online questionnaire facilitated easy access to the survey and encouraged rapid response
	Phase 4	Interviews I (30 interviewees)	Semi-structured Interviews and NVivo: the survey also provided a method to secure interviewees and devised questions on service operations based on the results of the SNA map. The network map allowed the author to identify key academic and service staff for a representative sample across the academic network
Post-IT implementation	Phase 5	Online survey II (100 participants)	Free choice and open ended questions: distributed a short online survey (similar to phase 2 structure) to understand how actors interacted to deliver a service under the new electronic-based system
	Phase 6	Mapping service II (SNA)	UCINET and NetDraw: results from the online survey allowed the researcher to map service interaction using SNA and visualised the change which occurred within the academic network relational structure as a result of the electronic system
	Phase 7	Interviews II (30 interviewees)	Semi-structured Interviews and NVivo: interviewed academic and service staff members to discuss the impact of the electronic grading system and developed insights of why the service network changed. This interview approach adopted ANT to report on the service environment
Examine impact of IT	Phase 8	Comparison (I and II)	Compared the pre- and post-implementation of the electronic grading system and explored what change has occurred and how this impacted on service structure and service performance

Table III.
Overview of case study research phases

findings to generate a complete "story" of the service network. While adopting these methods, the author was mindful of Yin's (2009, p. 102), description of the strengths and weakness associated with the main sources of evidence for cases studies and the suitability of a single case study for this research (Table IV).

To guide the qualitative analysis of this work, Miles and Huberman's (1984, pp. 21-23) account proved to be useful using three interwoven data collection phases. This may be summarised as follows:

- the data must appear in words rather than numbers;
- the data should be collected in a variety of ways (observation, interviews, extracts from documents);

Source of evidence	Strengths	Weaknesses
Documentation	Stable – can be viewed repeatedly	Retrievability – can be difficult to find
Policy and regulation	Unobtrusive – not created as a result of a case study	Biased selectivity, if collection is incomplete
Deloitte Report	Exact – contains exact names, references, and details of an event	Reporting ideas – reflects (unknown) bias of author
Quality Reports		
Archival records	Similar to documentation	Similar to documentation
Departmental reports	Precise and usually quantitative	Accessibility due to privacy issues
Grading documentation		
Interviews	Targeted – focuses directly on the case study topics	Bias due to poorly articulated questions
Semi-structured interviews	Insightful – provides perceived casual inferences and explanations	Response bias Reflexivity – interviewee gives what interviewer wants to hear
Direct observations	Reality – covers events in real time	Time-consuming
	Contextual – covers context of "case"	Reflexivity – event may precede difficulty because it is being observed
		Cost – hours needed by human observers
Physical artefacts	Insightful into cultural features	Selectivity
	Insightful into technical operations	Availability

Source: Yin (2009, p. 102)

Table IV. Five sources of evidence

- data are processed in some way before it is used; and
- analysis consists of three concurrent flows of activity (data reduction, data display, and conclusion drawing/verification).

Figure 4 illustrates the interactive nature of each phase as the three types of analysis activities are cyclical processes throughout the data collection and indeed, the duration of the entire research process. From the list above, one could piece parts of the puzzle together while coding what each piece represents and how it contributes to certain classes, patterns, processes, and the overall research findings.

7. Summary of findings

This section offers a discussion on the main findings. The academic service network comprises of a complex entanglement of governing bureaucratic departments and service provisions. The case study focuses on the Exam Administration Service Department (EASD). The case study was divided into two main phases: pre-IS implementation and, post-IS implementation. A comparison is visually presented using SNA and a summary of interview findings is presented.

7.1 EASD background

The EASD maintains controls and develops the university's student records, including all personal information, grant records, student registrations, performance reports, and student results. The EASD was traditionally a paper-based bureaucratic service system. However, the preference among EASD staff members was to implement an

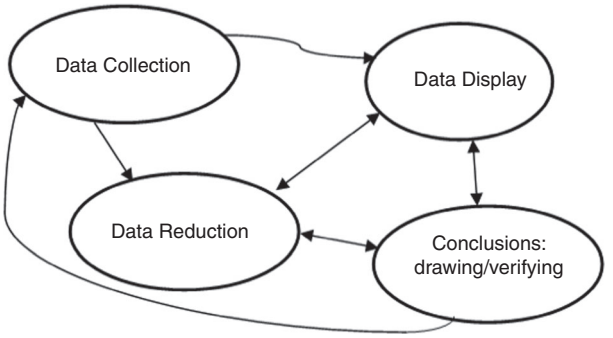


Figure 4.
Components of data analysis

Source: Miles and Huberman (1984, p. 23)

electronic grading system (EGS) to avoid the service bottleneck in the system. To do so, they introduced a web-based system to support academic staff with the grading process. This was proposed to allow lecturers to submit grades and reviews at any-time, and in addition, to hold academics' accountable for their own grade submissions. This increased the importance of the web-based application, which now must be always available "24/7" and have extended functionality to perform the tasks of EASD staff. In addition, the data input method facilitates EASDs ability to enforce data consistency to meet their requirements (or "interests").

7.2 Paper-based service system

The case study examined the impact of automating a bureaucratic paper-based grading service network within an academic environment. The observation and interview phases of this research allowed the author to identify that service tensions emerged as a result of some actors' failure to co-operate with academic service regulations. Failing to co-operate with service rules challenged EASD's ability to control the service network. Control is a significant factor of service stabilisation. The level of co-operation had a direct impact on EASD's ability to operate efficiently during this process. The number of grade exchanges along the chain of events impacts both on quality and performance of the service. When problems occurred, this required the need to determine who is responsible or accountable for errors which was time-consuming for EASD. The notion that actors are accountable for specific service behaviour is interesting in light of service science. Service science literature places significant emphasis on "co-creation" and "co-production" which emphasises the collective act of developing an approach to meet a specific objective in through agreement in service relations, i.e. value co-creation. This is evident within the private sector service literature which essentially examines how behaviours generate profits. However, as this research identified the negative associations with non-compliance, for example, co-destruction, or co-destabilisation. In this case, EASD must consume additional resources to accommodate for delays in grade submissions, i.e. overtime. The core reason which attributed to these issues is rooted in a minority of academics' inability to co-operate with academic calendar deadlines, i.e. grade submission dates. Blame also emerges as another significant theme. On further investigation, it appeared that the EASD published names in what became known as a "name and shame strategy". Therefore communication within a service network had served as a negative action and association to initiate desired behaviour to gain a greater sense of control

and ultimately, a greater sense of power. The evidence suggests that there were some considerable tensions between actors interests within the service network operations which are illustrated in Figure 5.

There are many factors that influence service actor behaviour which also impacts on service delivery, quality, and efficiencies. For example, the concept of "responsibility" appears to be a transferred property from academics' to EASD and vice-versa as EASD prompt academics and academics' submit grading sheets for the grading deadline. The structure of Figure 5 is divided up into "academic responsibility" and "EASD responsibility" in which the "deadline" separates both. Therefore, the deadline acts as the service obligatory passage point. Prior to meeting the deadline, academics' were typically in control of the grading process and often received EASD e-mails as reminders and prompts regarding the upcoming deadline. As co-operation increases, so too does EASD power within the actor-network. What is of interests here, is the changeover process from a paper-based grading service to an electronic grading process and understanding how that service network dynamics changed as a result. The changeover process was extremely complex which relied on the interrelation of several heterogeneous socio-technical factors.

7.3 Summary of online survey findings

Many academics welcomed the change towards an automated system for grading which eliminated the need for paper and reduce the risk of error and time required to complete the process. However, some academics' reported that their requirements had been overlooked and reduced to a "wish lists" since it did not support EASD's vision of a new service system. Academics reported that their requirements were not addressed. They suggested that the EGS represented a sense of "transfer of responsibility", or "accountability" onto academics, as academics' now saw themselves adopting one of EASD's primary tasks. The online survey facilitated the mapping of service interactions (Figure 5) amongst staff to exchange information (pre- and post-IT implementation). From an ANT perspective, this indicates a shifting in the service boundaries.

The author employed SNA to visualise the impact of the EGS. As a result of implementing the EGS, there has been a dramatic transformation of the grading service network with particular attention placed on the improved cohesion across the network, while eliminating the clusters of academics and EASD (see Figure 6). One can clearly identify how the triangular nodes which once occupied a central position and

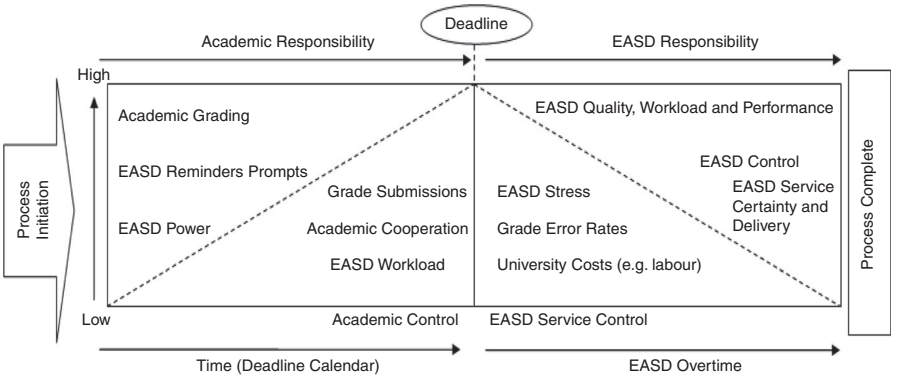
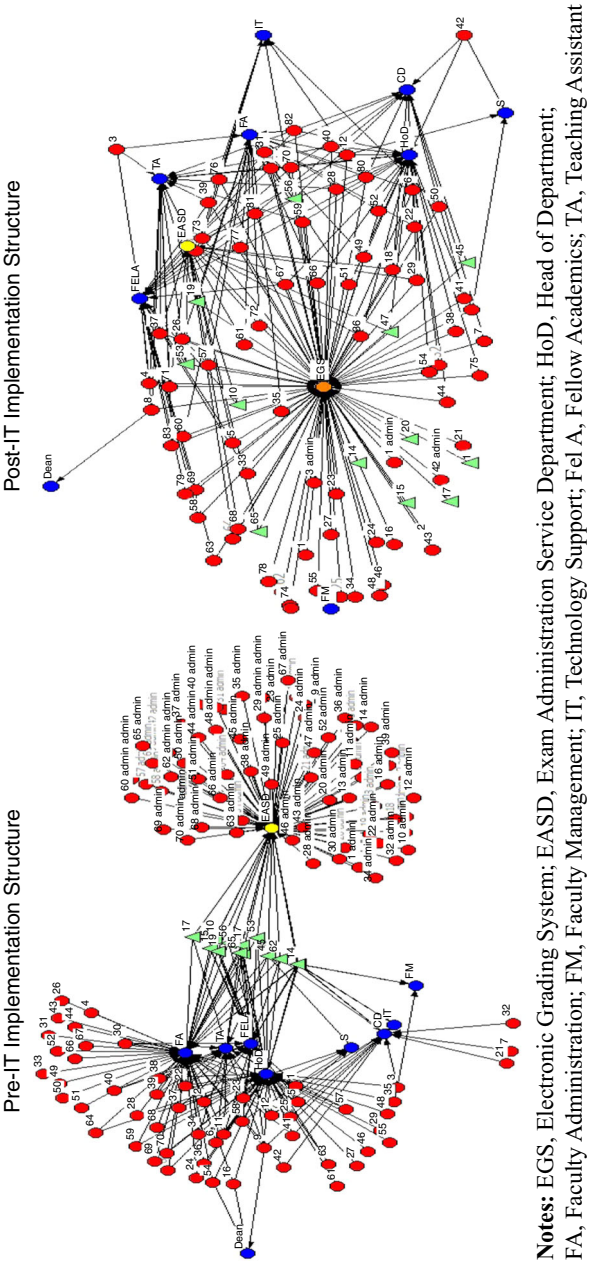


Figure 5.
Issues with the manual paper-based grading process



Notes: EGS, Electronic Grading System; EASD, Exam Administration Service Department; HoD, Head of Department; FA, Faculty Administration; FM, Faculty Management; IT, Technology Support; Fel A, Fellow Academics; TA, Teaching Assistant

Figure 6.
Examining the impact of IT on a service network

contributing to the bottleneck in the paper-based service has now been removed from their central position to a more distributed position within the service structure. What is interesting from this viewpoint, is the powerful or centred position of the EGS which partially "replaces" the role of EASD to manage grading activities. In addition, although EASD are the primary beneficiaries of the EGS, they are positioned to the edges or peripheries of the service network, which suggests a sense of remote power, i.e. managing the network from distance. One concern which is identified was the emergence of the IT department (IT) within the network which becomes an essential support link (or reliance) for the EGS. This suggests that the grading network has grown as it adopts an automated service. The IT department continues to support systems development at the cost of additional resources (human and financial) being used up for other departmental issues. This also adds a "technological" layer of bureaucracy to the service network. One of the more obvious benefits of the EGS is the removal of department administrators from the service.

7.4 Summary of interview findings

The interview findings provided excellent insight on the role IT-enabled innovation plays to meet specific interests. These interests act as mediators for the service ecology to examine the dynamic nature of service networks and the impact of technology on service networks. The exploratory nature of this study aligns with the adaptation of an ANT lens to examine (explore, describe, and analyse) the socio-technical nature of service networks. The main findings are summarised as follows:

- service is an abstract representation of socio-technical interaction to achieve various interests;
- micro and macro service network cliques influence the service innovation translation process;
- the "invisibility" of service networks inhibits the realisation of innovation value;
- initiating the need for change is an important factor of the translation process of a "power processor";
- the bureaucratic nature of power is altered but not dissolved through public service innovation;
- the concept of irreversibility may be challenged by the evolution of service innovation;
- technology is embraced with a sense of suspicion but actors presume it will improve service efficiency and performance (i.e. a perceived relationship between technology and progress);
- public service innovation shifts responsibility and accountability depending on the initiator of change and their alignment of interests;
- the bureaucratic nature of public service introduces the notion of "missed opportunity" in meeting service requirements;
- public service requirements are prioritised by senior management and the availability of budgetary resources;
- outsourcing technological service capabilities and accountability is viewed as offloading accountability or "blame" for service failures in public service;

- service control invites managers to maintain service replication instead of improvement though technological innovations within public service;
- there are significant tensions between local and global management service interests which threatens the up-rise of technological resistance;
- service regulation plays a significant role in shaping a service and dampening possible risks;
- public service value is "co-enacted" rather than "co-created" since there is an obligation to comply with service policy; and
- the use of authoritarian language provokes a sense of tensions between service management and service users.

The value of public service network innovation is realised through the availability of opportunity and the level of resistance to innovation. To realise service value, one must take into account public interests and protect various interests through service regulation. The strength of the service value may be determined by the strength of its "irreversibility". Thus, the explanatory findings presented in this research highlight a number of key lessons learnt about public service networks and technological innovation. In the next section, we are interested in modelling this change through the application of SNA.

7.5 Employing SNA concepts as service metrics

One can employ SNA concepts to examine the change in the relational structure of the EASD network. Table V summarises how some SNA concepts may be introduced as service network analytics to examine change to service dynamics within the service network (Carroll *et al.*, 2010a, b; Carroll and Wang, 2011). This demonstrates how SNA may be employed as service network performance analytics to examine the impact of technological innovation. For example, a sample of the findings summarised in Table V demonstrate how the power of social ties are the driving force of service value co-creation and value realisation within a bureaucratic service environment. The relational structure also indicates the change in relations (e.g. a brokerage) and processes which examine the sequences of mechanisms (e.g. the diffusion of knowledge).

The network analysis listed in Table V provides significant insights on the change within the service network due to IT-enabled innovation. To explore this data even further, one can apply techniques of descriptive and inferential statistical analysis to test the findings. Comparing the relational infrastructure examines network composition, relational algebra, roles and positions, and the complexity of the service environment. The descriptive statistics summarise the main facts of the relational infrastructure change of the service network. The inferential statistics examines the confidence on the findings (i.e. whether they are applicable to a larger population) using two main types of statistics:

(1) univariate (i.e. an expression to examine a distribution of one variable from a distribution of numerous variables); and

(2) bivariate (examines the relationship between two variables) descriptive and inferential statistics to describe the service network.

These results include the change in the number of ties, and the average strength of relations. The statistics applied to the network data are applied to

Concept	Paper-based process	Electronic-based process	Difference explained
No. of Ties	254	208	Reduced number of structural ties to deliver a service
Density	0.061	0.072	Increased density of network making the network more connected
Distance	Average: 1.97 Cohesion: 0.514 Fragmentation: 0.49	Average: 1.13 Cohesion: 0.73 Fragmentation: 0.28	Distance reduced as a result of technological innovation and improved the cohesiveness of the actor-network
Krackhardt GTD Measures	Connectedness: 1.00 Hierarchy: 0.00 Efficiency: 0.97 LUB: 1.00	Connectedness: 1.00 Hierarchy: 0.38 Efficiency: 0.10 LUB: 0.95	The "horizontal differentiation" of the service structure have reduced to improve "connectivity"
Hybrid reciprocity	0.0031	0.00	The reciprocity of ties has reduced which suggests greater service efficiency
Degree (centralisation)	Outdegree: 0.54% Indegree: 25.34%	Outdegree: 5.48% Indegree: 94.88%	IT service innovation introduces greater cohesion and efficiency and is less dependent on other individuals
Eigenvector centrality	55.02%	8.31%	IT innovation provides more equal service structures as it adopts the central position
Distance-weighted fragmentation	0.486	0.28	Reduces the distance between all nodes of a service through increased cohesion
Two-mode cohesion Measures	Density: 0.03 Avg. dist.: 2.48 Radius: 3.00 Diameter: 4.00 Fragmenta: 0.00 Transitiv.: 0.56 Norm dist.: 0.60	Density: 0.68 Avg dist.: 1.62 Radius: 2.00 Diameter: 4.00 Fragmenta: 0.23 Transitiv.: 0.98 Norm dist.: 1.18	Service IT innovation increases the service density, and transitivity, while it reduces the average distance, radius, diameter, fragmentation, and normalised distance across the network. Interestingly, the diameter remains the same in both networks suggesting that there was no significant impact on the actor-network boundary

Note: Least upper bound

Table V.
Service network analytics metrics

symmetric data. Table VI summarises the univariate descriptive statistics of the actor-network pre-IS implementation ("before") and post-IS implementation ("after").

For the information sharing relationship in the "before" column, we see that we have 11,523 observations which range from a minimum score of 0 to a maximum of one. For the information sharing relationships in the "after" column, we see that we have 188 observations which range from a minimum score of one to a maximum of one. In the "before" column, the sum of the ties is 181 and the average value of the ties is $181/11{,}523 = 0.016$. To compare this with the "after" column, the sum of the ties is 188 and the average value of the ties is $188/188 = 1$. Therefore, the mean is the proportion of possible ties that are present (or the density), or the probability that any given tie between two random actors is present (1.6 per cent before; 100 per cent after). In addition, the sums of squared deviations from the mean, variance, and standard deviation are computed. The Euclidean norm (i.e. the square root of the sum of squared values) is also provided. The coefficient of variation (standard deviation/mean × 100): "before" ($0.124/0.016 \times 100$) equals 20 per cent and "after" ($0/1 \times 100$) equals 0 per cent which suggest a low variation as a percentage of the average score. In adopting the use of statistics to describe network data, one may also describe properties of the distribution of relations rather than properties of the distribution of attributes across actors (see Table VII).

Examining the distribution of relations among actors within a service network and the tie-strength, the mean or central tendency is proportion of all ties that are present is the density. One can also examine the distribution of relations among actors in a network, and central tendency which is indicated by the average strength of the tie across all the service relations. The results suggest that one can be confident that there are ties present (null hypothesis: network density is 0, and any deviation observed is a random variation). The hypothesis is also tested to examine the proportion of binary ties present differs from 1. This suggests that the service network has a tendency to distribute information to all actors.

The test before the IT-enabled innovation suggests that a difference as large as one and as small as 0 calculates a value of 0.015 and the difference is −0.984. Employing the bootstrap method of constructing 5,000 networks by sampling random sub-sets of nodes each time, and calculating the density for each sample, the mean of the sampling distribution equals 0.017 (before) and 1 (after). Its standard deviation (or the standard error) is 0.005 (before) and 0 (after). Using this alternative standard error which based on random samples results in −192.5 (before) and 1 (after). This test is significant for

	Before			After	
	Descriptive statistics	1		Descriptive statistics	1
1	Mean	0.016	1	Mean	1.000
2	SD	0.124	2	SD	0.000
3	Sum	181.000	3	Sum	188.000
4	Variance	0.015	4	Variance	0.000
5	SSQ	181.000	5	SSQ	188.000
6	MCSSQ	178.157	6	MCSSQ	0.000
7	Euc Norm	13.454	7	Euc Norm	13.711
8	Minimum	0.000	8	Minimum	1.000
9	Maximum	1.000	9	Maximum	1.000
10	No. of obs	11523.000	10	No. of obs	188.000
11	No. of missing	0.000	11	No. of missing	0.000

Table VI.
Service network descriptive statistics

Before	After
Compare density with hypothesised value	
Parameter value is: 1.0000	Parameter value is: 1.0000
Density of academic network interactions 1 is: 0.0157	Density is: 1.0000
Difference is: −0.9843	Difference is: 0.0000
Variance of ties for academic network interactions 1: 0.0155	Variance of ties: 0.0000
Classical estimate of SE: 0.0018	Classical estimate of SE: 0.0000
Number of bootstrap samples: 5000	Number of bootstrap samples: 5,000
Estimated standard error for density of academic network interactions 1: 0.0051	Estimated standard error for density: 0.0000
z-score: −192.5126	Average bootstrap density: 1.0000
Average bootstrap density: 0.0176	Proportion of absolute differences as 1.0000
Proportion of absolute differences as large as observed: 1.0000	Proportion of differences as large as 1.0000
Proportion of differences as large as observed: 1.0000	Proportion of differences as small as large as observed: 1.0000
Proportion of differences as small as observed: 0.0002	

Table VII.
Compared density of service network

both before the IT implementation ($p = 0.0002$) and after the IT implementation ($p = 1.0$). Since the ties are created by the same actors the bootstrap method works best. Thus, employing SNA demonstrates how this approach assisted in developing an understanding of how IT-enabled technology influences various patterns of behaviour within a service environment.

8. Introducing public service science

This research has led to the theoretical development of public service science to explain the socio-dynamic nature of IT-enabled service networks within the public sector. The aim of this theory is to build on the notion of bureaucracy which is traditional focused on the politics of office environments. This theoretical contribution extends this notion to include the politics of serving interests through technological innovation within public service networks. It presents a new view of IT-enabled service by merging bureaucracy with service network theoretical developments based on the findings from the case study. It "explains" (Gregor, 2006) the implementation process of technology in a public service network which is a significant contribution to service science. In essence, this theory explains how public service technological innovations commands control over public sector behaviour and therefore acts as an agent of bureaucracy which alters the relational dynamics of power, risk, responsibility, and accountability. While the theoretical developments presented in this research provide significant contributions in service science literature, this research also presents practical implications. This section builds on service evolution and reformation while referencing service science literature and shifts the focus from being predominately on private sector services to public service networks.

8.1 Towards the development of public service science

This paper provides valuable insights into the socio-technical nature of a public service network. It introduced both theoretical and empirical developments on public service science. It appears that services are extremely complex environments. Introducing change in the form of technological innovation requires a strategy of translation (as supported within ANT). It is evident that service regulation dampens the opportunities presented by innovation. Thus, innovation should be cautiously

investigated with particular interest on how technology impacts the balance of power. Fostering an innovative environment ought to be a culturally integrated endeavour and not a departmental task to drive individual interests. The success of innovation relies on the methods used to evaluate the realisation of co-enacted value.

In a more troubled and competitive world, business leaders and government know that innovation and new methods of working are required is they are to succeed in their service delivery plans. Tight budgets, high costs, higher expectations from the public, and layoffs are among the reality for many public services, yet policy makers are thinking long and hard about how to improve competitiveness, boost jobs, and their respective economies. Thus the questions emerge: How do we foster innovation?; How do we manage revolutionary developments in service innovation?; How do we create service prosperity as opposed to the presumptuous attitude towards the "transformational power" of innovation? While the increasing blurring of service boundaries has created some tensions in service literature, we can also view this as opportunity to reframe what constitutes as modern public service within the domain of service science. While service behaviour describes actions across a service system, this paper highlights the need to examine the underlying socio-technical relational infrastructure while stabilise services through public service science. In doing so, we can learn not only about "how" services truly operate, but how services may share similar commonalities or how they may benefit from pooling resources. We can visualise innovation and its impact on a service system. For example, this may be achieved through the introduction of cloud computing initiatives within public sector service which generates greater interoperability between service systems. Service innovation should not be viewed solely as being technological, but rather, the intertwined socio-technical factors (i.e. hybrid innovation) which allow the social shape the technology and the technology shape the social.

9. Implications of research

This research provides a critical research platform to understand the socio-technical dynamics of service networks within the field of public service science and innovation. Innovation is critical within public service because it is a driver for growth and it provides many solutions to public sector changes and inefficiencies. Thus, it becomes increasingly more important to learn what "types" of innovation produces the greatest value and introduce methods to both explain and visualise the impact of IT-enabled innovation. Although technology-based innovation is important, the realisation of the greatest value is achieved when technology innovation is mixed with service innovation, business model innovation, and design innovation. The rapid blurring of service and technological boundaries further facilitates this goal. Therefore, one must pose the question: how do we unlock the potential of public service innovation and the realisation of public service value? This research argues that the need is to create an environment which is open and supportive of innovations which facilitates co-operation and provides a platform to address the challenges experienced with service management. However, it is evident that innovation is hampered by regulations and individualistic interests which influence the shape and potential of service technology. Public services must become more agile and remain focused on people and not become distracted by technology through collaboration and clarity of purpose. Although an important factor in public finance, there may be a need to remove the narrow focus on "performance metrics" if one is to realise the potential of service innovation. Some of the biggest rewards may come about through a change in culture and greater accountability to realise

service value. In addition, service metrics ought to shift focus towards socio-technical analysis to understand the impact of technology on service dynamics. This research introduces the application of SNA to demonstrate the impact of technology on service relational structures. Consequently, each actor must understand their role in service co-enactment and service delivery. Innovation is an inevitable yet slow and often an uncertain process but is required in order to remain effective in service delivery. There is little evidence within the public service network how value proposition is moved from a defined process of a realised and delivered outcome across the whole network. The public service appears to lack empathy and intimacy towards service needs and service technological requirements, thus creating a constant tension between service interests.

The relevance of this research to public service policy and practice was clearly demonstrated through the participants' willingness to engage in discussions regarding their environments. This was also reaffirmed by managements request for a copy of the research report summarising the findings presented in this research. The bureaucratic nature of public service networks are often viewed as being inefficient, governed by rules and "red tape", and a barrier to the flexibility and innovativeness required in the modern service environment. Within the case study, the author has learned of the several attempts of reform and modernisation of the service environment. However, at the same time, there are concerns regarding the cultural acceptance for lack of accountability which continue to spark debates across several public sector institutions.

Technology presents people with the sense of opportunity, effectiveness, and efficiency and therefore innovation is often greeted with an "expectation" of radical change. Nowadays, people have a relationship with the culture of technology. However, service computing innovations also come with an increasing expectation of the removal of risk, accountability, and responsibility. It often undermines certain social relations which often go unnoticed within managerial circles and consequently, innovation promotes a presumptuous attitude towards service delivery. Here the author is reminded of Postman (1992) for his observation on technology which is relevant in service networks: "all technological change is what I call a Faustian bargain. It gives you something, but it also taketh away something". Therefore, understanding the balance of gains and losses is of vital concern for service managers as service function follows form.

While reporting on the key research findings throughout this research, the author was mindful of the significant gap in the literature which this research addresses. This raises important questions regarding the nature of "modern" public services. We must advance the theory of bureaucracy and introduce new developments of "servicracy" (service bureaucracy), moving the conversation away from an "office" context and towards a service technological context (Carroll, 2014b). Through the influence of IT-enabled service processes, there is a greater sense of "openness" as it removes the need for localisation of service logic. Aligning the research findings within literature developments, it is evident that our traditional view that a service is for "wealth creation" is no longer valid nowadays, particularly within public service networks. Today, service is focused on the need to "create", while research must examine the complexity within the system to enact processes. The findings suggest that the concept of co-creation is not suitable within the public service environment since it suggests a sense of voluntary action to generate value or reward. The concept of co-enactment is introduced in this research to capture a sense of obligatory actions to comply with service regulation. The findings also suggest that there is a significant crisis of

understanding, for example, with the need to understand service evolution, transition, and order vs chaos. This highlights the need for educational developments to need for these research developments to:

- evolve new service models;
- strategise, design, and configure processes;
- understand relational order/disorder;
- extend methods to examine relational structures of service networks;
- understanding service descent and chaos;
- improve competency of entities and foster a service learning environment; and
- examine where and how various types of innovation which improve service provision.

In addition, this research contributes towards service science and demonstrates how it is a discipline which acts as an interface for business and IT research developments.

10. Discussion and concluding remarks

After an extensive literature review to examine various methods of understanding and visualising the socio-technical nature of service networks, this paper identifies a significant gap in the ability to explore and visualise service network infrastructures. This was particularly true while exploring the value of IT-enabled innovation across public service networks. This paper introduces a novel approach to visualise service relational infrastructure and the impact of technology on the service structure. As identified in the literature review, much of the focus is directed to "modelling practices" such as business process management notation, rather than examining methods to capture the underlying relational structures which support dynamic service network environments (Spohrer and Maglio, 2010). The findings demonstrate how a service comprises of a relational infrastructure which supports the exchange of resources and/or competencies through network interaction or assemblages.

There is an apparent presumption that technological innovations support service operations with little regard as to how technology impacts on relational structures and service network formation (Carroll, 2014b). What is interesting from this research perspective is that "requirements" plays a significant role in technological implementation. This is achieved by enroling people within irreversible service networks, which are inscribed by regulation and challenges some of the underlying logic of service requirements. The hierarchy of interest addressed (top-down) supports that there is a strong relationship between service interest and service control at both a micro and macro management level.

It is interesting to note that there is a strong sense of evolutionary developments implied in technological innovations of a service network. Innovation is not considered a "once off" implementation, but rather an incremental process of streamlining a service network while addressing service requirements. Service evolution is strongly linked to service innovation which influences the structure of the service network and the dematerialisation of service actants. Service innovation also impacts on the distribution of service responsibility and accountability which is a "transferable concept" with workflows and a traceable one when issues arise. This is considered to be one of the main motivations for outsourcing service innovations, in the hope to remove "blame" for technological

inadequacies internally. In addition, increasing the level of innovation must imply increasing the levels of system integration to support technical and cultural expectations. What has come to light is that internal cultural experiences influence the attitudes of people towards the concept of "innovation". For example, considering innovation is a slow and incremental process, technological developments are implemented to address departmental self-interests. This has a negative impact on the ability to improve greater system integration as many departments have conflicting objectives. Separate service systems increase the complexity of heterogeneous operations which often clouds manager's ability to truly identify how a service network interacts. Managers often rely on experience, tradition, regulations, and friendship to gain an understanding of service performance. It is also apparent that there is a lack of adequate reporting mechanisms to understand public service operations. Thus, service actants are dependent upon one another to stabilise the service network through self-interest and trust.

The public and private sector services are working more closely together and in some cases championing the interests of both through various umbrella services although some alliances may be initially unpopular, for example, outsourcing. However, with the increasing challenges faced by government in economic crisis and public sector cut-backs which tickle down through public services, we need new business models which incorporate greater agility and service analytics. These models should have a greater sense of inclusion for service clients in areas of decision making and value realisation in a responsive and integrated manner. The structure of the services plays a significant factor in influencing the implementation of service innovation and innovative opportunity. There is a strong contrast regarding power of decisions in the public and private sector, as public service decisions are far more likely to impact on people's lives. Thus, innovation is a driver of service success. However, private sector services appear to be more motivated to experiment with various innovation strategies to increase profits which may hamper their willingness to share knowledge on service innovation. This suggests that there is a need to develop programmes which share knowledge and best practice on service innovation and IT-enabled service initiatives through the right service delivery models and change the default bureaucratic delivery model. This would encourage service providers to become less risk averse and permit them to try alternative approaches to optimise service delivery.

References

Bannister, F. (2001), "Dismantling the silos: extracting new value from IT investments in public administration", *Information Systems Journal*, Vol. 11 No. 1, pp. 65-84.

Benjamin, R. and Blunt, J. (2012), "Critical IT issues: the next ten years", *Sloan Management Review*, Vol. 33 No. 4, available at: http://sloanreview.mit.edu/article/critical-it-issues-the-next-ten-years/ (accessed 11 August 2016).

Blau, P. (1964), *Exchange and Power in Social Life*, Wiley, New York, NY.

Callon, M. (1986), "The sociology of an actor-network: the case of the electric vehicle", in Callon, M., Law, J. and Rips, A. (Eds), *Mapping the Dynamics of Science and Technology*, Macmillan, Basingstoke, pp. 19-34.

Callon, M. and Latour, B. (1981), "Unscrewing the big leviathan: how actors macrostructure reality and how sociologists help them to do so", in Knorr-Cetina, K.D. and Cicoure, A.V. (Eds), *Advances in Social Theory and Methodology: Toward an Integration of Micro- and Macro-Sociologies*, Routledge and Kegan Paul, Boston, MA, pp. 277-303.

Camisón, C. and Villar-López, A. (2014), "Organizational innovation as an enabler of technological innovation capabilities and firm performance", *Journal of Business Research*, Vol. 67 No. 1, pp. 2891-2902.

Carr, N. (2003), "IT doesn't matter", *Harvard Business Review*, Vol. 81 No. 5, pp. 41-49.

Carroll, N. (2012), "Service science: an empirical study on the socio-technical dynamics of public sector service network innovation", PhD thesis, University of Limerick, Limerick.

Carroll, N. (2014a), "Open innovation: assessing the socio-economic factors", in Tatnall, A. (Ed.), *Human Factors in Software Development and Design*, Chapter 1, IGI Global Publishers, Hershey, PA, pp. 1-22.

Carroll, N. (2014b), "Actor-network theory: a bureaucratic view of public service innovation", in Tatnall, E. (Ed.), *Technological Advancements and the Impact of Actor-Network Theory*, IGI Global, Hershey, PA.

Carroll, N. and Helfert, M. (2015), "Service capabilities within open innovation: revisiting the applicability of capability maturity models", *Journal of Enterprise Information Management*, Vol. 28 No. 2, pp. 275-303.

Carroll, N. and Wang, Y. (2011), "Service networks performance analytics: a literature review", *Cloud Computing and Service Science Conference (CLOSER 2011), Noordwijkerhout, 7-9 May*, pp. 301-304.

Carroll, N., Helfert, M. and Lynn, T. (2014), "Towards the development of a cloud service capability assessment framework", in Mahmood, Z. (Ed.), *Continued Rise of the Cloud*, Springer, London, pp. 289-336.

Carroll, N., Whelan, E. and Richardson, I. (2010a), "Application of social network analysis to service networks performance analytics: a literature review", Lero Technical Report No. 06, University of Limerick, Limerick, December.

Carroll, N., Whelan, E. and Richardson, I. (2010b), "Applying social network analysis to discover service innovation within agile service networks", *Journal of Service Science*, Vol. 2 No. 4, pp. 225-244.

Carroll, N., Whelan, E. and Richardson, I. (2012), "Service science – an actor-network theory approach", *International Journal of Actor-Network Theory and Technological Innovation*, Vol. 4 Nos 3/4, pp. 55-69.

Chesbrough, H. (2011), "Bringing open innovation to services", *MIT Sloan Management Review*, Vol. 52 No. 2, pp. 85-90.

Contractor, N., Monge, P.R. and Leonardi, P. (2011), "Multidimensional networks and the dynamics of sociomateriality: bringing technology inside the network", *International Journal of Communication*, Vol. 5 No. 1, pp. 682-720.

Cross, R.L. and Parker, A. (2004), *The Hidden Power of Social Networks: Understanding How Work Really Gets Done in Organizations*, Harvard Business School Press, Cambridge, MA.

Davis, F.D. (1989), "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly*, Vol. 13 No. 3, pp. 319-340.

De Keyser, A. and Lariviere, B. (2014), "How technical and functional service quality drive consumer happiness: moderating influences of channel usage", *Journal of Service Management*, Vol. 25 No. 1, pp. 30-48.

DeLone, W.H. and McLean, E.R. (2003), "The DeLone and McLean model of information systems success: a ten-year update", *Journal of Management Information Systems*, Vol. 19 No. 4, pp. 9-30.

Eisenberg, E.M., Johnson, Z. and Pieterson, W. (2015), "Leveraging social networks for strategic success", *International Journal of Business Communication*, Vol. 52 No. 1, pp. 143-154.

Eisenhardt, K.M. (1989), "Agency theory: an assessment and review", *Academy of Management Review*, Vol. 14 No. 1, pp. 57-74.

Fitzsimmons, J. and Fitzsimmons, M.J. (Eds) (1999), *New Service Development: Creating Memorable Experiences*, Sage Publications, Thousand Oaks, CA.

Gregor, S. (2006), "The nature of theory in information systems", *MIS Quarterly*, Vol. 3 No. 30, pp. 611-642.

Harmon, P. (2015), "The scope and evolution of business process management", in vom Brocke, J. and Rosemann, M. (Eds), *Handbook on Business Process Management 1*, Springer, Berlin and Heidelberg, pp. 37-80.

Hassan, N.R. (2009), "Using social network analysis to measure IT-enabled business process performance", *Information Systems Management*, Vol. 26 No. 1, pp. 61-76.

Hassard, J., Law, J. and Lee, N. (1999), "Actor network theory and managerialism", *Organization*, Vol. 6 No. 3, pp. 387-390.

Latour, B. (1987), *Science in Action*, Harvard University Press, Cambridge, MA.

Latour, B. (1992), "Where are the missing masses? The sociology of a few mundane artifacts", in Bijker, W.E. and Law, J. (Eds), *Shaping Technology/Building Society: Studies in Sociotechnical Change*, MIT Press, Cambridge, MA and London, pp. 151-180.

Latour, B. (2005), *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford University Press, New York, NY.

Law, J. (1986), "On methods of long-distance control: vessels, navigation and the Portuguese route to India", in Law, J. (Ed), *Power, Action and Belief*, Chapter 10, Routledge and Kegan Paul, London, Boston, MA and Henley, pp. 196-233.

Law, J. (1999), "After ANT: topology, naming and complexity", in Law, J. and Hassard, J. (Eds), *Actor Network Theory and After*, Blackwell and the Sociological Review, Oxford and Keele, pp. 1-14.

Leih, S., Linden, G. and Teece, D. (2014), "Business model innovation and organizational design: a dynamic capabilities perspective", in Foss, N. and Saebi, T. (Eds), *Business Model Innovation: The Organizational Dimension*, Oxford University Press, Oxford.

Mancioppi, M., Carro, M., van den Heuvel, W.-J. and Papazoglou, M.P. (2008), "Sound multi-party business protocols for service networks", *6th International Conference on Service-Oriented Computing (ICSOC 2008), Volume 5364 of Lecture Notes in Computer Science*, pp. 302-316.

Miles, M.B. and Huberman, A.M. (1984), *Qualitative Data Analysis 16*, Sage, Newbury Park, CA.

Morabito, J., Sack, I. and Bhate, A. (1999), *Organization Modeling – Innovative Architectures of the 21st Century*, Prentice-Hall Publishers, Englewood Cliffs, NJ.

Normann, R. and Ramirez, R. (1993), "From value chain to value constellation", *Harvard Business Review*, Vol. 71 No. 4, pp. 65-77.

Oosterhout, M.P.A., van, Waarts, E., van Heck, E. and van Hillegersberg, J. (2006), "Business agility: need, readiness and alignment with IT-strategies", in Desouza, K.C. (Ed.), *Agile Information Systems: Conceptualization, Construction and Management*, Butterworth-Heinemann, Oxford, pp. 52-69.

Orlikowski, W.J. (2007), "Sociomaterial practices: exploring technology at work", *Organization Studies*, Vol. 28 No. 9, pp. 1435-1448.

Orlikowski, W.J. and Baroudi, J. (1991), "Studying information technology in organizations: research approaches and assumptions", *Information Systems Research*, Vol. 2 No. 1, pp. 1-28.

Ostrom, A.L., Parasuraman, A., Bowen, D.E., Patrício, L., Voss, C.A. and Lemon, K. (2015), "Service research priorities in a rapidly changing context", *Journal of Service Research*, Vol. 18 No. 2, pp. 127-159.

Postman, N., (1992), *Technopoly: The Surrender of Culture to Technology*, Vintage Press, New York, NY.

Räisänen, V. (2008), *Service Modeling: Principles and Applications*, Wiley, Chichester.

Rogers, E.M. (1962), *Diffusion of Innovations*, The Free Press, New York, NY.

Rosemann, M. and vom Brocke, J. (2015), "The six core elements of business process management", *Handbook on Business Process Management 1*, Springer, Berlin and Heidelberg, pp. 105-122.

Sarker, S., Sarker, S. and Sidorova, A. (2006), "Understanding business process change failure: an actor-network perspective", *Journal of Management Information Systems*, Vol. 23 No. 1, pp. 51-86.

Scott, W.R. (2005), "Institutional theory: contributing to a theoretical research program", in Smith, K.G. and Hitt, M.A. (Eds), *Great Minds in Management*, Oxford University Press, Oxford, pp. 460-484.

Simon, H. (1996), *The Sciences of the Artificial*, 3rd ed., MIT Press, Cambridge, MA.

Soh, C. and Markus, M.L. (1995), "How IT creates business process value: a process theory synthesis", in Degross, J., Ariav, G., Beath, C., Hoyer, R. and Kemerer, C. (Eds), *Proceedings of the Sixteenth Annual International Conference on Information Systems*, The Association for Information Systems, Amsterdam, pp. 29-41.

Spohrer, J. and Maglio, P.P. (2010), "Service science: toward a smarter planet", in Karwowski, W. and Salvendy, G. (Eds), *Introduction to Service Engineering*, Wiley & Sons., New York, NY, pp. 3-30.

Spohrer, J., Golinelli, G.M., Piciocchi, P. and Bassano, C. (2010), "An integrated SS-VSA analysis of changing job roles", *Service Science*, Vol. 2 Nos 1/2, pp. 1-20.

Spohrer, J., Maglio, P.P., Bailey, J. and Gruhl, D. (2007), "Steps toward a science of service systems", *IEEE Computer*, Vol. 40 No. 1, pp. 71-77.

Star, S.L. and Griesemer, J.R. (1989), "Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939", *Social Studies of Science*, Vol. 19 No. 3, pp. 387-420.

Tatnall, A. and Gilding, A. (1999), "Actor-network theory and information systems research", *Proceedings of the 10th Australasian Conference on Information Systems*, *School of Communications and Information Management, Victoria University of Wellington, 1-3 December*, pp. 955-966.

Tichy, N.M., Tushman, M.L. and Frombrun, C. (1979), "Social network analysis for organizations", *Academy of Management Review*, Vol. 4 No. 4, pp. 507-519.

Vargo, S.L., Maglio, P.P. and Akaka, M.A. (2008), "On value and value co-creation: a service systems and service logic perspective", *European Management Journal*, Vol. 26 No. 3, pp. 145-152.

Voss, C. and Hsuan, J. (2011), "Service science: the opportunity to re-think what we know about service design", in Demirkan, H., Spohrer, J.C. and Krishna, V. (Eds), *The Science of Service Systems*, Springer, New York, NY, pp. 231-244.

Walsham, G. (1997), "Actor-network theory and is research: current status and future prospects", in Lee, A.S., Liebenau, J. and DeGross, J.I. (Eds), *Information Systems and Qualitative Research*, Chapman and Hall, London, pp. 466-480.

Walsham, G. and Sahay, S. (1999), "GIS for district-level administration in India: problems and opportunities", *MIS Quarterly*, Vol. 23 No. 1, pp. 39-66.

Weber, M. (1978), *Economy and Society: An Outline of Interpretive Sociology*, University of California Press, Berkeley, CA.

Weill, P., Subramani, M. and Broadbent, M. (2002), "Building IT infrastructure for strategic agility", *Sloan Management Review*, Vol. 44 No. 1, pp. 57-65.

Yin, R.K. (2009), *Case Study Research: Design and Methods*, 4th ed., Sage Publications, London.

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