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# Service Science: An Actor-Network Theory Approach

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## ABSTRACT

*Service 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. Service networks become increasingly complex when technology is implemented to execute specific service processes. This ultimately adds to the complexity of a service environment, making it one of the most difficult environments to examine and manage. In addition, although the emerging paradigm of 'Service Science' calls for more theoretical focus on understanding complex service systems, few efforts have surfaced which apply a new theoretical lens on understanding the underlying trajectories of socio-technical dynamics within a service system. This paper presents a literature review on Actor-Network Theory (ANT) and discusses how it may be employed to examine the socio-technical nature of service networks. ANT offers a rich vocabulary to describe the interplay of socio-technical dynamics which influence the service system reconfiguration. Thus, this paper offers a discussion on how ANT may be employed to examine the complexity of service systems and service innovation.*

*Keywords:* Actor-Network Theory, Literature Review, Service Innovation, Service Network, Service Science

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## 1. INTRODUCTION

In paper we offer a discussion on Actor-Network Theory (ANT) – the sociology of technology and science, which, as the literature suggests, is often viewed as a more radical approach towards understanding technological influences (i.e., a socio-technical view). The paper discusses how ANT may be used to examine actors' behaviour within a service system, since every action leaves a 'footprint' which provides us with more insight on the underlying infrastructure

of service operations. Often, researchers are tasked with defending a particular theory to focus their research, but as Walsham (1997, p. 478) suggests:

*“There is not, and never will be, a best theory. Theory is our chronologically inadequate attempt to come to terms with the infinite complexity of the real world. Our quest should be for improved theory, not best theory, and for theory that is relevant to the issues of our time.”*

We adopt ANT to examine Service Science since it addresses both social and technical di-

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mensions of service network and the impact of service innovations. This paper also discusses how ANT is a 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 & Gilding, 1999, p. 962). Thus, this paper also discusses why ANT is considered appropriate to apply within Service Science research undertakings. It pays particular attention to the concepts of ‘materiality,’ ‘inscription,’ and ‘translation’ explaining how the introduction of a service system impacts the structure of a service network. This draws our attention towards the need to understand how, within a service environment, the social influences the technical, and the technical influences the social.

## 2. SOCIETY AND TECHNOLOGY

There have been numerous conceptualisations of the relationship which exists between technology and society and many studies highlight the important factor in which information technology (IT) plays to enable and increase the transformations of organisations (Orlikowski, 1991; Demirkan et al., 2008). However, it is difficult for Service Science practitioners to accept a presumptuous attitude towards the promise of technology, and suggest that these assumptions regarding the affordance of technology are becoming a cliché (e.g., Demirkan et al., 2008).

In the past, there have been two differing schools of thought on the relationship of IT and social factors. One school of thought focused on technological determinism (Winner, 1977), which suggests that technology follows its own logic and patterns of usage. Alternatively, there was considerable support for constructionism which suggests that society develops the technology and society determines technology’s role (Woolgar, 1991). These schools of thought were much debated throughout literature over in the 1970’s and 1980’s. But, in recent years, researchers began to examine the role in which both arguments played simultaneously to advance our understanding of the embedded

relationship of IT and the organisation. Continued interest focused towards the question of how IT and the organisational roles interplay and how they come into ‘being,’ suggesting the need to pay more attention to the characteristics and properties which support their co-existence (Kling, 1991; Orlikowski, 1992). Nowadays, we acknowledge that there is a mid-point between the two schools of thought which offers us a ‘truer’ picture of technologies ability to ‘enable’ and ‘restrict’ transformations. There have been increasing efforts to propose suitable models to explain the socio-technical factors of organisations. One approach in particular which is gaining more research ground across diverse research fields is ANT, which offers a radical vocabulary to examine the socio-technical building blocks on the nature of service networks.

A service system comprises of socio-technical systems which stabilise a service network through the exchange of resources and competencies which generate value. Ng et al. (2010) discuss the transformation of system thinking during the 1960’s which viewed the organisation as an ‘open system’ made up of socio-technical factors. Within this school of thought, Emery and Trist (1960) examine how a system maintains quasi-stationary equilibrium despite changes in the environment. A socio-technical view of organisations incorporates the need to examine the hybrid nature of social (i.e., people) and the technical (i.e., things) in order to understand how actions are executed and the factors which influence the actions’ outcomes. Although technical factors are often concerned with machinery, it also includes methods and procedures to explore how work is organised as a process (Ng et al., 2010). Nowadays, technology (i.e., service systems) plays a critical role in supporting critical organisational functions which highlight the importance of understanding how socio-technical systems impact of service relational structures. This paper argues that ANT is a fitting research approach to gain insight of socio-technical systems. This work also complements the emergence of Service Science developments.

### 3. THE EMERGENCE OF SERVICE SCIENCE

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. Service networks become increasingly complex when technology is implemented to execute specific processes to deliver a service. This ultimately adds to the complexity of a service environment, making it one of the most difficult environments to examine and manage. 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. However, although Service Science calls for more theoretical focus on understanding complex service systems, few efforts have surfaced which apply a new theoretical lens on understanding the underlying trajectories of socio-technical dynamics within a service system. We suggest that ANT provides a suitable theoretical lens to examine and explain the underlying trajectories of socio-technical dynamics within a service system.

The design, management and delivery of complex service systems suggest that we need to develop a scientific understanding regarding the configuration of resources to deliver service excellence. In order to extend our understanding on service delivery, there is a need to establish alternative methods to examine service formation and the value propositions which connects them. Within the service-dominant environment (Normann, 2001; Vargo & Lusch, 2008), organisations are faced with increasing challenges to develop their capabilities in complex service models (Vargo et al., 2008). The emergence of “Service Science” as a discipline in recent years confirms the fundamental change which continues to alter the nature and application of technology within business environments.

Service Science is an attempt to understand the complex nature of service systems and acts as an interdisciplinary umbrella which incorporates widely diverse disciplines to construct, manage, analyse and evolve service systems (Spohrer et al., 2007). This suggests that we need a more systematic, analytical, and overarching approach to examine service co-production operations to generate knowledge regarding the overlap between the social, business, and technology factors within a service environment (i.e., bridging service management and service computing). As services become more “open,” collaborative, flexible, agile, and adaptive, there are greater pressures on business to reconfigure and meet change through strategic realignments (Carroll et al., 2010). In doing so, managers should develop an understanding as to how this impacts the ‘value’ of the service system. A service system comprises of a provider(s) and a client(s) who collaborate to deliver (i.e., co-create) and benefit from a service (Vargo et al., 2008). A service system may be defined as (IfM & IBM, 2007, p. 5):

*“...a dynamic value co-creating configuration or resources, including people, technology, organisations and shared information (language, laws, measures and methods), all connected internally and externally by value propositions, with the aim to consistently and profitably meet the customer’s needs better than competing alternatives.”*

The environment in which the configuration of resources is achieved is described as a service network. A service network comprises of clear linkages which define the service structure and interactions in which it co-ordinates its tasks to achieve a certain business objective. Since it accounts for the collective effort of all service interactions to generate and realise value, co-creation is an important concept within a service network. This suggests that ANT can assist Service Science researchers in their quest to understand the complexity of service systems.

#### 4. ACTOR-NETWORK THEORY—AN OVERVIEW

*“To put it very simply: A good ANT account is a narrative or a description or a proposition where all the actors do something and don’t just sit there.” (Latour 2005, p. 128)*

ANT continues to make a significant contribution to science and technology studies. 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. ANT suggests that the world is made up of intertwining networks which are comprised of many complex interactions (locally and globally) which constantly reconfigure itself on a regular basis. This systematic approach focuses on the infrastructure which supports socio-technical developments and their interactions. ANT also provides us with a lens to examine the links between the so-called social and the technical and suggests that actors can be enrolled to stabilise the network. Steps may involve identifying stakeholders and their interactions; the development of an actor-network model; the identification of irreversible technologies, enablers and inhibitors of specific processes and activities which are socially embedded in a service network. ANT breaks away from the social science school of thought as it does not fix itself upon any set theory per se, but rather enjoys the radical uncertainty of human behaviour in which actions are not predetermined. ANT provides an approach to understand how both social action shapes technology and how technological innovations shape social action. Thus, ANT acts as a toolkit to explore how human and non-human actors interact with one another to make sense of their world (Latour, 2005). Law (2007, p. 2) provides an account of ANT and explains that:

*“Theories usually try to explain why something happens, but Actor-Network Theory is descriptive rather than foundational in explanatory*

*terms, which means that it is a disappointment for those seeking strong accounts. Instead it tells stories about ‘how’ relations assemble or don’t. As a form, one of several, of material semiotics, it is better understood as a toolkit for telling interesting stories about, and interfering in, those relations. More profoundly, it is a sensibility to the messy practices of relationality and materiality of the world. Along with this sensibility comes a wariness of the large-scale claims common in social theory: these usually seem too simple.”*

ANT 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. To appreciate the value of ANT, it is also important to understand the background of ANT.

#### 5. ACTOR-NETWORK THEORY BACKGROUND

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) since ANT adopts socio-technical symmetry to explore actants’ (human and non-human) participation within heterogenous network assemblages through negotiation and translation.

ANT provides the ability to uncover the chain of actions or 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, 1986a). Translation is a complex view of interactions which suggest that actors:

1. Assemble similar definitions and meanings;
2. Define network representatives;
3. 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 & Griesemer, 1989). They describe boundary objects as being adaptable to different viewpoints and robust enough to maintain identity across them and identify four types of boundary objects (Star & Griesemer, 1989):

1. Repositories;
2. Ideal types;
3. Coincident boundaries;
4. Standardised forms.

These boundary objects relate to how information may be interpreted by different communities but with enough fixed content to maintain its reliability. They also discuss how problems from conflicting views are often managed from a variety of ways including (list extracted from p. 404):

- Via a 'lowest common denominator' which satisfies the minimal demands of each world by capturing properties that fall within the minimum acceptable range of all concerned worlds; or
- Via the use of versatile, plastic, reconfigurable (programmable) objects that each world can mould to its purposes locally; or
- Via storing a complex of objects from which things necessary for each world can be physically extracted and configured for local purposes, as from a library; or
- Each participating world can abstract or simplify the object to suit its demands; that is, 'extraneous' properties can be deleted or ignored; or
- Work in the worlds can proceed in parallel except for limited exchanges of standardised sorts; or
- Work can be staged so that stages are relatively autonomous.

The list above places emphasis on actant configuration and their properties which may be interpreted to facilitate the exchange of resources and competencies across a service network. In addition, this list acts as a platform upon which we can develop a socio-technical view of a service network. Berg and Timmermans (2000) explain that ANT does not assume that order can hold totalitarian control but rather, order is a co-produced achievement. This is an interesting concept which links ANT to Service Science logic while both schools of thought are focused on examining the intertwining nature of co-creation and co-production interactions. One of the main differences between actors and actants is that actors have the ability to circulate actants within a system. Latour (2005) denies that sociology can never attain an objective

viewpoint and look beyond its participants (i.e., a meta-language). Actants influence one another. Law (2008) refutes that technology is transferable since it does not originate from a fixed point and instead suggests that technology is passed and changed to a point that it becomes 'less and less recognizable.' Within a network, actors tend to present one another with a version of their necessities, and from that other actors understand the strategies they attribute to each other (Latour, 2005, p. 163). This often allows them to create their own society, sociology, language, and meta-language. ANT suggests that there is no single theory of action (Walsham, 1997; Latour, 2005), i.e., it denies a fixed frame of reference as indicated from a relativistic sociology (which examines deviant phenomena through a fixed theory), and instead embrace a fluctuating reference approach ("*follow the actors*"). Due to the complex and intertwining nature of actants within service networks, ANT presents a significant contribution towards Service Science research undertakings. It has excellent potential to provide a significant contribution towards the emerging paradigm of Service Science, for example service formation, service evolution, and service innovation. Thus, one can examine the formation of service systems through a radical and rich vocabulary offer through ANT.

## 6. ACTOR-NETWORK THEORY—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. Latour, Callon, and Law are among the most cited scholars whom introduce a vocabulary which is used to distinguish between objects and subjects and explore particular network phenomena, i.e., the objective and the subjective. Many ANT studies examine 'success' and 'failure' and examine the concept of 'power'

which established actor-networks and imposing 'order' on actants to meet specific interests (e.g., Berg & Timmermans, 2000). Additional studies began to examine multiplicity and difference of multiple 'orders' (Gad & Jensen, 2010) which act almost automatically and simultaneously. ANT suggests 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 phenomena, ANT suggests 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. This is also suggested by Latour (1992), as he explains that ANT overcomes the need to discuss knowledge and objects using a one dimensional language and instead adopts a dualism as a second dimensional approach. He suggests that, "*instead of being opposite causes of our knowledge, the two poles are a single consequence of a common practice that is now the single focus of our analysis*" (p. 281). There are a number of key concepts which one has to become familiar with while adopting ANT. These are summarised in Table 1.

Although Table 1 lists the key vocabulary used throughout ANT studies, Hassard et al. (1999, p. 392) explain that the success of ANT is with the "*habit of failing to forge its own internal and external boundaries,*" which presents us with a large degree of exploration freedom. Law (1999) suggests that ANT has become a strategy which has an "*obligatory passage point....with a more or less fixed location*" (p. 2). Latour (2005) provides what he describes as the '*intellectual architecture*' in his account of the social explanations of social phenomenon. He explains that the word 'social' cannot be conceptualised as a '*kind of material or domain*' which can be discussed using a '*social explanation*' (p. 1). ANT is often referred to as the sociology of translation (Callon, 1986a) which suggests that one must identify the meaning of 'assemblages' through ANT (Latour, 2005). ANT examines the "*motivations*

Table 1. ANT main concepts

Concept	Explanation
<b>Actant</b>	“Any element which bends space around itself, makes other elements dependent upon itself and translates their will into the language of its own” (Callon & Latour, 1981, p. 286).
<b>Actor-network</b>	A heterogeneous network of aligned interests formed through translation of interests (Walsham & Sahay, 1999).
<b>Assemblages</b>	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.
<b>Associations</b>	Non-social ties which can be used to trace associations and does not designate a thing among other things.
<b>Black box</b>	A snapshot of the network which illustrates its irreversible properties.
<b>Translation</b>	The creation process of an actor-network through four main phases (Callon, 1986a): 1. Problematisation 2. Interessement 3. Enrolment 4. Mobilisation
<b>Problematisation</b>	Defines identities and interests of other actors which align with its own interests (i.e., <i>obligatory passage point</i> ).
<b>Obligatory passage point</b>	A situation that has to occur in order for all the actors to satisfy the interests (Callon, 1986a).
<b>Interessement</b>	Convince other actors to agree on and accept the definition of the focal actor (Callon, 1986a).
<b>Enrolment</b>	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, 1986a).
<b>Mobilisation</b>	Ensuring actors represent actors interests (Callon, 1986a).
<b>Inscription</b>	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).
<b>Performativity</b>	“Entities achieve their form as a consequence of the relations in which they are located... they are <i>performed</i> in, by and through those relations” (Law, 1999).
<b>Irreversibility</b>	The point to which it is impossible to return to a point where alternative opportunities may exist (Walsham & Sahay, 1999).
<b>Immutable mobile</b>	Strong properties within a network which establishes its irreversibility, e.g., software standards (Walsham, 1997)
<b>Speaker/delegate/representative</b>	An actor that speaks on behalf of (or stands in for) other actors (Callon, 1986a; Sarker et al., 2006).
<b>Betrayal</b>	A situation where actors do not abide by the agreements arising from the enrolment of their representatives (Callon, 1986a; Sarker et al., 2006).

and actions of groups of actors who form elements, linked by associations, of heterogeneous networks of aligned interests” (Walsham, 1997, p. 468).

There are some subtle differences between the social science literature and ANT. For example, an actor may be considered as anything

which comprises of a process or a number of processes to execute a certain task, i.e., a person, group, department, organisation, or an information system. In ANT literature an *actant* (human and non-human) is more than what social science would describe as an actor, since an actant is often ‘enrolled’ in a certain



position to strengthen it. For example, software (actant) executes code (action) to perform an action to meet a business objective (the network) or, an elevator (the actant) strengthens the accessibility (the action) of the floors (the network) within a building. In addition, ANT promotes that humans are not the only beings of agency, and that we should consider machines, animals, and as demonstrated in other studies, matter (Latour, 1998) and thus can be considered an actant “*if it performs, or might perform [agency]*” (Callon & Law, 1995, p. 491). Actants may be considered as human and non-human stakeholders whom are focused on interests that influence technological applications (Monteiro & Hanseth, 1996; Walsham, 1997; Hanseth et al., 2004; Sarker et al., 2006). 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). Latour (2005), discusses the notion of the neologism “*valorimeter*” which refers to a measurement of a network’s ability to meet actor’s requirements are being addressed, and is of particular interest from an IS requirements perspective. Inscriptions also support the translation process through the design of the network and determine who will participate, how they will participate, and the impact on their roles. For example, once business processes have been established and automated, the software which supports business processes adopts the inscription role which often becomes fixed and irreversible, i.e., making it impossible to start the process again or explore alternative opportunities. The actors which participate in the network and operate the technology form the actor-network which creates an embedded black-box model of the system of what appears to be the optimum system operations.

## 6.1. Materiality in Actor-Network Theory

ANT suggests that objects have agency to establish relations and translate interests. For example, Latour (1992) discusses how a hydraulic door system is considered more reliable than a human operator or, how a car seatbelt imposes morality on humans. Although it is often considered controversial, ANT practitioners insist that researchers must refuse to distinguish between human and non-human as prior categories and is considered one of the main contributions to this research approach. Callon and Muniesa’s (2005) provide an interesting account of materiality and they caution that we should not confuse materiality with physicality. Instead, we should examine how properties are supported through specific process.

## 6.2. Inscription and Translation

The concepts of inscription (Akrich, 1992; Akrich & Latour, 1992) and translation (Callon, 1991; Latour, 1987) are of particular relevance within Service Science. Translation treats actants within an actor-network as a heterogeneous unit of analysis with particular on network formation. Translation examines the various meanings which actors provide about a specific phenomenon which actors discuss the intersement process of various interests. The ultimate aim of the intersement is to enroll actors to support a set of defined interests and stabilise a network. Translation suggests that the nature of power plays a significant role in actor-network formation. For example, Callon (1986a, p. 223) explains that:

*“To translate is to displace... to express in one’s own language what others say and want, why they act in the way they do and how they associate with each other: it is to establish oneself as a spokesman.”*

Translation is a very complex task which undergoes four main phases (Callon, 1986a):

1. **Problematisation**: defines the problem or opportunity with which an actor proposes a solution. Defining the proposed solution acts as the obligatory passage point;
2. **Interessement**: attracts other actors in the proposed solution to favour a new opportunity which confirms the problematisation phase.
3. **Enrolment**: is a negotiation process to exhibits how the interessement meets the actors' interests and needs and persuades them to accept the new actor-network.
4. **Mobilisation**: is an important process which ensures that actors represent other actors' interests.

Inscription refers to what may be described as the patterns of use but is relatively flexible in the nature of use, for example, computer applications. In order to stabilise a network and establish social order, actors engage in continuous negotiation to align particular interests (interpretation, representation, or self-interests) to mobilise support as part of the translation process. Inscription translates specific interests within technical objects, for example, text, software, user requirements, or regulations, which typically impacts on actors' roles. This process varies substantially as there are many factors which impact on its success, for example:

1. What is the desired outcome from the inscription?
2. What medium is utilised for the inscription process?
3. Which actors inscribe the particular interests;
4. How strong are the inscriptions (what level of resistance could oppose the inscriptions)?

Consequently, the design of the translation process is realised to align with users needs to provide a particular solution. The solution is then translated to complete a task, while actions are translated to specific outcomes. Inscriptions are

typically provided with more concrete content to record actors' interests within a material which vary in their flexibility, for example, policy and regulations. Therefore, the strength of the inscription may be determined by the possibility of irreversibility. Translation and inscription play a fundamental role in the formation approach of an actor-network. In addition to understanding the theory of ANT, one can also adopt ANT as an approach to examine service systems.

## 7. ACTOR-NETWORK THEORY—THE APPROACH

Technology is impacted and consequently shaped by a number of factors including, for example, social interests, existing networks or network formation, power structures within a network, influence structures, political nature of the network, and attitudes. In order to understand how social actions shapes technology and technological innovations shape social action there are a number of phases one can adopt as a roadmap which is significant to the research methodology. The phases listed in Table 2 (adapted from McBride, 2000) outlines the research methodology which may be adopted by the Actor-Network theorist to apply in Service Science research. According to Latour (1993), ANT's theoretical ability rests in its refusal to reduce network explanations to natural, social, or discursive categorisations although identifying the importance of each one (p. 91). In addition, to support this logic, Law (1990, p. 113) suggests that "*the stability and form of artifacts should be seen as a function of the interaction of heterogeneous elements as these are shaped and assimilated into a network*". The phases listed in Table 2 provide a roadmap on how to employ ANT to explore the nature of a service network. This is important as Latour (2005) denies that sociology can ever attain an objective viewpoint and look beyond its participants (i.e., to develop a meta-language). In addition, Mitchell (2002) suggests that with the continuous pursuit social abstraction, there is a

Table 2. Phases of adopting the ANT approach (adopted from McBride, 2000)

Phase	Description
<b>Identify the stakeholders</b>	Comprise of human or non-human actors which influence or becomes influenced by other actor's policies and practices.
<b>Investigate the stakeholders</b>	Understanding the character of the stakeholders through, surveys, or interviews with network representatives, accessing documentation, understanding their attitudes, interactions, interests, etc.
<b>Identify stakeholder interactions</b>	Tracing interactions between stakeholders to explore the level of influence between stakeholders (e.g., trust and control).
<b>Construct an actor-network model</b>	Construct an actor-network model to determine for example, the networks complexity, cohesion, strength, and influence.
<b>Examine irreversibility</b>	Determine to what degree it is difficult to make a change, e.g., through understanding the culture and the nature of acceptance in the network.
<b>Source of inhibitors and enablers</b>	Determine who enables and inhibits actions to shape technology and the network under investigation, e.g., technology, attitudes, resistance, or network infrastructure.
<b>Tracing actions</b>	Identify what activities led to the alignment of the actor-network, for example, training.
<b>Reporting on the actor-network</b>	Report on the overall nature of the network and explain how social actions shapes technology and technological innovations shape social action within the network.

growing division of our social world “*into image and object, representation and reality*” (p. 93).

Social abstraction also takes into account the performance of the actor-network. For example, Knox et al. (2007) discuss performances of ‘calculability’ (or the ‘effects’ of calculability) which accounts for social practices in terms of the abstract workings of a ‘locationless logic.’ In addition, Knox et al. (2007) draws on Callon and Law (2005, p. 25) to suggest that ‘calculation’ is, “*a process in which entities are, so to speak, released from local entanglements and detached from specific contexts so that they can be ‘reworked, displayed, related, manipulated, transformed and summed up in a single space’*”. But the question remains: how is this accomplished?

From the extensive literature review on ANT, Figure 1 depicts our conceptualisation of how an actor-network is formed and stabilised, starting with the centre of the diagram which motivates network formation through ‘interests.’ Figure 1 provides an overview of ANT and illustrates what we conceptualise as to how the main concepts operate and intertwine with one another. Networks are created through aligned interests upon which actants enroll. When they

enroll, they accept allies’ interests through a process of translation which effectively states their agreement with their participation and efforts to stabilise the network. These processes form the network into what becomes known as the actor-network with which is irreversible and cannot explore alternative opportunities at this point (i.e., the actor-network becomes a black box). The process of translation and inscription are illustrated as follows (Figure 2).

Figure 2 depicts the relationship between translation and inscription to address a phenomenon (the formation of an actor-network) through various interests and to establish an irreversible network. Traditionally, organisations would implement technology to mediate complex or laborious tasks. This would essentially disentangle knowledge from one actant (e.g., a department) and transfer the knowledge and repackage it in various other locations for other people to benefit from the records. Therefore, one should consider how technology often ‘replaces’ methods of process execution and relocates knowledge which alters the socio-technical world through a representative view. Adopting this approach places emphasis on

Figure 1. ANT overview

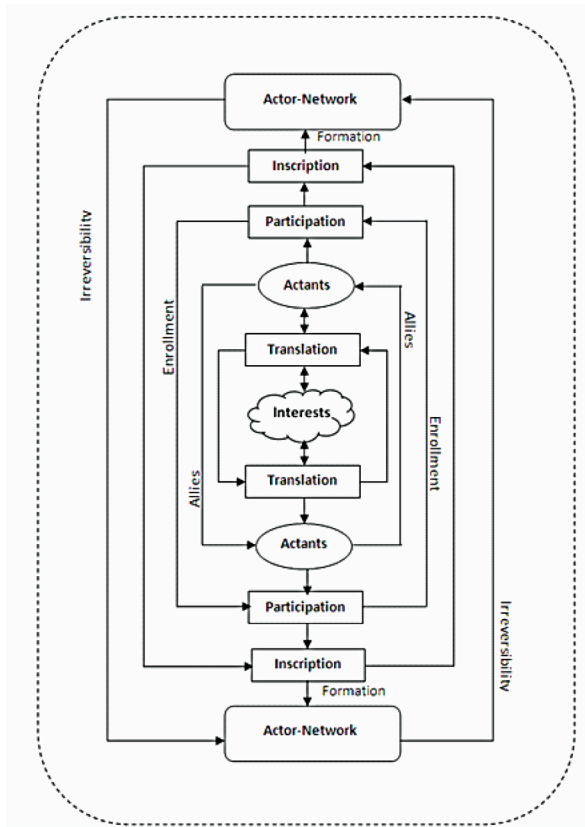
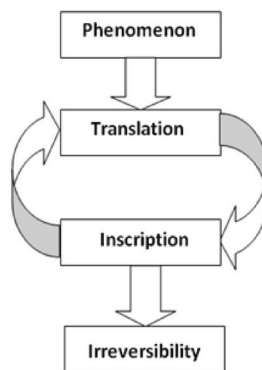


Figure 2. Process of translation and inscription



‘how’ actants form service networks which directs attention towards the application of ANT.

## 8. APPLYING ACTOR-NETWORK THEORY

It is important to gain an understanding the problematic relationship in IS and organisational development (van den Hooff & Winter, 2011). This is critical when, for example, it is applied within the public sector considering the unsatisfactory application and culture of IS in public administration. Latour (2005) discusses the “division of labour” which suggests that one can only create sub-projects after a project succeeds which is often determined by whether it is of a continuous compromise nature. Interestingly, Latour suggest that the more a technological project advances, the more likely the impact of technology diminishes in relative terms (p. 126). ANT prescribes two main methodological approaches:

1. Follow the actor (i.e., using interviews and ethnographic research);
2. Examine inscriptions (i.e., text sources which are also central to credibility, e.g., the strategy of enrolling others).

Although traditional research approaches have guided researchers to gain insights on various demographics of the social world, there appears to be a void in our ability to truly understand how technology continues to shape our world. Latour’s expression, “*follow the actors*,” suggests that we can examine what actors do, why they do it, and their interests or beliefs in doing so through their interactions which support their existence. The focus of the theory is to trace and explain where stabilising networks are the result of aligned interests, or in some cases, fail to establish themselves (Walsham, 1997). This, it is suggested, provides us with insight as to what shapes network infrastructures which is significant when applied to the public sector (Ali & Green, 2007; Feller & Finnegan, 2008; Cordella & Iannaccin, 2010;

Davis, 2010). Within an IS perspective, there are several key studies which develop ANT concepts, in particular the IS-related studies.

## 9. ACTOR-NETWORK THEORY STUDIES

In the past, there have been a wide range of applications of ANT to examine socio-technical factors. Some of the more traditional or classic ANT studies are quite varied and examine socio-technical factors across various environments. For example, Callon (1986a) examines the electric car in which encompasses technical, economic, social, and cultural factors. He examines the various components to analyse the “*co-evolution*’ of ‘*society*,’ *technological artefacts and the knowledge of nature*” (p. 20). This research explains how the process of ‘translation’ is appropriate to describe the mechanisms which constructed as a result of the actor-network. This goes beyond social science since it isolates social elements to examine the interrelationship of actors. He examines Renault’s assembly of a car engine and transmission with particular attention on how electrical charge drives the motor through a black-box viewpoint. Callon (1986b) also provides an ANT account of scallops and fishermen. He examines the concept of power through translation through three principles: agnosticism, generalised symmetry, and free association. His work uncovers the causes for the decline on scallop populations in St. Brieuç Bay and supports strategies to remove these causes. Callon focuses on four main processes using ANT, namely, problematisation (defining the problem), interressement (align actors with specific roles), enrolment (define roles for actors), and mobilisation (ensure actors represent actors interests), and explains that translation is a process which is never a completed accomplishment which may also fail.

Law (1986) explores the spice trade through the use of ANT, providing an interesting insight on the trading networks of the fifteenth and sixteenth century Portuguese mobility. He ex-

plains that trade was only made possible through the mobility and durability of their vessels. He argues that it was only through the innovation of the vessels which made it possible for the expansion of the Portuguese trading network. He explains how ‘documents, devices and drilled people’ were important resources to exercise long-distance control. Latour (1992) offers an interesting contribution on a socio-technical view of technology. He offers a number of interesting views of how technology failed actors failed to sustain it through negotiation and adaptation to a changing social situation through various interviews. One of these technologies includes the use of seatbelts, and later discusses the socio-technical nature of car park barriers. While he examines the power of “mundane artifacts” such as seatbelts and hotel keys he explains how these artifacts influence human behaviour. In 1996, Latour also examines the socio-technical view of public transport systems (Latour, 1996). He examines ‘Aramis,’ which was a public transport system, proposed for the French between the 1970s and later 1980s but never materialised. This work examines the reasons why the project never materialised (“*who killed Aramis?*”) discussing various approaches towards Aramis project management. He examines how additional people become involved in the project and how requirements change based on various interest groups. Latour (1996) argues that technology is always embedded in a social and cultural context and that it is only realised through the human investment (emotional, financial, knowledge, etc.).

Technological-centric ANT studies have quenched many assumptions of technology-entangled environments on users and on society. Technology may be described as a social or cultural product which reflects the behaviour of a particular environment. More recently, there have been continued efforts to examine the socio-technical factors of people and technology within the IS fields. Recently, Ngosi et al. (2011), examine how ANT vocabulary provides a radical insight on the behavioural aspects of design science and present an understanding of how specific roles contribute to certain achieve-

ments. They describe a content management development through a translation model to interpret the principles of a critical process. Mitev (2009) provides an ANT account for the implementation of technology within a transport company and explains some of the difficulties encountered in merging ANT with IS research.

Ramiller and Wagner (2009), also examine the importance of ‘surprise’ in qualitative research on IS-related topics. In their study, they explore the element of surprise through ANT within social theory. Navarra and Cornford (2009), examine the interplay of globalisation, networks, and governance, and suggest that technology is defined as universal methods of organising policy, institutions, business interests, and managerial developments. While adopting ANT, Navarra and Cornford (2009) discuss how ANT offers a new theoretical lens to understand the influence of information technology across the world. In addition, Darking and Whitley (2007), present empirical research which examines the various “engagement practices” of a large technological (FLOSS) project (European Commission, 2002) which highlights multiplicity and its impact on the technological infrastructure (i.e., objects they both change and stay the same). The ANT method often gains interests to understand how it fits with the seemingly tried and tested traditional research ontology. For example, Cordella and Shaikh (2006), discuss ANT as an interpretive research method in IS and considers this to be a disadvantage since it prevents ANT from remaining faithful to its own ontology. They argue that while adopting interpretivism, reality exists within, although within ANT literature, reality exists ‘out there.’ Additionally, Introna (2006) discusses the application of phenomenology to understand technology and examine the “morality of our machines.” ANT has also received much research attention within the business domain. For example, Sarker et al. (2006) discuss how they interpret business process change and a telecommunications organisation failure through an ANT lens which they suggest, allows organisations to better prepare for change and accommodate its complexities.

Tatnall and Burgess (2006) also examine a business environment with particular attention on e-commerce and understanding its interaction with people and technology from a socio-technical context. They suggest that ANT offers them a more concrete view to investigate the strength of networks and technological innovation and examining what 'aspects' of innovation organisations are more interested in through the process of translation. Gao (2005) explores the socio-technological construction of China's strategy for the telecommunications market transformation. They examine how actors' interests are influenced by the situation of technology advancement and policy developments within telecommunications reform. Levy and Powell (2005, p. 355), also offer a discussion on small and medium-sized business (SMEs), examining how strategic management of IS is practiced through substantial case studies while adopting ANT to discuss the significance of SME practice. Within an organisation, Linderoth and Pellegrino (2005), examine "*frames and inscriptions*" across IT projects. They examine how technology can be explored a much deeper analytics level to explore the implications of IT change through ANT. Tatnall (2005) suggests that ANT provides a suitable lens to understand user requirements in developing IS by examining how IS brings about change through technological innovation. Braa et al. (2004), examine the importance of networks (within the health sector in this study) within action research and efforts which share experience through local intervention which they consider is necessary to sustain an action research. In addition, Hanseth et al. (2004), examine research efforts on IS which take a social stance, a technological stance, or a socio-technical stance.

Emphasis is placed on the how ANT can be employed to provide a powerful tool which develops improved understanding within IS research. This is supported by Mutch (2002), who also examines the popularity of ANT in IS research from a realism perspective. He suggests

that its 'flat' ontology is suitable when exploring human behaviour through IS. Tatnall and Gilding (1999) discuss how ANT may be applied to qualitative research traditions for IS studies, in particular, to examine the implementation of IS and other technological innovations. Finally, for the initial ANT literature review, Hanseth and Monteiro (1998) focus on IT-enabled information infrastructures and explore how they are shaped by a large user community across large geographical areas.

## 10. CRITICISM OF ACTOR-NETWORK THEORY

While ANT offers significant benefits to the Service Science community, there exist several criticisms of ANT, mainly because of its denial to accept a pre-existing paradigm within social sciences. For example, one criticism includes the fact that ANT addresses human and non-human factors equally and traditionally while social science suggests that interaction differs between these. Law (2008) acknowledges these criticisms which suggest that ANT attempts to dehumanise the human, but provides an example where Charis Cussins (1998) asks what is so bad about being treated like an object and suggests that this is not necessarily 'inhumane,' but vital to remain subjective for research purposes. Infrastructure may be described as a relational concept considering it enables something else (Star & Ruhleder, 1996). For example, technology is often enabled by humans. The four main criticisms of ANT are captured by Walsham (1997):

1. **Limited analysis of social structures:** ANT fails to capture the importance of the '*broader social structures*' which inherently influences the local social structures. However, Latour's (1993, p. 119) defends this criticism when he states that: "*the macro-structure of society is made up of the same stuff as the micro-structure.*" Callon and Latour (1992) 'refuse' to consider them

as priori and hierarchy and prefer to treat them with equal importance. To combat this criticism Walsham (1997) suggests that “*one approach for IS researchers is to combine the methodological approach and conceptual ideas of Actor-Network Theory with insights and analysis drawn from theories of social structures*” (p. 473).

2. **An amoral stance:** Concerns emerged regarding the ‘equal’ treatment of human and non-human actors. However, the introduction of the term ‘actant’ was considered by Collins and Yearley (1992) in an attempt to alleviate this. One can interpret ANT as a method to view actants rather than complete acceptance that there is no ‘difference’ in human and non-human. One may adopt ANT to understand how actants operate simultaneously across a heterogeneous service network to remove any bias of hierarchy.
3. **The problem of generalised symmetry:** Criticism arose with regard to the moral and political stance which ANT reportedly disregards (Winner, 1993). However, Latour (1991) suggests that ANT offers a method to firstly ‘describe’ the network and removes any such bias. For example, “*follow the actors*” allows actants tell the story.
4. **Problems of description:** There have been some concerns with regard to ANT as a methodology for network descriptions although there is little debate on this criticism. Walsham (1997) identifies this as a criticism since there is often a lack of discussion on the actual method of description. When there it, it often varies, for example, to lengthy accounts of detail (Latour, 1996). Latour (1996) suggest that one should trace and describe how an infinite number of entities form within a limited number of ways and draws our attention on ‘how’ to present the findings

while describing specific entities in great detail.

## 11. CONCLUSION

Exploring the co-existence of human and machine has been well documented throughout literature across various research fields (business, engineering, law, social science, and medicine for example). However, an interesting angle which emerged as a significant research gap in their co-existence is the underlying relational interplay which exists between the social and the technological systems which influence our everyday lives. This paper discusses the importance of developing a socio-technical understanding of the service network and tracing how networks establish themselves while aligning interests or, in some cases, failing to establish a network. This paper supports the use of ANT to explore service networks and to develop an understanding of service network formations and complexities. The paper also provides an overview of some of the most influential studies in ANT, particularly within the IS field. Thus, ANT addresses the challenge of exploring reality as transitional in its becoming, and as trajectories of network creation which offers an alternative method to uncover the ‘truths’ of service network formation. This presents us with the opportunity to gain valuable insights on service networks within the domain of Service Science.

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