Application of Social Network Analysis to Service Networks Performance Analytics: A Literature Review

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Abstract

Services are considered one of the most important business developments which have emerged to the forefront of our economic development over the last decade. We live in a service-dominant economy, which has become increasingly complex and intertwined in service networks, business transactions, and collaboration exchanges. However, there are major concerns as to the lack of research efforts which examine methods to successfully manage the complexity of technology within service networks and its impact on service performance.

This technical report presents a literature review which highlights the need to conceive tools and techniques to manage the complexity of service networks without jeopardising the performance of service networks through service network analytics. It examines the significant void in literature in understanding the impact of digitising a service structure and explores the need to implement key performance indicators (KPIs) within service structures. Specifically, we examine the effectiveness of a technique called "social network analysis" (SNA) in extending business process management (BPM) to enhance the manageability of network based services. This report also explores how SNA can be a powerful tool for managers to understand organisational network performance and service interaction (e.g. behavioural, functional, and structural) and presents unique metrics which may be applied to service network analytics.

1. Introduction

Nowadays, organisations are becoming increasingly interested in understanding the operations of service networks as a means to adapt to the ever-changing business environment. In order to deliver effective services, providers are being advised to '*innovate'* their service delivery systems. Innovation in this context often refers to technology, technique or restructuring service improvements. However, the difficulty is that in the modern organisation, service delivery is dispersed across complex service eco-systems. Thus, there are greater pressures on organisational service systems to deliver higher quality and more efficient service as management continue to invest in information systems (IS) or business applications. Management must attempt to develop a greater understanding of service processes to identify where improvements may be made by employing business process management (BPM). The network approach ultimately makes service innovations and service (re)configuration more difficult to implement, monitor, and report on service performance. We are often led to believe that we live in a 'global network', surrounded by networks of power, influence, and relationships (for example, [1]). If we adopt this view, we may adapt Mitchell's [2] description of a network (p.2) as *a specific set of linkages among a defined set of actors, with the additional property that the characteristics of these linkages as a whole may be used to interpret the service behaviour of these actors involved*. The interaction patterns exhibited within service environments (physical and virtual) are of critical importance to performance analytics. In this report, we discuss how social network analysis (SNA) allows us to explore how we may analyse, design, and/or reconfigure service networks, across distributed communication and collaboration structures [3]. In addition, we adopt actor network theory (ANT) as one of core theories upon which we can examine service relations and their effects on service performance between service actors (for example, people, organisations, and IS). The network topology which is exhibited as a result of service interactions are often concerned with '*spatiality*'. The networks measurable and scalable attributes which emerge over time and attempt to retain service integrity provides us with insight on service dynamics and resulting performance. This report explores the concept of a 'service network' with particular attention placed on performance analytics and identifies the need to incorporate service performance analytics within BPM to enhance the manageability of service networks. Often, an important decision requires better knowledge of both tangible and intangible factors in services. If managers fail to report service performance, it is increasingly likely that resources will be misallocated, innovative ideas will be rejected, money is wasted, quality of service is jeopardised, and service reputation is at risk. For example, the risk may increase the probability of failure with an IS to support service delivery, the value of information exchanged between service actors, the strength of a service and its relational ties, strategic alignment, of which is economically justifiable, within a service eco-system. This is largely the result of lack of measurement on service performance analytics to inform decision-making tasks within the service environment.

2. The Service Environment

The service environment is comprised of complex business interactions often influenced by the affordance of technology. The growth in '*service science*' as a discipline has underscored the need to investigate the contributory value of business processes and its influence on how a service system affects the delivery of organisational performance. Within organisational and technological management theory, understanding and measuring value (i.e. *application of competences*) of service networks is considered one of the key problems which prevent the sustainability of organisational growth ([4]; [5]; [6]). Value may be referred to as "*the adaptability and survivability of the beneficiary system*" ([7]; p. 148) although we focus on value through performance analytics. Understanding the value of service system infrastructure after investing often proves to be one of the greatest challenges [4]. Therefore, assessing the business value of service processes is of critical importance. Service science explores the value *co-creation* of interactions between service systems (for example, [7]; [8]). Modern service systems have become very complex while technology continues to contribute towards organisational "*flattening*" [9] which adds to the complexity and evolvement of service system [10]. The wealth of information available on people and their roles, technology and processes, organisations and activity or performance has never been greater, nor has the prospect to (re)configure them into service relationships to examine, create, and manage service value. Technological advances continue to act as a driving force for '*making new patterns and a new elevated level of value creation possible'* [11] (p. 8). Service businesses cannot neglect strategic innovation. Table 1 examines the driving forces behind innovation in service management systems of which we adapt for a service network:

	External driving force		
Internal basis for service management innovation system	**Fossilised or regulated institutional context**	**New values, lifestyles and problems**	**Need for greater efficiency (core or non-core activities)**
Social innovation • Client participation • Roles sets • New linkages • New sources of human energy	Traditional organisation	Service network performance analytics	Web 3.0
Technological innovation	Service network	Business process management	• Cloud computing • Service computing
Network effects	• Service eco-systems • Actor Network Theory	Service modelling techniques, e.g. social network analysis	Mobile technology
Reproduction innovation or scale advantage in management	Value co-creation systems	Service network management	• Service management • Risk Management • Performance Management • Decision support systems

Table 1 - Driving forces of service management systems (adapted from [12])

Table 1 above explores the internal and external forces which impact on the evolution of innovation across service management systems. As service networks continue to grow, understanding the dynamic exchange of resources which creates "service value", determined through specific relationships and interactivity between service systems and specific business processes is of significant importance. This is often overlooked as service networks are often perceived to be immeasurable. According to Hubbard [13] there are three different factors why people believe something cannot be measured (p. 19):

1. *Concept of measurement:* the definition of measurement itself is widely misunderstood. If one understands what it actually means, a lot more things become measurable.
2. *Object of measurement:* the thing being measured is not well defined. Sloppy and ambiguous language gets in the way of measurement.
3. *Methods of measurement:* many procedures of empirical observation are not well known if people become familiar with some of the basic methods, it would become apparent that many things thought to be immeasurable, may be measured.

In addition, Hubbard [13], lists three main reasons why measurement may be considered inappropriate, namely; economic (too expensive), usefulness and meaningfulness, and ethical objections. Within a service system, measurement of performance, i.e. performance analytics, plays a fundamental role to inform management to quantify activities and reduce uncertainty by mapping business process interaction and their influence on performance within the service environment. The 'uncertainty reduction' is critical in service environments as it also has greater 'value' in reducing risks in decision-making tasks. Consequently, this has sought the establishment of the discipline of service science, which is briefly discussed in the next section.

3. Defining Service Science

In 2002, Professor Henry Chesbrough of Berkeley's IBM Almaden Research Centre identified the need to research services from a social engineering perspective, and coined the concept of "*service science*". The "*science*" within services has emerged from the amalgamation of engineering and management disciplines. There is no clear definition of what constitutes as service science, as it is in its infancy while its context often changes when applied to various research fields or industrial sectors. However, Spohrer et al., [5] offer a definition of 'science' as, "*the agreed upon methods and standards of rigor used by a community to develop a body of knowledge that accounts for observable classes of phenomenon in the world with conceptual frameworks, theories, models, and laws, that can be both empirically tested and applied to benefit society*" (p. 1). As service science undergoes numerous theoretical developments and evolves across several research fields (for example, management, supply chain, computing, human resource management, contracting economics, operations, marketing, engineering, innovation, and social science) it is premature to expect that we can pin down service science precise meaning. However, Spohrer et al., [5] identifies four key observations about these disciplines:

1. The disciplines are ***heavily resource dependent*** (people, information systems, interaction of organisations). There is a need to understand the efficient application and configuration of resources to create value.
2. Disciplines often tend to ***integrate or coordinate resources*** to meet an organisational goal.
3. ***Measuring performance*** is very important and criteria to measure may vary according to each discipline.
4. Many of these disciplines ***incorporate the word "service"***, e.g. service engineering, service management, service innovation, and service supply chain. This is due to the transformation in society with the view of value in goods and value in service exchanges.

Service science seeks to develop a knowledge-base from several research areas including service innovation, operations and performance, business process management, and information or service technology. This is increasingly more obvious, as we develop the concept of the '*service network*' with a view to understand performance analytics. Therefore defining service science is largely influenced by the context in which it is applied. Broadly speaking, services science may be described as a discipline which sets out to develop methods to extend the availability and accessibility of business processes across service systems while developing methods to evaluate service performance through a scientific lens. It is also concerned with improving manager's ability to predict risk, estimate their effects, and reduce uncertainty through modelling the value-exchange which results from provider and client interaction during intellectual, behavioural, economic, and/or social activities. Services are normally characterised by a number of key factors, including:

1. Intangible
2. Differentiation or 'uniqueness'
3. Non-transfer of ownership rights
4. Difficult to access before initiating a service agreement, and
5. Production and consumption occur simultaneously.

The notion that within a service, it is difficult to access its contribution towards a business's performance must be addressed within service science. The service sector has come to the forefront of the developed economies to add increased value and accessibility within several sectors (private and public). In many cases services have ignited a change within international industrial structures and indeed within business. For example, Abe [14] suggests that if compared to the manufacturing industry, productivity in the service sector is low and requires vast improvements which affect the process of accessing service network value. We have witnessed several trends in innovation across service industries. These are summarised in table 2 as follows:

Transfer of manpower and product	→	Transfer of: • Customer-orientated systems • Knowledge • Management
Innovation in 'products' and 'service packages'	→	Innovation in delivery systems and distribution: • Reproduction ('McDonaldisation') • Packaging of knowledge
The dominating 'product'	→	The active, dominating customer (tools for self-help)
Technical innovation	→	Social innovation and 'hi-tech'-'hi-touch' (organising behaviour and social interaction).
Network innovation	→	Combines the transfer of skills, competence, technology, and innovation to deliver a service.

Table 2 Trends in innovation of service industries (adapted from [12])

Although table 2 above highlights some of the emerging trends across the service sector with particular attention towards 'network innovation', the literature indicates that service science practitioners have fragmented understandings of what constitutes as service science, how are services managed, and how can managers exploit service capabilities. This is often based on practitioners experience and an attempt to scientifically document their experiences, such as assessing risk, or measuring the level of productivity. Nowadays, technology is often referred to as the backbone to many of the service providers. In addition, the Internet has fuelled the expansion of a plethora of services and service networks, for example, service clouds. The number of services and variety of services continue to increase and so too will their complex environments. In fact, services are now the dominant contributor to the developed economies. As a result, the business landscape has significantly changed, i.e. a shift from a goods-dominant logic towards a service-dominant logic ([11]; [7]). It is evident that a scientific understanding of modern services is under-developed and may even be described as an unexplored topic which sought the introduction of "*service science*", although it is an attempt to "*study the application of the resources of one or more systems for the benefit of another system in economic exchange*" [5] (p. 2). One of the fundamental objectives of service science is to understand the mechanics of service networks and define how and why they generate value. One of the core problems in understanding the dynamics and complexity of service science: "*powerful dynamics are in play around the world when it comes to applying resources effectively to solve problems and create value*" [5] (p. 10). Value (for example, economic, social, and interaction exchange) is the core of service sustainability. Across large service networks, reorganising, consulting, and exchanging on business processes is becoming increasingly more important within service science. Therefore, understanding the complexity of network structures, process patterns, and methods to improve network performance is critical to the success of service eco-systems, for both the service provider and client.

Service science extends business functionality and attempts to optimally map business performance in vertical and horizontal business structures. Spohrer et al., [5] identify five main criteria within a service (summarised in table 3 below):

Criteria	Explanation	
Resource	Must begin to understand the value of resources and how does service interaction behaviour influence value, i.e. what is gained and what is lost during interactions?	
Entity	The entity is the service system (or an actor; person, organisation, information and technology or the configuration of all four). One of the resources must be the operant resource. Informal interactions have not been recognised or measured within service science to anticipate problems that may arise in value co-creation value interactions. Much focus is on service design, propose, agree, and realise value within a service system. It must dynamically adapt the value proposition and change over time.	
Service	One or more entities must perform the application of competencies and one or more entities must receive the benefit. Must understand what resources are transmitted over certain time and space which interact and co-create value. All entities judge value from a unique frame-of-reference and context. What happens when things go wrong?	
Interaction	**Value Outcome**	Interactions generate an outcome. Value is determines whether it has been added or destroyed through unique frames of reference. Desired outcome is a win-win co-creation value. There are four main outcomes from interaction: 1. Win-win value co-creation 2. Lose-lose value co-destruction 3. One entity judges that value is created 4. One entity judges that value is destroyed Assessment of value depends on the frame of reference of the service system which may judge on historical performance as well as expectations (goals), quality, satisfaction of customer experience, improved value, and agility.
	Value Proposition	Designing value propositions and realising the potential in interaction is what service systems must embrace in order to exist. The design of a successful value proposition requires knowledge of: 1. The provider's capabilities and needs 2. The customers' capabilities and needs 3. The competitions capabilities and needs 4. What authority (legal system) will allow Failing to understand any one of these factors can destroy value opportunities within the system. The ISPAR Model (Interact-Serve-Propose-Agree-Realise) allows us to view the world as populations of interacting systems of different types (people, business, etc). Interaction patterns can also reveal the value of participation.
Success criteria	An important question for a service system is to anticipate what constitutes success? Success requires both relevance and rigor. Calling for a rigorous theory of service systems to explore how entities interact, how they persist, what value they co-create will require integrating theories. Literature indicates that there is a significant opportunity in integrative system thinking in service science. We explore this in the context of key performance indicators (KPIs)	

Table 3 - Main Criteria within a Service (adapted from [5])

As identified above, service science plays a central role in supporting our quest to learn how service network and service exchange influence service performance. Interestingly, the evolution of business process management over the last decade provides an overlap on the need to gain a greater insight on business processes.

4. Exploring and Refining Business Processes

Although the service sector is considered the primary contributor to the global economy, there are minimal research efforts to introduce methods which examine service network performance analytics. This is particularly true within the field of information systems (IS). In addition, service quality management efforts have been limited within BPM and service science, and one of the reoccurring arguments for this is that *service processes are unseen, intangible, and even immeasurable* [15]. As a result, performance analytics is often overlooked and this mindset towards services allows managers to become rather presumptuous especially within the service eco-systems. This section briefly examines what is implied by a business process, and in doing so, this study sets out to fragment the business process into measurable factors which impact on service performance (which is discussed later). Hubbard [13], describes this process as a 'clarification chain' which is '*a series of short connections that should bring us from thinking of something as an intangible to thinking of it as tangible*' (p. 26):

1. If it matters at all, it is detectable/observable
2. If it is detectable, it is detected as an amount (or range of possible amounts)
3. If it can be detected as a range of possible amounts, it can be measured.

The overall objective of evaluating the implementation of a business process within a service network is an attempt to improve business or service functionality. Thus, we must understand the various dimensions of the business process (for example, structural, behavioural, compositional, and functional) and its contribution towards service performance. The term, 'business process', has been well documented across literature in the hope to shape and reshape a more universally accepted meaning of the term. For example, Davenport [16], defines a business process as *"...a structured, measured set of activities designed to produce a specific output for a particular customer of market*" (p.5). In addition, Hammer and Champy [17] defines a business process as a: *"…collection of activities that takes one or more kinds of input and creates an output that is of value to the customer*" (p.35). In more recent years, Smith and Fingar [18] define a business process as, "…*the complete, end-to-end, dynamically coordinated set of collaborative and transactional activities that deliver value to customers*". Smith and Fingar [18] also dissect their definition, and extract the key characteristics of business processes. They specify eight characteristics of business process as follows:

1. ***Large and complex:*** involving the end-to-end flow of materials, information and business commitments.
2. ***Dynamic:*** responding to demands from customers and to changing market conditions.
3. ***Widely distributed and customised across boundaries:*** within and between organisations, often spanning multiple applications on disparate technology platforms.
4. ***Long-running:*** a single instance of a process such as "order to cash" or "develop product" may run for months or even years.
5. ***Automated:*** at least in part. Routine or mundane activities are performed by computers whenever possible, for the sake of speed and reliability.
6. ***Both "business" and "technical" in nature:*** IT processes are a subset of business processes and provide support to larger processes involving both people and machines.

7. ***Dependent on and supportive of the intelligence and judgment of humans:*** the tasks that are too unstructured for a computer or require personal interaction with customers are performed by people. The information flowing through the automated systems can support people in solving problems and creating strategies to take advantage of market opportunities.
8. ***Difficult to make visible***: these processes are often undocumented and embedded in the organisation. Even if they are documented the definition is maintained independently of the systems that support them.

While this study explores business processes in a service network from a managerial perspective, the last characteristic is an interesting flaw within business process management (‘*difficult to make visible’*) in terms of process dynamics. If we can model and understand the behaviour of business processes, surely we can offer a method to management to visualise the business processes behaviour and what influence (enables or inhibits) service process performance. We can also approach this, as described by Latour [19], as concentrating “*on what is not directly visible in the situation but has made the situation what it is*” (p. 17). After all, Papazoglou [20] defines a business process as “*a set of logically related tasks performed to achieve a well defined business outcome*” (p. 49). In addition, Papazoglou [21] explains that a business process is designed to achieve a well-defined business outcome that determines the ‘results to be achieved, the context of the activities, the relationships between the activities, and the interactions’ with other processes and resources. Therefore, the behaviour exhibited within BPM can provide us with a critical insight as to what influences service performance. Understanding this, relates back to how Curtis et al., [22] once used the term ‘business process reengineering’, and defines it as ‘*the redesign of an organisation's business processes to make them more efficient*’. This is necessary considering the evolution of the “business transaction” to enrich the functional capabilities with the advent of BPM and Service Oriented Computing (SOC) which is a computing paradigm that utilises services as fundamental elements to support, rapid, low-cost development of distributed applications in heterogeneous environment [23]. The SOC paradigms gives rise to the Service Based Application (SBA) approach which is composed of distributed services in service networks. The rising of SBAs fosters new complexity relating to transactions and consequently, service eco-systems. SBAs transcend the organisational boundary, where services interact with multiple participants to accomplish transactions for end-to-end processes and these interactions underlie the transactional properties of services. In other words, transaction properties are the main drivers of the interactions between (or among) services or participants in networks of services. Thus, any erroneous or faulty transaction configuration (or modelling) underpinning the composition of SBAs may exacerbate the risk of degrading the overall performance of entire service networks no matter how well the other functionalities were configured. Additionally, the incomplete transaction configuration is similar to the traditional transactional approach because it does not add any advantage on the top of traditional approaches. The incompleteness refers missing essential business elements such as Quality of Service (QoS), KPI, and Business Protocol in transaction approach that supports transactionality of SBAs, all of which are determines by the execution of the ‘business process’.

5. The Problem with Analysing Service process Performance

In recent years, much emphasise has been on the need to examine business processes to enhance service efficiency. However, this notion of business process performance analytics in not entirely new, for example, back in 1993, Hammer and Champy [17] advises us to “*forget everything you have known about how business should work – most of it is wrong*”. Interestingly, the literature to date up to 2010 coincides that this is largely true as we are beginning to realise that we remain uncertain as to the contributory value of service network infrastructure and processes within and across organisations ([24]; [25]; [3]; [26]; [27]; [28]; [29]; [30]; [31]). In fact, Normann [11], challenges Porters goods-dominant 'value chain' and suggests that this is no longer relevant within the service-dominant world. Within the service-dominant environment, organisations are under increased pressure to adapt their business processes at a much faster pace than they have ever experienced before ([13]; [32]). Time and quality are two key factors in the deliverance of a service. Managers must be proactive and decisive to embrace change and meet consumer needs [4]. Thus, strategic management of service technology is essential to reduce the probability of failure, risk, and damaging service reputation ([4]; [33]) as well as the coordination of people within the service system. We will refer to these as 'actors' which are comprised of, for example, organisations, people, IS, and software, which is further explored later in this report. According to Weill et al., [4] investing in IT infrastructure is a major challenge for senior managers as many of them are often unprepared to make such decisions. In addition, understanding the value or influence in service performance of this infrastructure after huge investment often proves to be an even greater challenge ([4]; [34]). Assessing the value of the IT-enabled business processes is of critical importance as it reveals how an organisation is positioned within a much larger eco-service network. Managing business processes (for example, discovering, monitoring, changing or redesigning) are essential activities across distributed business applications. According to Brem and Voigt [33], many companies fail because they cannot manage these fundamental factors successfully. Thus, understanding the BPM lifecycle (see figure 1 below) is of critical importance to understand the ecology of service networks and the various tasks assigned to each cycle.

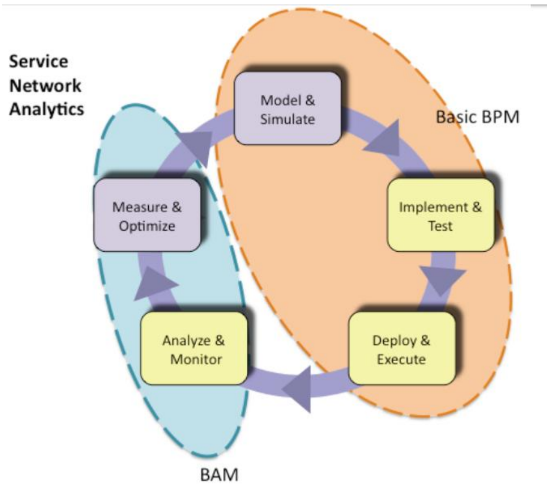


Figure 1 BPM Lifecycle ([95])

Figure 1 above depicts the BPM lifecycle; basic BPM view (model, simulate, implement and test, deploy and execute) and the need to analyse performance; business activity monitoring (BAM) and service network analytics (analyse, monitor, measure, and optimise). We encapsulate this lifecycle view to service networks.

A common objective of measurement, as described by Hubbard [13] is that "*the problem is unique and has never been measured before, and there simply is no method that would ever reveal its value*" (p. 27). Gathering data on the health of service performance across a large service network is of critical importance. Organisations must attempt to shape and exploit service data, information and knowledge if they want to strengthen their competitive position or form strategic service network alliance. One of the major problems, as outlined by Becker [36], is that managers are faced with a serious issue of how to manage "*a completely invisible asset*". Another problem highlighted by Cross and Parker [3], is that in the past managers have ignored the "*dynamic characteristics of networks and the ways that dynamic qualities of networks affect organisations' flexibility and change*" (pp. 133). This has unavoidably led to organisations failing to capture and understanding the 'health' of their service performance, positioning, structure and infrastructural workflows within business processes. Many technologies and business models are incapable of meeting dynamic requirements of today's business world, and appear to employ a continuous 'catch-up' approach, forcing organisations to compensate for technological inadequacies ([37]; [38]). The modern business model should present methods to calculate the value of organisational networks [11]. Another problem appears to include that although the business infrastructure (delivering a service) has changed over the last few decades (service-dominant), the fundamental logic ("back to basics") of running a business has remained quiet static (goods-dominant). Morabito et al., [39] advocates that it is now time to move from the 19th century organisational model towards a 21st century model. The organisational model has never drastically changed, although IS development continues to accelerate, influence, and alter organisational phenomena, in what is now a service-dominant environment. The literature indicates that we must begin to unwrap the underlying principles in dynamic business processes to learn how processes operate and become more efficient (for example, see, [40]; [41]; [42]; [43]; [44]; [45]; [46]; [47]; [48]; [49]). In addition, Camarinha-Matos and Afsarmanesh [50], draw our attention to the need to clearly understand related reference models before we attempt to capture organisational complexity through a new reference model. This is especially true within the service network.

6. The Service Network

This section explores the concept of the '*service network*'. To gain a better understanding of the service network, we must first explore what is meant by a service. Today's customer offerings, whether packed as physical 'products' or offered as 'services', 'software', 'portals', 'relationships', or in other shapes, all embedded in a 'brand' concept, tend to be designed to evoke and stimulate emotional, intellectual, and physical actions within the customer [11] (p.119). This is a generally accepted explanation of how services generate value within service literature. Within the IS discipline however, little research exists towards the exploration into the influence of technology in service design, delivery, and overall performance, i.e. the implications of relational structures on service performance, which suggest the need to revisit the modern concept of the 'service'. For example, back in 1977, Hill defines a service as: "*a change in the condition of a person, or a good belonging to some economic entity, brought about as a result the activity of some other economic entity, with the approval of the first person or economic entity*" [51]. Economics typically attributes 'transactional value' or market value to assets, but when applied to a service, it becomes more difficult to assign an individual economic actor [11]. A market handles these complexities and establishes the market value which is determined by the buyer and seller, mainly through interaction and the exchange of resources and/or competencies. What is of interest here is the transactional value of a service network. Transactional value may refer to satisfying transactional properties including performance constraints (e.g., key performance indicators), quality constraints (e.g., 'Quality of Service' guarantees), action constraints (e.g., 'notification'), and consistency (e.g., consistency of interaction states). This is critical within a service environment, considering a service involves multiple parties (at least two) and a service may be viewed as the networked behaviour to offer a specific capability from one party to another through a predefined protocol or service compositions (for example, a service level agreement). Defined by Jobber [52], a service can be defined as "*any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything. Its production may or may not be tied to a physical product*". This suggests that the emphasis has shifted from the change in condition to the performance of the actor. In fact, a physical product may be referred to as a representation, or an accumulation of past knowledge and activities [11] (p. 116). Here Normann shifts the focus to the relational value of delivering a service. In addition, Fitzsimmons and Fitzsimmons [53] offer a definition of a service as a "*...time-perishable, intangible experiences performed for a customer acting in the role of a co-producer*." Thus, service interaction plays a significant role in the evolution of service networks and presents us with greater insight on service performance.

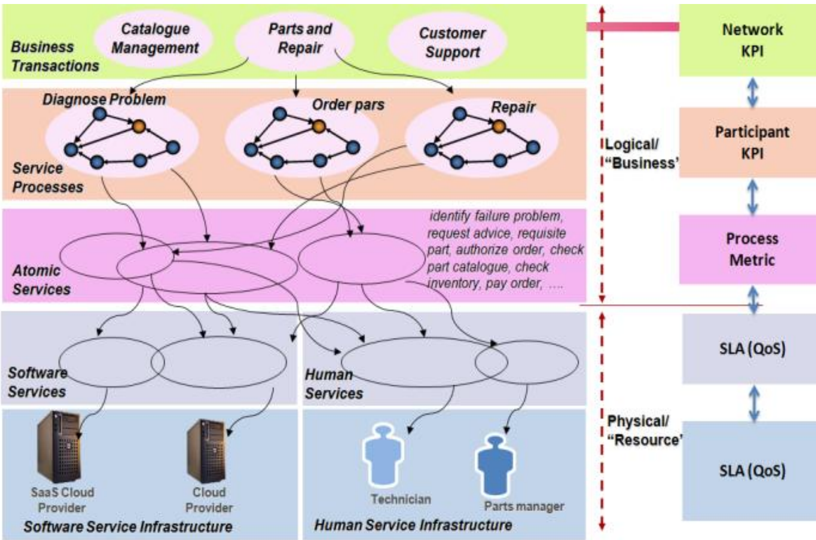


Figure 2 Service Network Anatomy [95]

Figure 2 above illustrates the five tiers which form the service network anatomy; the human and software infrastructure and the software and human services governed by service level agreements (SLA) and Quality of Service (QoS); the atomic services monitored controlled by process metrics; the service processes managed by participant metrics; and the business transactions managed by network KPIs and other techniques of service measurement.

Services are a fundamental factor in every organisation, for example, telecommunication, health care, education, retail, and finance, thereby extending the value of the 'business transaction'. In this sense, business transactions carry a code or a pattern which embodies specific performance analytic metric matches and allows us to monitor the dynamic behaviour. Figure 3 illustrates the dramatic shift in business logic from an assets dominant perspective to a reconfiguration of value-creating system. This is adapted from Normann [11] as figure 3 illustrates that significant shift towards a new strategic logic of the 'service networks'. Services extend business processes and business functionality within (cross-departmental) and outside (cross-organisational) of an organisational service network. The behaviour in which it exhibits (through the mapping and visualisation of actor exchange) indicates the value of business processes and the emergence of the service network begins. The emphasis here is on the relational structure which exists between service processes and business transactions. Bearing in mind that a service is often referred to as "*protocols plus behaviour*" [54], a service network may be defined here as a collection of actors (people, groups, organisations, information systems, etc) who exchange resources and competencies, governed by business protocol (including behavioural protocol) via collaborative relational structures. To emphasis the behavioural factor, Normann [11], considers services as "*activities (including the use of hard products) that make new relationships and new configurations of elements possible*" (p. 114). Service activities include co-generated exchanges of largely intangible assets, collective coordination, orchestration, and integration of knowledge under negotiated conditions which are transacted between the service provider and client. The complexity of the service system or on-demand business architecture (i.e. within IBM) is often misunderstood which requires the introduction of new theoretical developments. Therefore, managers must begin to view services through a scientific lens to construct reusable and standardised modelling methods to evaluate and govern service networks. The main emphasis here is the competence to organise value creation as it extends beyond the traditional boundaries and transactions are dispersed across a web of interrelated service networks. This is largely due to the affordance of technology and the virtual organisational infrastructures (for example, cloud computing). Normann [11] coins the paradigm "reconfiguration of value-creating systems", although we extend this to incorporate "business transactional networks" to highlight the shift of focus on the customer now placing more importance on the relational structures and business transactional properties which exist within service ecosystems. The importance of this is further highlighted in the emerging discipline of service science. However, the concept of business transactions within service science is overlooked. We identify the need to bring business transactions into a service network context (figure 3).

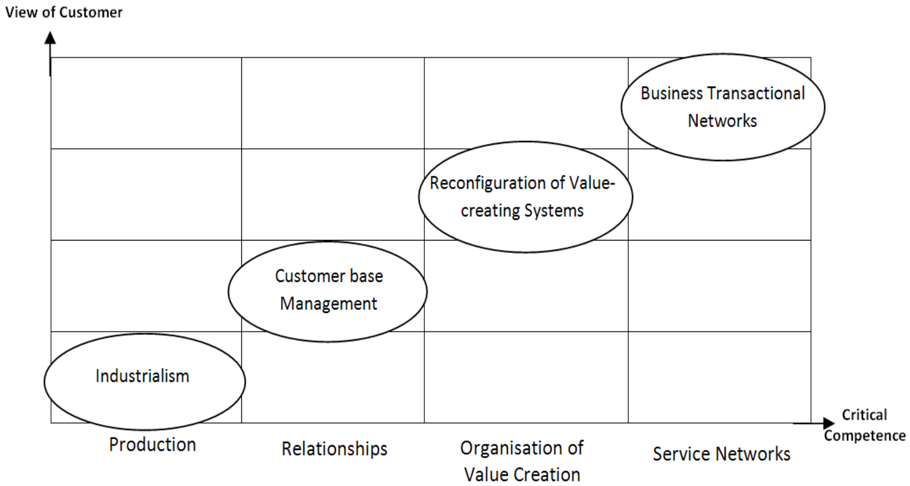


Figure 3. Evolution of Strategic Paradigms (adapted from [3])

Our traditional understandings of the 'organisation', with solid boundaries and internally focused on operations, time, and individuality are becoming less apparent today. As competitive advantages of single organisational strategies continue to erode over recent years, organisations are experiencing greater demands to operate with increased innovation, collaboration, scalability, efficiency, agility, and virtuality ([55]; [39]; [56]; [57]; [58]; [59]; [9]; [60]; [61]; [13]; [62]; [63]; [64]). Therefore, this study defines a service network as 'a complex sets of social and technical interactions which exchange resources and competencies to create economic or social value'.

Over the past few years business practices have changed dramatically for several reasons including; globalisation, world financial crisis, accessibility of a global educated and mobile workforce, technological advances ('death of distance'), and global outsourcing. Understanding how these influences have distorted our understanding of business plays a significant part on how we interpret service networks. Many of these changes require that we view business with a new mindset to understand the interactions of global and electronic infrastructure which supports service operations. Transparency within service operations is envisioned as a critical factor within service innovation [10]. In the next section, we briefly discuss the application of actor network theory (ANT) as a suitable theory to understand the dynamics of service networks and consequently, service network performance analytics.

7. Adopting Actor Network Theory

We live in a complex socio-technical environment, governed by the embedded interactions of several complex multi-actor systems and often result by influence of external entities, for example, groups, organisations, institutions, nations, and societies. Nowadays, centralised hierarchical organisational structures are becoming less apparent. Network-based constructs are reported to generate more 'openness' and are subject to frequent change within the organisational system structure. Such openness and agility within modern organisational structures promote flat hierarchies and more flexible structures [9], which are fundamental characteristics of the modern organisational architecture [3]. However, as organisations are beginning to move away from the traditional corporate hub of business practice towards a more diffused and distributed web of relationships and agile alliances, it is becoming increasingly more difficult to manage and monitor service systems delivery. There is a growing body of evidence which supports that actor network theory (ANT) allows us to gain a greater understanding of networks within IS and consequently we can explore ANT in the service science discipline. ANT is traced back in sociological theory, developed by Bruno Latour, Michel Callon and John Law in the early 1980s. ANT can provide a deeper understanding about 'how' and 'why' processes of 'technological innovation and scientific knowledge-creation' operate and is not concerned with the network per se, but rather the infrastructure which supports the network's evolution [65]. It examines the performance of network relations and explores the influence of objects towards those relations [1] (p. 7). ANT research examines socio-technical influences and relational effects of actor (i.e. human and non-human) interaction within networks which support, for example, people, organisations, and technology. Law [1] describes how ANT "*is a ruthless application in semiotics. It tells that entities take their form and acquire their attributes as a result of their relations with other entities*," (p. 3). For example, one of the main factors explored by Law [1], is the *translation*, which he describes as 'making two things that are not the same, equivalent', although it cannot inform you on how this links is formed (p. 8). In IS literature, this is often referred to as *integration*, especially when we are concerned with the homogeneity of systems integration within service eco-systems. Therefore, we can interpret translation as service integration, i.e., translated into more general and unified service solutions. This is an interesting notion when we examine the alignment of IT with business or service strategy when there is often the presumption of IT supporting service networks or service integration and ANT lends itself nicely to the exploration of doing so. Therefore, service actors (organisations, people, IS) may be viewed as representations of a networked effort to deliver a service, while unfolding the meaning (or value) of influential service actors. ANT may be adopted as a research method for a soft case study approach to examine the trajectories of service networks (for example, [66]) and service actor interaction. The effects of such interactions are of significant interest when we examine service network interaction performance or outcomes. Law [1] refers to these interactions as *relational materiality* and *performativity* which examines the "*consequence of the relations in which they are located*" (p. 4). Thus, ANT provides an alternative view from management literature of service management with the aim to understand how service systems and business strategies evolve and align from a socio-technical perspective. ANT presents a lens or a framework which provides a detailed description of the underlying mechanics and its infrastructure which support dynamic networks and the unbiased viewpoint of the network actors [65]. ANT supports a scientific view of business activities is not necessarily different from many social activities performed by actors which form as networks and often linked to other networks. This approach also supports the emergence of service science. However, the core principle upon which ANT hinges is the notion of a *"heterogeneous network which facilitates different but inseparable socio-technical elements"* [65].

ANT is concerned with a bottom-up concept of alignment and strategy formation while alignment is more concerned with a top-down view on planning and decision-making processes [65]. Understanding the value of service network relationships, especially from a service perspective can prove to be extremely beneficial. In this sense, value may be referred to as "the adaptability and survivability of the beneficiary system" [7] (p.148) by creating "opportunities for reinvestment and cross-subsidisation of activities that may potentially benefit people not involved in the original transaction" [67] (p.53). A major consequence of ignoring service analytics is that managers cannot determine the value of the overall service eco-system or *"...capture the adaptive and evolutionary characteristics of a value network ...* [and] *the nesting of supply chains with larger and more encompassing value networks*" [68]. Gathering information on customer interaction with a service provider supports managers with rich insights as to how a service network is performing to meet customer needs and how service infrastructure supports service demands. This approach is necessary as we explore key performance indicators (KPI) strategies.

ANT provides an analytical framework and explores the mechanics of network evolution, for example, power: the formation, stabilisation, and reproduction of interactions, the construction and maintenance of network structures, and the establishment of control. Power is viewed as being generated in a relational and distributed manner. Within ANT, the process of translation is also interesting regarding its application to service level agreements (SLA), considering it is the process of establishing identities and the conditions of interaction, which characterise their representations. In this sense, translation may be described as a practice (i.e. making equivalent; service integration) and an outcome (realised effects; service reconfiguration). Therefore ANT provides a theoretical platform upon which we can begin to analyse the implications of service relational structures on performance analytics to establish clearer of facts, effects, beliefs or technological solutions within service networks and learn how IT enables and inhibits service performance. The importance of adopting this theoretical approach to value service networks (i.e. performance analytics) is further discussed in the next section.

8. Value of Service Networks & Challenges

Understanding the value of service network relationships, especially from a service perspective can prove to be very difficult although extremely beneficial. In this sense, value may be referred to as "*the adaptability and survivability of the beneficiary system*" [7] (p.148) by creating "*opportunities for reinvestment and cross-subsidisation of activities that may potentially benefit people not involved in the original transaction*" [67] (p.53). Service value refers to the relational exchanges and examines how network interaction generates a value to satisfy a service client's need (i.e. value exchange). Thus, the value of a service network is "a spontaneously sensing and responding spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting through institutions and technology, to: (1) co-produce service offerings, (2) exchange service offerings, and (3) co-create value" [68]. Within service systems there is a large element of barter (method of collaboration and exchange) involved in the transactions and it is often difficult to examine the 'complementary resources' which are exchanged within a service system, for example, information resources. In addition, the literature indicates that the tools to create, track, and manage outsourcing business process opportunities are incompatible, slow, and difficult to use ([69]; [35]). To exasperate this, it is also reported throughout literature that critical business data is incorrectly collected, shared, standardised, or analysed to provide business intelligence ([69]; [35]). This study suggests that one solution towards modelling service performance analytics is to examine the relational structures to support service networks. Despite the volume of research which concentrates on complex business applications and modelling processes there are no research efforts to explore the implications of relational structures on service network performance. In addition, Camarinha-Matos [70], report that based on an analysis of past modelling efforts there appears to be a significant lack of understanding among practitioners and researchers on the "*comprehensive spectrum of suitable modelling processes, tools, and methodologies*" (p. 4). Technology is considered an essential factor towards the virtualisation and success of service networks. However, as we promote the need for IT infrastructure across service networks, we know relatively little regarding the influence of IT on service performance and strategic advantage. This is emphasised in Carr's [34] infamous book on, "Does IT Matter? Information Technology and the Corrosion of Competitive Advantage." He reports that although IT has been widely adopted by business, there is still know little known about what influence IT has on service performance and competitiveness. Organisational processes and indeed their structures have become less transparent with the emergence of service systems. To emphasise the importance of modelling service network structures, Papazoglou et al., [71] states that there is a need to understand business processes and organisational structures, with the aim to identify organisations '*pain points'* and identify potential solutions that can be applied to correct them. Within a new service network business model, many of these pain points exist as Cross and Parker [3], explain that little attention has been paid to access the effectiveness of strategic partnerships of strategic developments or to the value of their networked relationships. Thus the relational structure of service networks shared amongst organisations to support business operations may prove to be the key to modelling service networks and their performance. We identify the need to visualise and understand the relational contributions of service structures to further enhance decision making tasks while restructuring service network business processes. A major consequence of being unable to model service performance is that managers cannot determine the structure and value of the overall service eco-system or *"…capture the adaptive and evolutionary characteristics of a value network …* [and] *the nesting of supply chains with larger and more encompassing value networks*" [68]. We posit that understanding the implications of relational structures and service behaviour allow us to develop the service network paradigm and in particular, in service network performance analytics.

9. Performance Analytics

A service network is a complex system which relies on the harmonisation of numerous actors. Service performance is often influenced by external entities causing structural variability across a service eco-system which impacts of the networks characteristics and ultimately, its performance. Therefore, it is critical that service managers gain a thorough understanding of what influences service performance for two main reasons; firstly to enhance service management decision-making tasks (service management), and secondly, to feed this information into service requirements engineering (service computing). While this study will later discuss performance using key performance indicators (KPIs), we will also focus on network analysis considering there are five other main exploratory analytical methods to examine performance; relational (interaction), attribute (properties of vertices and edges), position, structure, and dynamics analysis. However, before we attempt to measure service network though performance analytics, we are reminded of Hubbard's [13] advice to first question how and what gets measured as it has some conceivable effect on decisions and behaviour (p. 43):

1. What is the decision this is supposed to support?
2. What really is the thing being measured?
3. Why does this thing matter to the decision being asked?
4. What do you know about it now?
5. What is the value to measuring it further?

As the questions listed above allude to, managers must rethink (design, innovate, deliver, and support) new strategies and possible structures to transcend their competencies which impacts on performance across service networks [54]. This includes technology, network topology, human behaviour, business strategy, service design, and economics [72]. More specifically, managers must pay close attention to how service management is conceptualised (capabilities, structures, and processes) and how behaviour is orchestrated to interact and innovate service development [72]. Table 4 below, provides a holistic view of the interchange between 'soft' and 'hard' views of the service system.

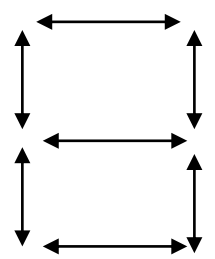
	"Soft" **"Hard"**
Service Package (core and peripherals)	
Interaction and the delivery process	
Whole system (image, culture, 'the club')	

Table 4 Socio-technical view of service networks (adapted from [12])

Service interaction is a functional process as competencies are typically exchanged between actors. Actors can refer to a 'soft' and 'hard' socio-technical view of service systems (as identified by adopting ANT). Applying this business logic the service actors and service competencies draws our attention towards the relationship or tie which determines the exchange patterns within a service network. Therefore, service (actor) interaction patterns should be possible to model and provide insight on how specific actor relations enable or inhibit service business processes. We can also categorise the type of relationship within performance analytics and KPIs. It can also provide greater insight within the service exchange process and the 'value' of the exchange, for example, information and financial data. If managers fail to report on the influence that each independent level plays on other levels, they may be applying incorrect performance measures. For example, there are three main types of performance measures (table 5 and figure 3):

Performance Measure	Explanation	Examples
Key Result Indicators (KRIs)	<u>*Examine*</u> the past to determine how a service has performed, for example, sales last month.	• Customer satisfaction • Net profit before tax • Profitability of customers • Employee satisfaction • Return on capital employed
Performance indicators (PIs)	<u>*Inform*</u> what you ought to do to enhance service.	• Profitability of the top 10% of customers • Net profit on key product lines • Percentage increase in sales with top 10% of customers • Number of employee participating in the suggestions scheme
Key Performance Indicators (KPIs)	<u>*Prescribes*</u> what you ought to do to increase service performance.	• Utilisation of assets, optimisation of working capital • Increase customer satisfaction, targeting customers who generate the most income • Deliver in full on time, optimising technology, effective relationships with key stakeholders Empowerment, increased expertise and adaptability

Table 5 Main Types of Performance Measures (adapted from [73])

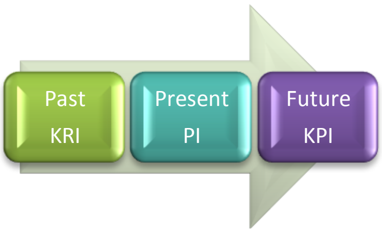


Figure 3 Performance Measures and Time

As summarised in table 5 above, and illustrated in figure 2 above, performance indicators (KRIs, PIs, and KPIs) analyse how key activities influence service performance and adopt certain views of performance (i.e. past, present, and future respectively). Service delivery systems also distinguish five main factors which are invariably influenced by the physical setting of technical tools to deliver a service [12] (p. 98): cost rationalisation, quality enhancement, beneficial customer linkages, behavioural implications, and technology adaption. These tend to blend or overlap in most cases in the deliverance of a service, making it more complex to analyse. The affordance of service oriented applications also places questions as to the effects technology has on service behaviour, an area often disregarded, as technology can fulfil a key function creating the desired human behaviour; but concerns emerge about how it may be managed. Technology affects many if not all the other components in the service [12]. Since services involve social actions, technology must be accompanied by other changes in the service management system.

Services which have implemented performance management models (for example, IT Service Management – ITSM[1]) are not supported through a well defined or benchmarked strategy as each

[1] ITSM: http://www.itsm.info/ITSM.htm

management strategy has its benefits and challenges. In alignment with performance analytics, the Information Technology Infrastructure Library (ITIL[2]) has suggested to answer four important questions. It is evident that these questions relate directly back to critical success factors (CSFs), key Results Indicators (KRI), Performance Indicators (PI), and Key Performance Indicators (KPIs). The first question is "*where do you want to be?*" This suggests that organisation must be committed to service transformation and cooperated to meet the business objectives, mission, and vision. The second question, "*where are we now?*" may be a difficult question to answer but managers must identify where changes are needed, for example, people, process, practice, technology/technical infrastructure, and data (i.e. metrics) to steer the service towards the service vision. The third question asks, "*how do we get to where we want to be?"* which requires a more detailed plan including a top-down (process-orientated technical infrastructure) and bottom-up (influence the development of processes) of a service system (see figure 4).

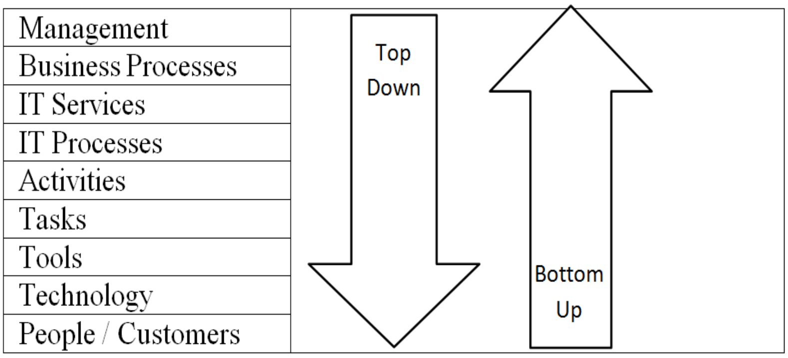


Figure 4 Approaches to Performance Analytics

The top-down approach is mainly preferred by large organisations and is characterised by defined processes and by the design and creation of a technical infrastructure to support the processes. The bottom-up approach is typically preferred by small service networks and is driven by the advantages of using current tools to assist in defining the required processes. A quick return on investment is considered important and deploys a process-supported infrastructure. The fourth and final question is "*how do we know when we have arrived*?" This is a critical question as it determines the success criteria (a major factor within service science). Therefore, it is paramount that management focus on a number of performance metrics. Regardless of the criteria for success, it should have some direct or inferred business value and reflect a continually supportive role in service networks units.

Although often considered problematic, gathering data on the health (e.g. structural, positional, communication, functional, relational, decision, interactional, and behavioural) of a networks performance is very important [74]. This report will further explore the development of KPI for each of these categories and develop a framework upon which to evaluate service performance analytics. Organisations must attempt to shape and exploit service data if they want to strengthen their competitive position and knowledge to enhance their performance ([11]; [31]). One of the major problems, as outlined by Becker [36], is that managers are faced with a serious issue of how to manage "a completely invisible asset". These invisible assets may be referred to as intangible assets which are often difficult to model and consequently, often unaccounted for. Performance analytics plays an important role in service networks as customers are afforded smarter choices through the availability of technology allowing them to compare services. Turning performance

[2] ITIL: http://www.itsm.info/ITIL.htm

data into information allows customers to make informed choices on service value and reputation. The reverse is also true. Gathering information on customer interaction with a service provider provides managers with rich insights as to how a service network is performing to meet customer needs, how service infrastructure supports service demands, and emerging service markets. This allows mangers to make faster and more informed decisions (by reducing uncertainty) on network strategies and enable them to model service interaction and exchange patterns and open opportunities of network alliances and creating 'smart service' systems. This is also evident with the need to adopt a key performance indicators (KPI) strategy.

10. Key Performance Indicators

"*What gets measured gets managed*" – Peter Drucker

Service networks require an innovative smart service system to advance their business to compete in this increasingly complex and dynamic markets with emphasis on the business domain and technical domain. Understanding the complexity of network structures, process patterns, and methods to improve network performance is critical to the success of service eco-systems, for both the service provider and client, especially within a smart service network. Key performance indicators (KPIs) are quantifiable measures of an organisations progress to meet specific goals. KPIs also assist managers in decision making to determine the right course of action. When we incorporate network science approaches, the level of dimensional support across the process structures is expressed in several forms including, structural, functional, compositional, and behavioural. Often these dimensions are taken for granted and overlooked although this information provides both tangible and intangible metrics on service network performance. Sifting through departmental and cross-organisational conflicting objectives clutters manager's ability to extract key performance information [63]. There are several reasons why service metrics often fail, for example, service networks may use incorrect metrics which do not measure the business value of the network. Incorrect metrics may also mean that the performance findings are not actionable as probing for a complete analysis of the network is more difficult to collect data. In other cases, managers may set poor performance targets and fail to implement incentives or penalties to enhance the service performance. Another reason may include the over emphasis on service cost over business benefits. Within a service environment, SLA often governs the level of performance and quality of service which may provide us with more insight on what KPIs supports the service processes. Figure 5 below illustrates how manages might attempt to introduce a KPI strategy in an organisation.

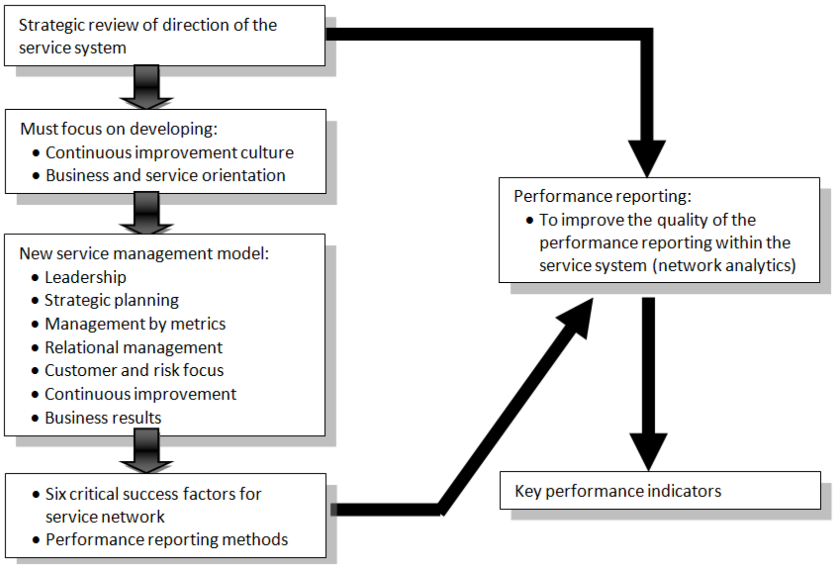


Figure 5 Introducing Key Performance Indicators (adapted from [73])

As figure 5 above illustrates, introducing KPIs requires a carefully planned strategy; a strategic vision, continuously improving business and service orientation, adopting a new business model, identifying critical success factors, reporting performance, and evaluating how whether performance meets the predetermined KPIs. Many services are exceedingly complex phenomena which can be conceptualised in several different ways [12]. Taking a qualitative perspective and trying to really understand primarily what relational structures mean in service network, how they evolve, and then try and address and look at how they change with the impact of IT and service performance from a quantitative perspective. The relationships which exist between these services can determine the service innovation and operations efficiencies across networks. This will also allow us to identify the critical success factors (CSFs) which enable (KPI) or inhibit business processes. Papazoglou [20], draws our attention to the focus of the current practice of business transactions, and the lack of insight into the behaviour or the relationships of transactions between trading partners which can enhance their business value when transaction functions are combined. Sifting through departmental and cross-organisational conflicting objectives clutters manager's ability to extract key performance information [63]. Freeing up resources to develop value-added information is critical to managerial activities (e.g. rapid decision making and execution). To address these issues we must uniquely define the business KPIs. KPIs allow us to measure the success of goal achievement and to generate insight to discover how service performance and value may be enhanced. Characteristically, service network KPIs should be simple for decision making, relevant to unique (service-dominant) business models, present timely results, useful, and instant for actionable insights. Here, one is reminded of services seeking the right balance or requisite variety between 'use, usage, and usability' [75] of their resources and processes through service-oriented approaches. In addition, Parmenter, [73] identifies seven key characteristics of KPIs:

1 Nonfinancial measures (not expressed in currency)
2 Measured frequently (e.g. daily, or 24/7)
3 Acted on by the CEO and senior management team
4 Understanding of the measure and the corrective action required by all staff
5 Ties responsibility to the individual or team
6 Significant impact (e.g. effects most of the core CSFs and more than one balanced scorecard perspective)
7 Positive impact (e.g. affects all other performance measures in a positive way).

Determining service behaviour involves qualitative behaviour analysis (across many dimensions such as structural, functional, compositional, and behavioural; for example, see [50] (p. 11). In addition, Kaushik [76], reports that KPIs are quiet limited in what they can present to manager or analysts for strategic direction, i.e. they present what happened. This has led to the slowly emerging concept of Key Insights Analysis (KIA). The concept of KIAs will be further explored in regards to service analytics, i.e. how and why specific service behaviour on a network occurred but we incorporate it within the concept of KPIs and performance simulation. We also encapsulate this when we refer to the notion of 'performance analytics'. Figure 6 below, illustrates a model to apply a strategy to understanding service network performance analytics within a service environment.

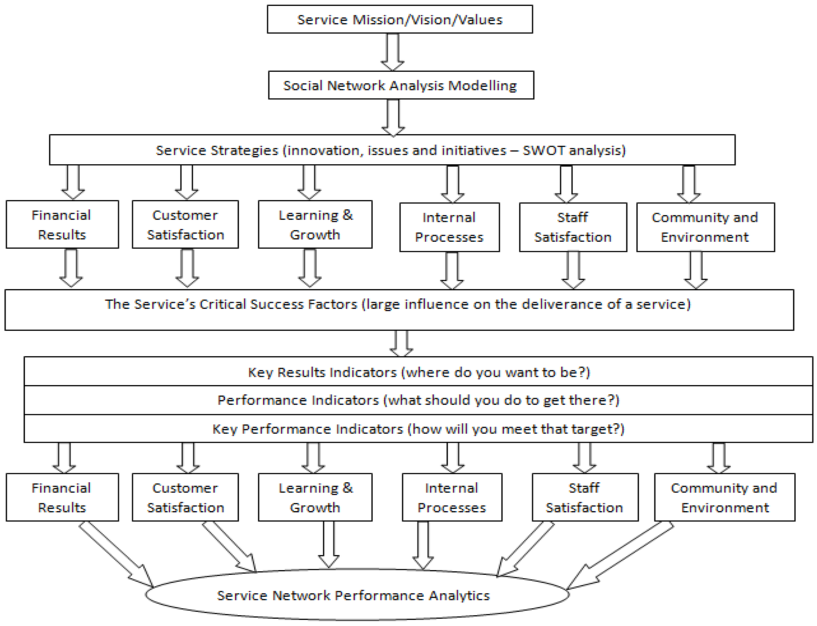


Figure 6 Understanding Service Network Performance Analytics (adapted from [73])

Within a service environment, it is paramount to begin the process of establishing performance measures by exploring the nature of the service mission, vision, and values. Considering services are typically unique in many ways, each service must determine their mission, vision, and values. A service mission may be a philosophical view and never be reached, for example, IBM adopts the following mission statement:

> At IBM, we strive to lead in the invention, development and manufacture of the industry's most advanced information technologies, including computer systems, software, storage systems and microelectronics. We translate these advanced technologies into value for our customers through our professional solutions, services and consulting businesses worldwide."

In addition, mangers must develop a vision (often an intangible or philosophical view) on what they must achieve in order to successfully meet their goals, for example, IBM adopts: "*solutions for a small planet*". Services must also devise strategies to achieve their visions. Within the service environment, managers need to identify areas to introduce service innovation, service initiatives, and identify issues which may present opportunities or threaten service sustainability. This may be achieved through a SWOT-like analysis (strength, weaknesses, opportunities, and threats) of the service environment while adopting the balanced scorecard critical success factors; financial results, customer satisfaction, learning and growth, internal processes, staff satisfaction, and community and environment. These may be adapted to suit a service environment and identify KPIs to examine service competencies, relations, and resource exchange.

Freeing up resources to develop value-added information is critical to managerial activities (e.g. rapid decision making and execution). To address this we must uniquely define the service KPIs which may be determined by modelling the implications of relational structures on service performance. The four key operational metric categories may be summarised as volume (what gets done), quality (compliance with requirements), responsiveness (timeliness to deliver a service), and efficiency (cost and effort to deliver a unit of service). Understanding the influence of relational structures allows us to explore, for example, number of vertices, number of edges, directed and undirected edges, positions, adjacent (in and out) vertices, degree, direction, and other metrics which will be borrowed from network science theory where applicable to service network performance. The KPIs will represent data structures which will be illustrated using a network graph or map to depict service performance. The graph will present us with an overview of the KPIs which allow us to examine the success of goal achievement and to generate insight of the implications of relational structures on performance within the service network. Network analysis allows us to explore questions such as, what is the optimal network performance. This research will explore this question a little further in this document (i.e. social network analysis section). While the study explores KPIs, Parmenter, [73] suggests that we need to ask the following key questions:

1. Who owns the metric?
2. Where will the data be acquired and how often?
3. How might the raw data be manipulated (normalised) to allow more equivalent comparison over time?
4. How often should the metrics be reported and analysed for decision making?

It is critical that managers attempt to evaluate the metrics for gaps, alignments and conflict across the service network, or perhaps the eco-service system. In addition, to successfully align the metrics, one must determine how metrics interrelate at various management levels, i.e. vertical alignment and horizontal alignment (positions in the value) contribute towards the service strategy. Parmenter, [73], provides an example of this and provides an outline of the tree format which makes it more comprehensive (table 6):

Exploring the interrelation of key performance indicators:

1. Percentage of loyal customers (cooperate level)
   - 1.1. Customer service satisfaction (cooperate level)
     - 1.1.1 On-time deliveries (operations level)
2. Service reliability (operations level)
   - 2.1. Maintenance done on-time (maintenance department level)
     - 2.1.1. Friendliness of service staff (operations level)
3. Training effectiveness(training level)

Table 6 Interrelation of KPIs at various levels

The interrelation of KPI’s plays a significant role in the process of evaluation. It is important that managers have a clear understanding of how processes impact of the overall service at various levels. Through the use of KPIs, organisations can gain continuous and insightful feedback on how business processes are actually being executed, and where "gaps" or "pain-points" may exist. This is important, as Bender-deMoll's [77] explains that organisations vary in many ways, and not only in their size and budget available, but also in "*how well connected they are, whom they work with, and how closely integrated they are with the groups they are aiding*" (p. 2). Many studies have reported the need to investigate the interaction between systems through the introduction of newly designed processes to improve service health. Reporting KPI is also an important task and directly impacts in the successful deployment of a service performance analytics strategy. Parmenter [73] provides a list of instructions when recording and reporting on performance measures. These are as follows:

1. Description and explanation of the performance measure and calculations
2. The type of performance measure (KRI, PI, KPI) and person responsible for them
3. System where data is sourced from or to be gathered
4. Refinements that may be required to produce "real-time" information
5. Which business scorecard (BSC) perspective(s) the performance measure impacts
6. Recommended display (type of graph)
7. Linkage of measures to CSFs
8. The required delegated authority that staff will need to have in order to take immediate remedial action

These may be recorder as outlined in table 7 below:

Name of performance measure	Calculation of measure	Type of PM	Person responsible	System where data is going to be gathered	BSC Perspective	Recommended display	Frequency of measurement; 24/7, weekly, monthly	Linkage to CSFs	Team xx	Suggested target	Required reliability/accuracy (± 5%, ±10%, ±20%)	Estimated time to gather information (15 mins, 1 hour, 1 day, >1 day)
Number of initiatives implemented from the quarterly rolling client survey	Number of initiatives implemented out if the total arising from survey	Performance Indicator	Staff Initials	Word	Customer Satisfaction	Number	Weekly	Retain Key Customers Increase repeat business	Y	All by 3 months post survey	±5%	5 mins
……….	……….											

Table 7 Service Network Performance Analytics (adapted from [73])

To build on this reporting format, the next section offers a discussion on the complementary application of SNA on modelling service analytics.

11. An Overview of Social Network Analysis

This section sets out to describe the suitability of social network analysis (SNA) as a technique which complements the research method of exploring the implications of service relational structures on service performance. In addition, this section discusses the need to describe a class of data to focus the research (i.e. performance analytics), which is considered essential to develop a formal way to define and characterise what will be observed and how it will be expressed [78] to view the world during data collection. SNA stems from the network science discipline. Lewis [79] defines network science as the study of the theoretical foundations of network structure/dynamic behaviour and its application to many subfields (such as SNA). In addition, to incorporate the dynamics of networks, we must avail of the information which informs us how the service interaction resulted in a specific outcome. Therefore it consists of both theory and application. Thus, we can define the structure of a system in terms of abstract mathematical objects called vertices (nodes) and edges (links). In addition, Lewis [79] suggests that the best way to describe a network is by what it does, i.e. "*the study of the structure of the collection of nodes and the links that represent something real*", and the "*study of dynamic behaviour of the aggregation of nodes and links*" (p. 6).

SNA is an approach and set of techniques which studies the exchange of resources and competencies (for example, information) among actors. SNA focuses on patterns of relations among nodes such as people, groups, organisations, or information systems ([80]; [81]; [82]; [83]). SNA also demonstrates the value of ties and relationships between each node to provide a visual and mathematical representation of interaction and exchanges which influence behaviour. Managers realise that the key to continued success is within their understanding of how workflows and business processes can be optimised (e.g. [84]). Balkundi and Kilduff [85], report that SNA may allow organisations, in financial trouble, to gain vital insights and discover survival prospects. Thus, additional focus should be placed on tailoring the business model and methods to guide and support the processes of monitoring and mapping KPIs across service networks (system, goals, and method patterns). Kawalek and Greenwood [86], describes an abstract model of an organisation, and how we can develop our understanding of value through the addition of three models when applied to a service network (which also relates back to KPIs):

1. ***A model of the system***: a high level, structural view of actor interactions (who and/or what interacts)
2. ***A model of goals***: having identified patterns of interaction in the model, how can we describe the interactions (why do they take place)
3. ***A model of methods***: having identified what interacts and why, a model is developed to determine why and how goals are achieved.

To add a fourth step to Kawalek and Greenwood [86] abstract model, from a service perspective, it would be extremely useful to implement a "*model of action*", i.e. a model which would allow us to explore strategic possibilities to simulate a "what-if" approach to understanding the influence of each relationship across business processes. A fifth model would include a "*model of evaluation*" which introduces service performance analytics (as depicted in figure 7 below):

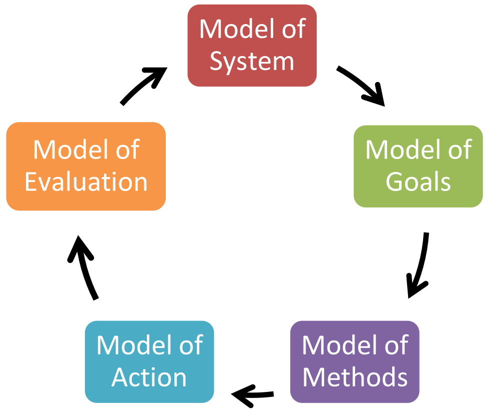


Figure 7 Abstract View of Service Network Analysis

Such an approach as illustrated in figure 7 above is necessary as Hassan [31], demonstrates that by studying IT-enabled processes, we can identify the contribution of IT to business process success, or improved performance. In addition, while adopting the SNA approach, Lundqvist [27] describes SNA as a method for detecting, describing, and analysing relationships. Another benefit of SNA is its ability to provide a methodology to gain deeper insight of how structural regularities influence behaviour [87]. SNA assumes that actors (i.e. services nodes) are interconnected, with real consequences for behaviour and performance. Structures may be altered to optimise the networks outcomes. Therefore, SNA is a very fitting methodology to deploy within this research to uncover more "truths" as to service activities, interaction, and exchange. In addition, SNA complements the worldview this research adopts using ANT for service networks.

There is a large body of literature which suggests that SNA can present us with a unique method to model and monitor the contributory value of network actors and infrastructure (for example, [88]; ; [80]; [81]; [82]; [83]; [89]; [74]; [31]). Managers have ignored the "*dynamic characteristics of networks and the ways that dynamic qualities of networks affect organisations' flexibility and change*" [3] (p. 133). This has unavoidably led to organisations failing to capture the 'health' of their service networks performance (for example, behavioural, functional, and structural) and the overall contributory value of service linkages (relational structures). SNA is an approach and set of techniques which studies the exchange of resources (including competencies) and behaviour among actors. It focuses on exchange patterns of relations among nodes such as people, groups, organisations, business processes, information systems or combinations thereof [78]. SNA also affords us the opportunity to model the relational ties between each node to simulate the service network behaviour to provide a visual and mathematical representation of interaction and exchanges which influence service performance. To understand the dynamic nature of services networks and its impact on service performance, it is critical to explore the underlying principles in service behaviour and analyses both how and why services perform in a specific manner. Spohrer et al., [5], posit that the success of service science will be achieved through the introduction of general theories of service interaction and co-creation of value. Service science is also an attempt to explore the value co-creation of interactions between service systems. As service networks continue to grow, understanding the dynamic resource exchange and the value of service relationships between service systems is of critical importance. As discussed earlier, a service is often referred to as "*protocols plus behaviour*" [5]. Failing to measure the mechanics behind the behaviour and 'value-exchange' of service networks (i.e. their relational structures) inhibits our capability to examine real business process performance and additional opportunities.

12. Applying Social Network Analysis to Service Networks

In recent years there has been significant interest in our ability to effectively and efficiently manage and (re)engineer services. It is clear throughout literature that manager's continue to face serious issues in managing 'a completely invisible asset' (i.e. service network) which inhibits their ability to monitor and exploit the value of service innovation. Services must gain continuous and insightful feedback on how business processes are actually being executed, and where 'gaps' or 'pain-points' may exist. This enables BPM to overcome three major problems:

1. The need to isolate and measure the impact of IT on service networks in order to plan and design how the technology should support the business process across service eco-systems [31].
2. The need to measure the success of IT-enabled BPM efforts as they are being implemented through KPIs [31].
3. Determine how service-orientated process patterns influence the configurability of service system networks (i.e. service evolution).

In addition, Cross and Parker [3] summarise the common SNA applications including, supporting partnership and alliances, assessing strategy execution, improving strategic decision in top leadership networks, integrating networks across core processes, promote innovation, ensuring integration post-merger or large scale change, and developing communities of practice. Thus, BPM can also benefit from the application of SNA in service modelling. More notable, SNA can support BPM to discover business process dynamic behaviour while identifying where strengths, weaknesses, opportunities, and/or threats lie across a service network and service eco-system using SNA metrics. Measuring business networks provide valuable insights on the operating status of a service network and determine whether change may be required, or provide knowledge where change may cause further problems through SNA simulation. Figure 8 below illustrates a simple example of a SNA map.

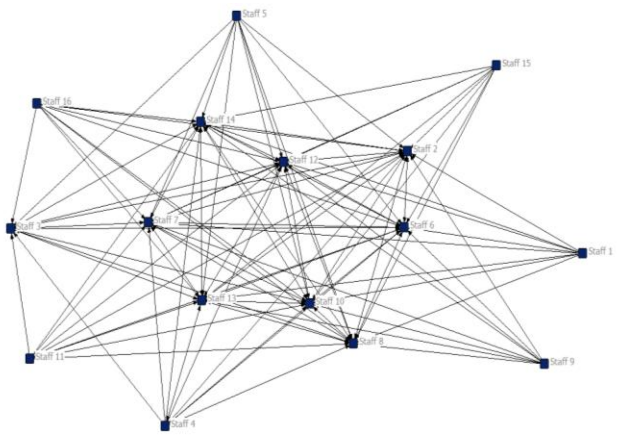


Figure 8 Example of SNA Map

Within SNA literature, there are a number of metrics which lend nicely towards service network analytics (see table 9). For example, the density of service network allows us to examine the ratio of service relations when compared to the maximum of possible relations [83]. The average relational distance within the whole network is calculated by determining the average shortest path between all vertices or actors. Depending on the nature of the service network, a short distance is best to transmit information accurately and timely, for example, customer service, financial, or medical networks. Cross and Parker [3], suggests that long relational structures generate slow and inaccurate information channels. Managers may also examine the degree of actors which explores the number of edges (links) which connect to a particular node. Business process modelling and the evaluation of various scenarios for service improvement are the main driving factors of restructuring business processes. SNA allows us to graphically capture organisational interaction, and can provide us with an insight into how people's understandings of business process through service interactions. Thus, SNA provides an excellent methodology to offer managers a more simplified, practical, and reusable framework. Figure 9 below, illustrates how SNA complements service performance analytics and supports the development of service science (service management and service computing) while under the guidance of ANT as a foundation for this research.

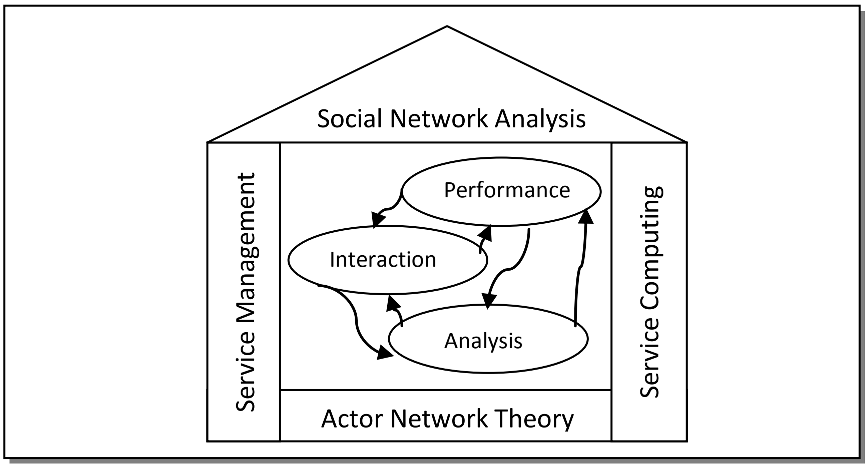


Figure 9 Service Network Performance Analysis Approach

As illustrated above, SNA presents us with a technique which allows us to monitor service behaviour (performance, interaction, and analysis). SNA also presents the opportunity to execute position analysis (for example, centrality to identify important actors involved in service relationships) at a micro (the service) and a macro (service eco-system) of a network and explore network characteristics. Both the direct and indirect service relations will be considered. Managers may analyse a service network to determine if a node/actor is a source or drain within the service. Other network measures may include network density, average distance, and average degree metrics. These metrics will be among the service relational structures measures reported in our undertaking of service network analytics. The term 'relational structure' may be used to describe a "*bundle of intuitive natural language ideas and concepts about the patterning*" [78] (p. 12) in service relations among organisations. Freeman et al., [78] add that a 'social network' is "*a collection of more or less precise analytic and methodologically concepts and procedures that facilitate the collection of data in a systematic study of such patterning*" (p.12). More notable, from this research's perspective, Stanley Milgram conjured up the notion of small-world network to understand how network topology influences behaviour. Thus, we can develop an understanding of a service network by describing its structure (nodes and links) and its behaviour (what the network does as a result of interactions among the nodes and links). This has an important application to the management, engineering, and design of service networks. Network analysis emphasises the relations which connect the node positions within a system, and "*offers a powerful brush for painting a systematic picture*" of a global structure and their interaction [90] (p. 173). Therefore the organisation of structural relations (emergent property of the connection and the exchange process) or attributes (intrinsic characteristics, e.g. value of an exchange) becomes a central concept to analyse a networks structural properties. Relational structures capture emergent properties which affect the systems performance and behaviour [90]. Simply put, Salancik [91], explains that "*a network theory about organisations should also be able to say how network properties themselves generate the properties of organisations*" (p. 349).

The major characteristics of attribute analysis are that the unit of analysis is the individual actor and the variable describes the behaviour of the network actor. Normann [11] suggests that co-ordinating efforts by different actors towards a common whole is not new, for example, he explains how economics describes the logic leading to complementary specialisation as that of 'competitive advantage'. Normann [11] adds that what is new is not co-production but the way it is now expresses itself in terms of role patterns and modes of interactivity and organically reshapes co-productive roles and patterns especially within service networks. The new roles which result in service interaction defy what was once understood as the 'value chain' within the goods-dominant mindset. If we focus on the service-dominant era, we can apply Lewis's [79] (p. 20-21) list of the key characteristics of network science which are applicable in the modern service era:

Characteristic	Description
Structure	Not a random collection of nodes and links and have a distinct format or topology which suggests that function follows form.
Emergence	Network properties are emergent as a consequence of a dynamic network achieving stability.
Dynamism	Dynamic behaviour is often the result of emergence or a series of small evolutionary steps leading to a fixed-point final state of the system.
Autonomy	A network forms by the autonomous and spontaneous action of interdependent nodes the "volunteer" to come together (link), rather than central control or central planning.
Bottom-up Evolution	Networks grow for the bottom or local level up to the top or global level. They are not designed and implemented from the top down.
Topology	The architecture or topology of a network is a property that emerges over time as a consequence of distributed – and often subtle – forces or autonomous behaviours of its nodes.
Power	The power of a node is proportional to its degree (number of link connecting to the network), influence (link values), and betweenness or closeness; the power of a network is proportional to the number and strengths of its nodes and links.
Stability	A dynamic network is stable if the rate of change in the state of its nodes/links or its topology either diminishes as time passes or is bounded by dampened oscillations within finite limits.

Table 8 General Principles of a Network ([79])

SNA may be simply described as an x-ray of the organisational service structure which highlights the importance relational structures to support service performance. According to Tichy et al., [88], network analysis is concerned with the structure and pattern of these relationships and seeks to identify both their causes and consequences (p. 507). Therefore, organisations can be viewed on an abstract level as social groupings with relatively stable patterns of interactions over time. However, this is not the case within a service environment and we require techniques to model the system relational structures though a coherent framework and methods of analysis to capture both emergent process patterns between a specific set of linkages and their properties among a defined set of actors. Tichy et al., [88] provides an overview of network concepts and network properties as listed in table 9 which are considered fundamental to service network performance.

Property	Explanation
Transactional Content	Four types of exchanges: 1. Expression of effect (e.g. initiate a transaction) 2. Influence attempt (e.g. negotiating a SLA) 3. Exchange of information (e.g. terms and conditions) 4. Exchange of goods and services (e.g. payment)
Nature of links	
1. Intensity	The strength of the relations between individuals (i.e. intensity of service interactions)
2. Reciprocity	The degree to which a relation is commonly perceived and agreed on by all parties to the relation (i.e. the degree of symmetry)
3. Clarity of Expression	The degree to which every pair of individuals has clearly defined expectations about each other's behaviour in the relation, i.e. they agree about appropriate behaviour between one another (i.e. SLA)
4. Multiplexity	The degree to which pairs of individuals are linked by multiple relations. Multiple roles of each member (e.g. consumer, supplier, negotiator, etc) and identifies how individuals are linked by multiple roles (the more roles, the stronger the link).
Structural Characteristics	
1. Size	The number of individuals participating in the network (i.e. service eco-system)
2. Density (Correctedness)	The number of actual links in the network as a ratio of the number of possible links
3. Clustering	The number of dense regions in the network (i.e. network positioning, structural holes)
4. Openness	The number of actual external links of a social unit as a ratio of possible external links
5. Stability	The degree to which a network pattern changes over time (i.e. level of innovation)
6. Reachability	The average number of links between any two individuals in the network.
7. Centrality	The degree to which relations are guided by the formal hierarchy
8. Star	The service with the highest number of nominations
9. Liaison	A service which is not a member of a cluster but links two or more clusters
10. Bridge	A service which is a member of multiple clusters in the network (linking pin)
11. Gatekeeper	A star who also links the social unit with external domains (i.e. knowledge diffusion and service network analyst)
12. Isolate	A service which has uncoupled from the network.

Table 9 Organisational network analysis concepts and network properties

The transactional content explores what is exchanged by actors (e.g. information) within the network. The nature of the links considers the strength and qualitative nature of the relation between two or more nodes, while the structural characteristics examine the overall pattern of relationships between the actors, e.g. clustering, network density, and special nodes on the network are all structural characteristics. Watts and Strogatz [92], report that real-world networks are neither completely ordered nor completely random, but rather exhibit properties of both. In addition, they claim that the structure of network can have dramatic implications for the collective dynamics of a system, whose connectivity the network represents, and that large changes in dynamic behaviour could be driven by even subtle modifications to the network structure.

Knoke and Kuklinski, [90] discuss the concept of relational form which refers to the properties between pairs of actors (dyads) that exist independently of specific contents, for example, the intensity or strength of a link between actors, or the level of joint involvement in an activity. Knoke and Kuklinski, [90] (p. 177) lists the common types of relational content:

1. *Transaction relations*: actors exchange control over physical or symbolic media, for example, a purchase.
2. *Communication relations*: linkages between actors are channels by which messages may be transmitted from one actor to another in a system.
3. *Boundary penetration relations*: the ties between actors consist of constitute subcomponents held in common, e.g. a board of directors.
4. *Instrumental relations:* actors contact one another in efforts to secure valuable goods, services, or information.
5. *Sentiment relations*: actors express feelings towards one another.
6. *Authority/power relations*: usually occur in complex formal organisations governed by rules and regulations.

Therefore the organisation of structural relations (emergent property of the connection, the exchange process) or attributes (intrinsic characteristics, e.g. value of an exchange) becomes a central concept to analyse a networks structural properties. Relational structures capture emergent properties which affect the systems performance and behaviour [90]. From a service network perspective, we can identify recent advances that extend network analysis towards dynamic analysis and multi-actor networks. For example, Carley [93] explores three key advances: the meta-matrix (focus on people, knowledge/resources, events/tasks, and organisations), treating ties as probabilistic, and combining social networks with cognitive science and multi-agent systems. These are outlined in table 10 below (and highlight the importance of adopting ANT).

	People	**Knowledge/ Resources**	**Events/Tasks**	**Organisations**
People	Social network (motivation to interact, and change in access)	Knowledge network (learning acquisition)	Attendance network	Membership network (mobility recruitment)
Knowledge/ Resources		Information network (discovery and analogical reasoning)	Needs network (innovation)	Organisational capability
Events/Tasks			Temporal ordering	Institutional support or attack (re-engineering)
Organisation				Inter-organisational network (alliance or coalitions)

Table 10 - Meta-Matrix ([93])

Table 10 above summarises the various dimensions which add to service network complexity. Carley [93], lists a set of measures which are not correlated, although they are key to characterise dynamic networks. These include; size of the network (number of nodes), density (number of ties or possible ties), homogeneity in the distribution of ties (the number of clusters, and variance in centrality), rate of change in the nodes, and rate of change in the ties. SNA assumes that actors are interconnected, with real consequences for behaviour and performance. Structures may be altered to optimise the networks outcomes which present an opportunity to model service network analytics. In addition, Durland and Fredericks [94] also support SNA and suggest that it stands apart from other methodological theories and focuses on the context and behaviour of relationships which is considered the blueprint of networks among actors making it an excellent technique for service network analytics.

13. Service Network Analytics

The affordance of Internet technologies to support the evolution of service economies has transformed businesses from local to global socio-technical network infrastructures. Service networks are complex, open, and dynamic systems through integrated end-to-end service systems. Managing service networks is a difficult task especially with the view to develop and model performance analytics. Business processes are largely influence by policy, service regulation standards, and compliance standards. However, simulating service performance within a dynamic environment is often overlooked and become presumptuous of managers although they have little insight regarding the mechanics of service networks. Thus, the main motivation here is to explore service network performance and optimisation from a practical and theoretical perspective to enhance service process management.

We are particularly interested in identifying and developing KPIs as quantifiable measures of service network and borrow SNA metrics as service network analytics to understand service network behaviour. Service KPIs can assist managers in decision-making to determine the right course of action or to identify service network opportunities (for example, structural holes). The level of dimensional support across the process structures is expressed in several forms including, structural, compositional, functional, and behavioural. Often these dimensions are taken for granted and overlooked although this information provides both tangible and intangible metrics on organisational networks. The relationships which exist between these services can determine the service innovation and operations efficiencies across networks. This will also allow us to identify the CSFs which enable or inhibit business processes using KPIs. Papazoglou [20], draws our attention to the focus of the current practice of business transactions, and the lack of insight into the behaviour or the relationships of transactions between trading partners which can enhance their semantic value when transaction functions are combined. Figure 10 below provides a simple illustration of how managers should explore the core service principles, i.e. the CSFs of the service. Managers must ask, what are the core areas upon which strengthen the service network before they can identify KPIs.

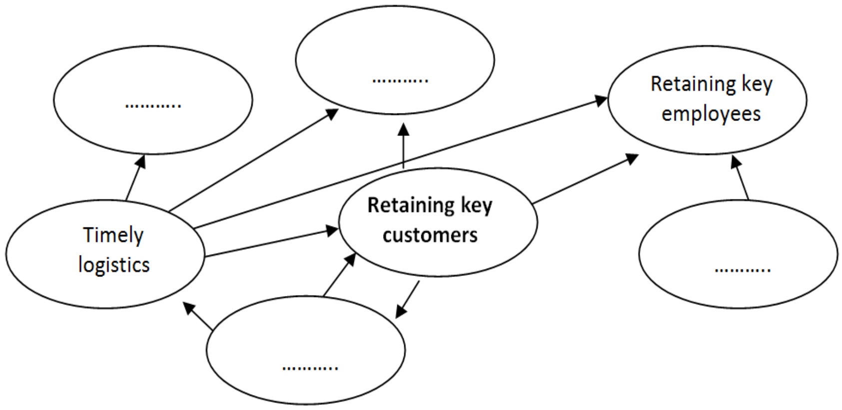


Figure 10 CSF Relationship Mapping

CSFs are also linked to one another and form a crucial insight as to how CSFs impact and influence the realisation of other CSFs. For example, retaining key customers may depend on the SLA which governs logistics and quality of a service. The logistics may depend on the deployment of supply chain management (SCM) techniques which are critical to the service operations. Retaining employees may depend on learning and growth opportunities within an organisation all of which affect the deliverance of a service and influence customer service loyalty, and ultimately the success of the service network. Managers can also assign weightings to reach CSF to indicate the importance placed on other CSFs to support one another. This allows mangers to develop robust methods of analysing the hierarchy of CSFs through relationship mapping [73]. The weightings to CSFs to highlight the importance or influence they play on one another. Managers can also cross-check the identified CSFs against the balanced scorecard perspectives (for example, see table 11 below) adopt to examine service performance.

BSC / CSF	Financial	Customer Satisfaction	Staff Satisfaction	Learning and Growth	Internal Process	Environmental/ Community
E.g. Timely Logistics	✓	✓	✓	✓	✓	Possible
E.g. Delivery of full and on time	✓	✓	Possible	✓	✓	✓
E.g. Retaining Key Customers	✓	✓			✓	✓
SCM….Etc						

Table 11 Checking impact of CSFs against the Six BSC perspectives

The importance of cross-checking CSFs with the balanced scorecard perspectives allows managers to further explore adopting a holistic view of the service network; financial, customer satisfaction, staff satisfaction, learning and growth, internal process, and environmental/community. In addition, managers must examine the service network topology and dynamic interaction. Once the CSFs have been identified, mangers must determine the relevance of each CSFs within a service network which report the six business scorecard perspectives. These may include some of the following factors (see table 12):

Business Scorecard Perspective	CSF Examples
Employee satisfaction	• Retention of key staff • Appropriate reward and recognition structure for all • Continuous learning environment • Promoting open decision making
Learning and growth	• Developing internal leadership • Increasing employee productivity • Developing strategic skills within management • Increase in adaptability and flexibility of staff • More open access for staff to strategic information
Customer	• Introduction of new services • Moving from satisfied to loyal customers • Customer acquisition • Increased satisfaction (timely service, reliability, quality, price) • Improving turnaround time • Increased repeat business (increased percentage of sales from key customers)
Finance	• Optimising from profitable customers • Growth in revenue and product mix • Cost reduction/productivity improvement • Optimal utilisation of assets and resources • Improved risk management (better forecasting, broaden revenue base, etc.)
Internal process	• Enhancing operational efficiency, reducing cost per transaction • Increased linkages with key suppliers • Optimising technology (return on investment) • Completion on time and to budget measure • Encouraging innovation • Timely, accurate, decision-based information • Delivery in time, all the time
Environmental /community	• Enhance community interaction • Positive public perception of service

Table 12 Example of CSFs though a Business Scorecard Perspective

Table 12 above outlines some of the CSFs which managers typically identify with when they examine the core process which support the growth of their service. Implementing a successful performance analytics strategy relies on the successful coordination of several key tasks including identification of KPIs, monitoring, reporting, interpreting, planning, and reconfiguring business process to align performance with the service strategy. Therefore, the implementation of service process plays a critical role in service performance, but more importantly, reporting on process activity and interactivity. Each process must have a clear logical flow of which a process must establish ownership, define the scope, objectives and design of process, negotiate and determine each process metric and how technology supports its performance, and report on its performance in a timely fashion (i.e. automated reported mechanism). Many KPI strategies are viewed as being intrusive by people and consider it as a threat to their roles within a service (i.e. judged on performance). Therefore, it is imperative that management understand the scope of service change if it affects people or other services within the service eco-system. Here we focus on service network performance analytics. Performance may be mapped on retrieving information on process event and modelling their interrelationship.

14. Discussion and Conclusion

This report presents a literature review which highlighted the need to conceive tools and techniques to manage the complexity of service networks through service network analytics. It examined the suitable application of SNA to enhance the manageability of network based services.

Understanding the value of service network relationships, especially from a technological perspective can prove to be extremely problematic. Moreover, the concept of network 'value' is often greeted with an expectation of vagueness or uncertainty, and tends to be avoided. One of the greatest concerns within today's service network landscape is the inability of business models to cater for the pace and dynamics of business. This places greater emphasis on the business model and the methods which facilitate service network contributions. Failing to examine the service network value increases the chances of ignoring the spatial and temporal structure of largely loosely coupled value proposing actors which dynamically interact through 'institutions and technology' offers little insights on service performance. As a result, managers are unable to determine the co-produce service offerings, exchange service offerings, and the co-creation value within a service network. As a consequence, managers cannot determine the value of the overall service eco-system and to "*...capture the adaptive and evolutionary characteristics of a value network ... [and] the nesting of supply chains with larger and more encompassing value networks*" [68]. Therefore, the value of service networks is an evolving characteristic of services as organisations adapt and learn to offer competitively compelling value propositions through liquefying resources. Within a service-dominant environment value is an evolving factor, so too must the relational structure which support value generation. Examining the implications of relational structures and service behaviour allows us to develop a paradigm that examines the mechanics of economic exchange and performance analytics within service network management. From this stance, this sets out to highlight the need to introduce service networks performance analytics and experiment with modelling techniques, for example, instance modelling, structural modelling, and behavioural modelling. We plan to develop a KPI framework which implements balance scorecard views and SNA metrics to establish a service network performance analytics (SNPA) matrix. The motivation for adopting this performance analytics view stems from Normann's [11] concept of the 'principle of density', which is mainly driven by technology and the shift in managers mindsets in restructuring or reconfiguration of new 'opportunities'. The focus on service network relational structures acknowledges the fundamental role on the generation of value through the sustainability of service network relationships and performance.

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