

# Don't make value co-creation ambiguous, social networks simplify it

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## Abstract

**Purpose:** Value co-creation is often necessary for situation where expertise and resources are beyond a single actor. Despite the vast study of value co-creation in service system by both academics and practitioners as an overarching theory, that describes collaboration between consumer and provider. More importantly, little is known about how value co-creation is established in social network analysis and there is little agreement on what depicts value co-creation. These missing concerns included; vast studies of value co-creation in dyadic relationships and sparingly in multi-actors, lack of study on theoretical and empirical features of value co-creation, lack of empirical investigation of strength of interactive relationships in networks for co-creation of specific value-in-use. These thought-provoking missing concerns necessitated this research by forwarding the question; “What are the features of social value co-creation in service system and how can it be established in social networks”?

**Methodology:** A case study approach is employed using the exploratory sequential mixed methods. The contextual investigation was carried out in water supply system called KAMOMI. The KAMOMI water scheme provides water supply facility and has in place a service system consisting both the provider, consumers and different stakeholders. The case represents a service system where value co-creation occurs within actor-to-actor interactive relationships to benefit the community.

**Findings:** The paper argued that the examination of value co-creation among multi-actors in social networks analysis is highly significant to its cogency and generalisation. The qualitative analysis provided evident features of value co-creation, which transforms value co-creation from dyadic to multi-actors interpersonal interactive relationships in social network analysis. The value co-creation features included resource integrating networks, defined value-in-use, actors' empowerment, perceived ownership and knowledge sharing. Meanwhile, the quantitative analysis discovered that closeness of both formal and informal relationships; including frequency of informal interactions enable access to integration of resources of multi-actors for value co-creation.

**Contribution:** The study of value co-creation in social network analysis represents an interesting gap and is highly essential for designing effective service system to enhance the goal of value co-creation. The paper contributes by illustrating (a) features of value co-creation in networks (b) empirical evidence of how strength of relationships of actors enhance resource integration in networks.

**Key words:** value co-creation, service system, social network analysis

## 1. Introduction

Value co-creation is presented as seemingly a very hard concept to achieve. This is evident in the use of ambiguous expressions and unclear statements. The paper is an exploration of much-needed evidence to determine the networks structures that influence value co-creation. In Maglio et al. (2009), it was elaborated that service science is the “systematic search for principles and approaches that can help understand and improve all kinds of value co-creation. Networks are fundamental and exist between actors of a water provider, water suppliers and the community (Ojuri et al., 2018). Service science is centred on the study of value co-creation within and among service systems—dynamic and adaptive webs of exchange composed of interactions among people, organizations, and technology (Ojuri et al., 2018, Vargo and Akaka, 2012). In the same manner, service-dominant (S-D) logic, and its definition of service as the application of resources for the benefit of another, centres on the concept of value co-creation (Vargo and Lusch 2011, Vargo and Lusch, 2008). Value co-creation in complex networks is specifically addressed in this paper from knowledge sharing feature, which will be explained within the concepts of resource integration and interaction. Resource integration is the central means for connecting people and technology in service systems and interaction factor because they influence knowledge sharing among actors within service systems. Understanding value co-creation processes are of crucial importance both for the development of the theory and its practical application. To this end, we propose a network system lens in studying value co-creation, and we propose social network analysis as a way of empirically understanding how value is co-created. It is expected that the methodological approach to social complex project networks to be demonstrated in this paper should simplify value co-creation. The paper is the combination of review of

literature with theoretical insights, and it is analysed within a relational context by describing the process of value co-creation within resource integration and interaction in interactive relationships. The paper is structured as follows. The basics of interaction is discussed, including resource integration. Knowledge sharing and social network analysis was described according to how value has been conceptualised within service system. There is increasing recognition in the literature that value is co-created by the interaction of multi-actors, rather than in a dyadic interaction process between two entities (Ojuri et al., 2018, Pera et al., 2016). A number of studies on value co-creation was carried out with business to consumer, or consumer to business perspective, the multi-actors approach has been in nascent stages. Understanding value co-creation features is of crucial importance, both for the development of the theory and its practical application. The engagement of multi-actors in value co-creation, and the investigation of various resource integrators within network service system represent interesting gaps specifically within a complex water project delivery setting. Sequential exploratory mixed methods is used to empirically understand how value is co-created. It is expected that the methodological approach of applying social network analysis to social complex water project will demonstrate a means of simplifying value co-creation. The objective is to determine the structural characteristics that determine value co-creation (knowledge sharing) in networks.

This paper contributes to value co-creation by providing greater understanding of how resource integration and knowledge sharing practices of multi-actors service system is established in informal networks that lead to value co-creation. The study is the first to attempt to explore value co-creation in water supply system and make its features determinable in networks.

## **2. Literature review**

### **2.1 Interaction**

Value co-creation is enabled by actor-to-actor involvement and commitment. It forms the basis of their capability to contribute to value co-creation through dialogue and exchange of knowledge and other resources for activating and sustaining organisational learning (Gummesson and Mele, 2010). In this way, interaction between parties is the most crucial antecedent to resource integration (Gummesson and Mele, 2010).

Interaction is the primary interface between parties involved in co-creation, it is an opportunity to understand, share and serve needs and to simultaneously assess and adapt resources commitments (Ranjan and Read, 2016). Interaction takes place to provide service and mutual benefits (Vargo et al., 2010). Interaction in service ecosystems takes place to enhance service and mutual benefits to actors in the service systems (Gummesson and Mele, 2010). The interaction within service systems are further connected to form a shared ecosystem, through which it is possible to understand how new resources emerge and constantly change for subsequent resource integration (Siltaloppi and Vargo, 2014). It can form the nucleus for action and the actors' interpretation of the surrounding world (Parton, 2008). By interacting, people can transform their subjective meanings into artefacts and give meaning to reality (Gummesson and Mele, 2010).

Interaction should be understood as not simply interfacing or having contact but be regarded as "service interaction". Service interaction enables an actor to enter the value creating processes of other parties, support them, and benefit from them (Gummesson, 2006). Interaction manifests itself through participation, and engagement, and it enables intricate sharing by raising the possibility of generating solutions. (Ranjan and Read, 2016). In value co-creation, interaction is a significant driver in terms of initiator of experience for the benefits of whole network (Ballantyne and Varey, 2016). During interaction, there is transfer of knowledge, resources, and learning.

Within the concept of value co-creation, the idea is that value is co-created through interaction as well as mutually beneficial relationships. Interaction enhances integration and application of resources, for and with actors exchange for service and service within services ecosystems that drives co-creation of value (Gummesson and Mele, 2010). In addition to exploring interaction process, the paper combined the varieties of communication interaction by adopting the model of Gummesson and Mele (2010) – actor-to-actor interaction process in integrating resources for value co-creation in many-to-many networks setting. The reason for its adoption is that, it is particularly appropriate for the paper's theoretical explanation of how value co-creation in service system emerges from interaction and resource integration processes explained empirically in networks. In a many-to-many context, actors interface and evaluate each other in terms of resources, competences, and processes. This forms the basis of actors' capability to exchange knowledge and other resources for value co-creation through dialogue (Gummesson and Mele, 2010).

By interacting, the members of a network can access knowledge, financial, human, capital technical including physical and other resources (resource transfer) (Gummesson and Mele, 2010). Knowledge, services, products, and solutions are activated and shared by actors according to their value-in-exchange resources for the purpose of achieving some sets of goals. The actors benefit from the experiences acquired in terms of knowledge, emotions and feedback (value-in-experience) generated from resources performance.

While the emergence and importance of networks in studying interaction process have been stated, there is limited investigation that shows how networks structural characteristics that enhance service exchange during interaction, establish knowledge acquisition and knowledge sharing; the fundamental feature of value co-creation. During interaction, the actors of a network can access human, physical, technical, financial, and other resources. There is an exchange and sharing of knowledge, products,

services, and solutions by actors according to their specific evaluation (value-in-exchange). They are activated in their value-creating processes in order to achieve certain goals (value-in-use). Interaction seems to play a critical role in explaining, “sharing” during the process of matching actors.

This promising aspect of antecedents of value co-creation seems significant to address its theoretical roots. What stimulates interactions into combination of resources within complex networks? With the view of mutually generating new beneficial ideas has not been well attended to in the interaction literature. This significant area needs to be uncovered. In this, should give a deeper understanding of value co-creation process. While interaction is not all-sufficient condition for all instances of resource integration, it is well documented that interaction represents a necessary condition for resource integration (Peters, 2016). This takes the paper to discussions on resource integration.

## **2.2 Resource integration**

Resource integration is the incorporation of an actor’s resources into the processes of other actors (Gummesson and Mele, 2010). Actors evaluate available and potential resources to understand what they have and what they can do (Agrawal et al., 2015). Resource integration is another crucial instrument for value co-creation, whereby two or several network of actors link their resources to produce mutual benefits. In Lusch et al. (2010), value co-creation occurs when a potential resource is turned into specific benefits. Resources and resource integration are part of the concept of S-D Logic, including the narration of service system. For instance, firms act as resource integrators as specialization forces them to access existing knowledge, skills, competences, people, products and money. Value co-creation occurs by integrating actor resources in accordance with their expectations, needs and capabilities (Gummesson and Mele, 2010). The process of resource integration fosters experience and value co-creation among actors (Mele et al., 2010). Thus, within the S-D logic’s premise, value is always co-created in exchange provides an appropriate theoretical framework for research in value co-creation.

Resource integration implies a social and cultural process that enables an actor to become a member of a network. The different actors; customers, suppliers, partners involved in the network of co-creating value are referred to as resource integrators (Mele and Polese, 2011). Actors’ resources become valuable when they are matched and positioned in a value-creating network providing benefits to all network actors. The importance and process of resource integration as an integral part of S-D logic, has been vastly studied qualitatively. There is no study to provide quantitative empirical understanding of resource integrating activities in networks. Resource integration requires a multidirectional process orientation in networks, particularly social networks analysis. The empirical study of what enables how actors link their resources to one another for value co-creation purposes is missing in the S-D logic literature. This view of studying resource integration in networks should potentially address this critical issue.

The next section of the paper would review knowledge as a significant resource in value co-creation with further expansion on knowledge sharing. Value co-creation is dependent on knowledge (Guan et al., 2018) of actors in the service systems. Both categories of knowledge; tacit and explicit are valued resources, although different in value co-creation concept. In value co-creation, S-D Logic emphasizes knowledge as primary resource for exchange (Vargo and Lusch, 2004, 2008). Knowledge is well acknowledged as the fundamental resource for value co-creation in the literature, although resources such as communication, skill, finance, and leadership skill are also important during value co-creation. In understanding how knowledge is used in joint activity of service provider and customer to co-create value, the next section of the study sheds more light on knowledge sharing as a form of value co-creation.

## **2.3 Knowledge sharing**

Although value co-creation can occur during interaction between service provider and customer, however, the summary of literature on knowledge and sharing as it relates to value co-creation suggest that, “knowing” and “sharing” during interaction between service providers and customer is crucial for establishing value co-creation. The knowledge of resources integrators and how it is shared among themselves to generate solution to certain identified problem is critical for co-creation of value. Value co-creation is a product of “knowing” and “sharing” between actors in the service systems. Knowing and sharing are antecedents of value co-creation. These antecedents are fundamental to value co-creation. In order to expound further the concept of value co-creation regards its antecedents; “knowing” and “sharing”, networks seem appropriate to theoretically and empirically scrutinise how knowledge sharing is identified. Networks is relevant because, the conceptualization of service systems as networks offers the opportunity for systematic investigation and theorizing on the structure of ties among resource integrators – actors in value co-creating activities (Huber, 1991). In addition, the study of value co-creation has been widely qualitative. The application of quantitative (self-administered questionnaires) research design as demonstrated in this paper should be rigorous to offer a deep explanation of the feature of value co-creation. This attempt would give a deeper understanding of the theory and consequently contribute to its general validity. The application of networks, specifically social network analysis (SNA) and its structural features to determine value co-creation (knowledge sharing) in networks was critically appraised in the next section.

## 2.4 Social network analysis and its structural characteristics for value co-creation

The conceptualization of service ecosystems as networks offers the opportunity for systematic investigation and theorizing on the structure of ties among resource integrators – actors in value co-creating activities (Huber, 1991). The network of relationships between the actors should reflect members' knowledge and exchange (Hubers et al., 2017, Huber, 1991). A network is a collection of people and or things that are connected to each other by some kind of relationship (Davies, 2016). Network theory refers to the mechanisms and processes that interact with network structures to yield certain outcomes for individuals and groups (Borgatti and Halgin, 2011). A network consists of a set of actors or nodes along with a set of ties of a specified type such as friendship that link them. The ties interconnect through shared ends to form. Much of the theoretical wealth of network analysis consists of characterizing network structures for example; small-worldness and node positions for instance centrality, and relating these to group and node outcomes (Borgatti and Halgin, 2011). Network analysis is the analysis of the structure of relationships within a network. The tool used for network analysis comes from a field of social sciences known as social network analysis (SNA) (Davies, 2016).

Social network analysis is grounded in the idea that ties, (relationship with others) determine the extent to which an actor has access to resources in a network and often the type and quality of resources, for example knowledge (Pryke, 2012, Hubers et al., 2017). Social networks comprise actors who are tied to one another through socially meaningful relationships (Prell et al., 2009). Social network analysis (SNA) stemmed from the study on the social relations and network characteristics of individuals (Zheng et al., 2016). The importance of the use of SNA as a methodology in the analysis of the relationships is well-established (Pryke, 2005).

The appealing focus of SNA is on relationships among social entities, and on the patterns and implications of these relationships (Wasserman and Faust, 1994). A social network consists of one or more sets of units—also known as “nodes,” “actors,” or “vertices”—together with the relationships or social ties among them. (O'Malley and Marsden, 2008). SNA methods provide precise mathematical definitions of five groups of characteristics of the actors and of the network itself; cohesion, equivalence (role-groups), power of actors, range of influence, and brokerage. These characteristics are expressed in terms of corresponding Network-Structure parameters derived from the relations among the actors (Aviv et al., 2003). SNA is an effective tool to understand the characteristic of information circulation, social barriers to reach information and knowledge (Cozen and Sagsan, p.44). Social networks are important strategies for promoting communication within and between organisations, which are viewed by Conway (2002) as structures that supplement, complement, and add value to the formal organisation. SNA was particularly selected because is applicable to explore informal relationships of actors in the water supply system which is one of the main views of the research. A perspective supported by Drucker's assertion, that is, it is informal organisation, say service system rather than management, which actually determines rates of its outcomes.

There are quite a number of reasons for taking a network perspective. (1) all organisations are social networks and therefore need to be analysed in terms of networks and relationships, (2) organisations operate in environments comprising networks of other organisations, (3) Actions of actors in organisations can best be explained in terms of their position within networks of relationships (Pryke, 2005).

## 2.5 Theoretical framework

The value-creation process is a key theme in network management entailing an analysis of the interconnectedness of relationships and the interdependence that exists among parties (Chang et al., 2013). Co-creation occurs through interactions (Smyth et al., 2018). Several scholars in marketing (Grönroos, 2006, Gummesson, 2006) have pointed the interactive relationship between networks and value co-creation. This paper argues that networks provide cogency to value co-creation. Few articles addressed the link of value co-creation and networks. There have been several benefits and sacrifices of consumers at different levels of network analysis (such as analysis of the individual, the firm and network) (Chang et al., 2013). Value co-creation was explored within networks to indicate actor-to-actor service system within a public service system (Alexander and Jaakkola, 2011). The authors identified prerequisites for value co-creation including the actors' resources contributed as regards achieving balanced centrality within the service systems. The study did not use the fundamental structural characteristics of social networks to investigate the indicate features of actors-to-actors network to support the claim of exploring value co-creation in networks.

In S-D logic, actors are viewed as social and economic resource integrators (Lusch and Vargo, 2006, Lusch et al., 2008, Mele et al., 2010), in which interaction is central. Interaction can only be meaning when carried out in relationship settings. Interaction is built upon dialogical prescription as offered by Ballantyne and Varey (2006), which calls for communication between all network actors to co-create value through adaptation trust and learning. In addition, network notion is resource-integration concept of S-D logic (Lusch and Vargo, 2006) and density concept of Norman (2001).

The theoretical findings of the paper was anchored on resource presence and integration, maximum density is reached when at a given time and place, an actor provides and integrates all the resources necessary to co-create the best possible value (Lusch et al., 2010). While this idea implies that value co-creation is an interactive process of integrating and transforming

resources (Lusch and Vargo, 2006), it is rather too shallow to indicate the potentials of networks in exploring resource integration for value co-creation.

Resource such as knowledge, specifically tacit knowledge, which is regarded as the most important resource for exchange in value co-creation (Vargo et al., 2008, Meynhardt et al., 2016) can be shared, developed and learned in social interactions among actors in service system. Knowledge exists in tacit form and has to be shared in order to become valuable to the service system, there has to be opportunities to facilitate the sharing and creation of knowledge. This phenomenon exist in actor’s network of relationships (Davel et al., 2017). The relationships between individuals are the “vehicle” for the exchange of knowledge and the overall configuration of these relationships in social networks (Hubers et al., 2017). Social network analysis is recognised as an instrument to plot knowledge and expertise as well as to confirm the character of relations in networks within organisation or say, service system (Davel et al., 2017).

The potential structures of social network analysis such as; density measure and eigen centrality measures to expound resource integration and value co-creation deserves rigorous study for more clarification. This paper selected SNA from other analysis and management methods because social network draws attention to informal networks in work places. This line of argument conforms to Drucker’s assertion that it is informal setting, rather than management that actually determines rates of organisation’s outcomes. SNA was chosen because it can be applied as a theory view and set of method. SNA extends and complements traditional social science by focusing on the causes and consequences of relationships between participants rather than the features of individuals. While in terms of method, SNA focuses on the measurement of relationship between participants (Ruan et al., 2013).

The justification for the adoption of SNA plays a crucial role in its applicability to examining value co-creation. The context investigated for instance in this research is a social system (water supply system), the perspective of the research in exploring value co-creation is not in business ecosystem, rather in service ecosystem, that is, benefits derivations to the consumers and community from the water supply system.. Nonetheless, the highlighted criteria of adoption synchronize with fundamental concepts of value co-creation, which are; interaction and integration of resources integrators. SNA can in fact provide evidence to the key determinants of interaction and integration concepts in value co-creation.

Therefore, the paper hypothesises that:

There is a significant association between social networks and value co-creation.

Therefore, it was accordingly set out to break further and exemplify the main hypothesis into two

The first hypothesis is:

Hypothesis 1: There is a significant association between tie strength of formal relationships and value co-creation.

Based on the previous hypothesis 1, the following sub-hypotheses were constructed to test the prediction statistically:

H1a: A close formal relationship is a predictor of value co-creation

H1b: Frequency of formal interactions is a predictor of value co-creation

The second hypothesis is:

Hypothesis H2: There is a significant association between the strength of informal relationships and value co-creation

Based on the above hypothesis 2, the following sub-hypotheses were constructed to test the prediction statistically:

H2a: A close informal relationship is a predictor of value co-creation

H2b: Frequency of informal interactions is a predictor of value co-creation

Figure 1.1 summarises the theoretical framework, propositions and hypothesised relationships

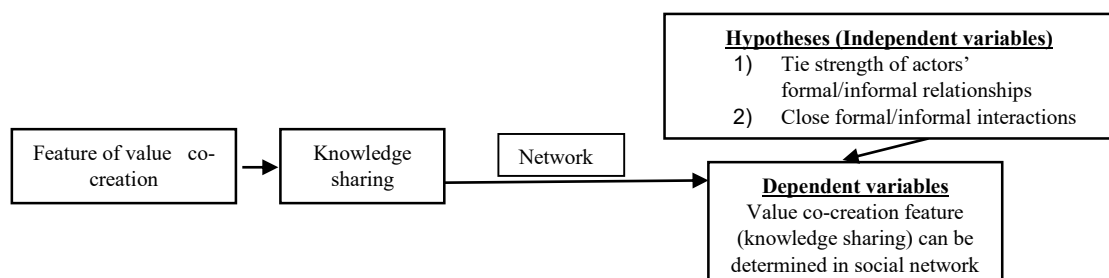


Figure 1.1: Theoretical framework, propositions and hypothesised relationships<sup>1</sup>

### 3. Data collection

#### 3.1 Case Study

The case study of the study is water supply service system. The water facility was constructed through direct labour type of contract by the Rural Water Supply and Sanitation Agency (RUWASAN); a government agency. There were 36 semi-structured interviews undertaken to deliver the case study. The interviews were conducted face-to-face among Water Supply, Sanitation and Hygiene (WASH) Committee named “WASHCOM” members, community people representing each water endpoints. The interviews lasted 40 minutes on average per respondent. The second part of data collection was self-administered questionnaire to same number of participants that were interviewed.

The water scheme known as “KAMOMI” promotes community ownership of water facilities, water provision and maintenance to sustain the functionality of the water facilities. Therefore, during the construction of the water facility, there was a formation of “WASHCOM” (consumers) to serve as the service ecosystem for the water service provision. After the formation of the service ecosystem; the members of WASHCOM were trained and kitted for effective performance of their activities in the service ecosystem. WASHCOM was formed in a general community where members were residents and must be residents in the community for the period of 2 years, meaning they were end-users. The maintenance officer was the representative of the water service provider in WASHCOM particularly during major facility repairs. The responsibilities of WASHCOM included; facilitation of community meetings for interaction and financing the maintenance of water facilities for effective water supply to the community. Network data for this study was collected using a self-administered questionnaire to 36 respondents. Self-administered questionnaires. The analysis was done using the statistical package UCINET VI (Borgatti et al., 2002).

#### 3.2 Qualitative analysis (Knowledge areas for water service system)

The specific feature of value co-creation based on the review of literature was knowledge sharing. Although, other features were equally important in establishing value co-creation features in network of multi-actors in service system, the influence of actor’s relationships in determining sharing of tacit knowledge as a way of service exchange for the benefit of the community could be well determined in social network analysis. Furthermore, this section identified the knowledge areas shared among actors that supported effective water supply provision. In looking out for the knowledge areas shared between the actors in water service ecosystem, the researcher was mindful of the knowledge areas that made the water service ecosystem successful. Using Nvivo 11, the codes from 36 interviews were abstracted to form common themes, which initially revealed seven generic features of knowledge areas essential for successful water service delivery.

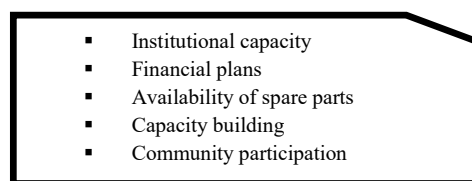


Figure 1.2: Knowledge areas for water service system

However, this was later compressed, by reducing the data to sets of generic codes of five necessary for describing the phenomenon in the study, see figure 1.2. Apart from this, it was also categorised for theory building. Two researchers through deliberations further triangulated these themes, this was necessary to provide validity to the findings.

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<sup>1</sup>: The paper hypothesises that there is a significant association between social networks and value co-creation. As two hypothesis are identified: Hypothesis 1: There is a significant association between tie strength of formal relationships and value co-creation and Hypothesis 2: There is a significant association between tie strength of informal relationships and value co-creation

### 3.3 Quantitative social network analysis (sharing of knowledge areas)

#### 3.3.1 Testing of hypothesis 1

The out-degree centrality and eigenvectors were well analysed for each of the networks on sharing of knowledge areas for successful rural water supply service. The out degree centrality assigns scores to well-connected actors; actors who are likely to hold most knowledge or individuals who can quickly connect with the wider network. Similarly, eigenCentrality measures a node's influence based on the number of connections it has to other nodes within the network. More importantly, eigenCentrality can identify nodes with influence over the whole network, not just those directly connected to it. EigenCentrality is a good 'all-round' SNA score, highly relevant for understanding human social networks.

Table 1.1: Eigenvector scores of actors for water service system

Actors	Knowledge areas	Institutional capacity	Financial Plans	Availability of Spare parts	Capacity building	Community participation
Maintenance officer		-0.477	0.067	0.219	0.103	0.107
Coordinator		-0.309	0.373	0.437	0.510	0.545
Ass. coordinator		-0.570	0.227	0.288	0.172	0.252
Secretary		-0.205	0.275	0.389	0.172	0.298
Assistant secretary		-0.205	0.203	0.273	0.103	0.211
Treasurer		-0.266	0.240	0.214	0.157	0.196
Financial secretary		-0.266	0.293	0.389	0.157	0.339
Electrician		-0.205	0.171	0.389	0.103	0.139
Technician		-0.205	0.117	0.180	0.507	0.108
Operator		-0.205	0.196	0.257	0.172	0.238
Endpoint 1		0	0.102	0.041	2.8E-0045	0.105
Endpoint 2		0	0.054	0.000	0.205	0.073
Endpoint 3		0	0.167	0.071	0.205	0.092
Endpoint 4		0	0.054	0.140	2.8E-0038	0.105
Endpoint 5		0	0.054	0.200	-5.1E-0039	0.073
Endpoint 6		0	0.080	0.041	-0.000	0.073
Endpoint 7		0	0.159	-0.00	0.102	0.193
Endpoint 8		0	0.117	0.115	-0.000	0.105
Endpoint 9		0	0.095	-0.00	0.102	0.165
Endpoint 10		0	0.180	0.115	0.000	0.179
Endpoint 11		0	0.095	0.011	0.000	0.073
Endpoint 12		0	0.095	0.054	-0.000	0.073
Endpoint 13		0	0.122	-0.00	0.000	0.073
Endpoint 14		0	0.117	0.110	-0.000	0.105
Endpoint 15		0	0.114	0.104	-0.000	0.092
Endpoint 16		0	0.481	0.000	0.205	0.100
Endpoint 17		0	0.054	0.000	0.102	0.073
Endpoint 18		0	0.054	0.000	0.102	0.073
Endpoint 19		0	0.054	0.000	0.102	0.073
Endpoint 20		0	0.054	0.000	0.102	0.073
Endpoint 21		0	0.095	0.000	0.102	0.073
Endpoint 22		0	0.054	0.000	0.268	0.073
Endpoint 23		0	0.080	0.000	0.102	0.073
Endpoint 24		0	0.054	0.000	0.102	0.073
Endpoint 25		0	0.054	0.000	0.102	0.073
Endpoint 26		0	0.054	0.000	0.102	0.073

On sharing useful knowledge areas regards institutional capacity in WASHCOM, the analysis discovered that the eigenvectors were 0.373 and 0.481 for the coordinator and the leader of endpoint 16 respectively. Consequently, the leader of endpoint 16 was highly prominent and influential to address the issues such as reasonable fees and realistic payment plans to community, this indicated that the community leader in water point 16 is an important actor. Similarly, the eigen vectors of 0.545 computed for the coordinator were 0.339 and 0.298 for the financial secretary and secretary, meaning that, the financial secretary had more influence than the secretary while the coordinator was the most influential out of the actors within the network. On capacity building knowledge area, the eigen vectors scores were 0.507 and 0.510 for the technician and coordinator respectively. They seemed to have shared initiatives with other actors on continuous learning and improvement as it relates to repair skills to progress community ownership and to keep the water supply system running, therefore, the coordinator is more influential in capacity building network than the technician.

### 3.3.2 Testing of hypotheses 2 and 3 - multiple regression quadratic assignment procedure (MRQAP)

This section applied regression analysis; multiple regression quadratic assignment procedure (MRQAP) to estimate the effect of the four independent variables relating to strength of ties on knowledge sharing. The reason for applying regression analysis is that inferential statistics have proven to have very useful applications to social network analysis (Krackhardt, 1988). Regression analysis helps to answer the question; how much confidence can one have in the pattern that one sees in the data the researcher has collected in a typical large population. It is also to have a check that the apparent pattern is not really just a random occurrence (Krackhardt, 1988). The MRQAP tests are permutation tests for multiple linear regression model coefficients for data organized in square matrices of relatedness among  $n$  objects (Prof et al., 2007). Square matrices such as typical data structure in social network studies as used in this research, where variables indicate some type of relation between a given set of actors. Another main advantage of using MRQAP is that it reduces bias resulting from the interdependence of observations if ordinary least square techniques (OLS) were used (Laila, 2007).

To analyse the second and third hypotheses, the independent variables were identified in the sub-hypotheses which are; closeness of formal and informal relationships, and frequency of formal and informal interactions while the dependent variable is *knowledge sharing*. See table 1.2

Table 1.2: Coefficients for knowledge sharing

	Coefficients	P-value
Intercept	0.0000	0.0000
Closeness of formal relationship	0.4151	0.0005
Frequency of formal interaction	-0.1406	0.0005
Closeness of informal relationship	0.6794	0.0005
Frequency of informal interaction	0.0613	0.0040
R Square	0.849	

The small p-values, for example 0.000 indicates that the coefficients are significant with 100% confidence interval. Similarly, a low p-value ( $< 0.05$ ) indicates that the researcher can reject the null hypothesis. In addition, the R-squared coefficient of 0.85 showed that the model explained 84.9% of the variations in the dependent variables.

The hypotheses is stated below based on the findings in table 1.3

H2 states that, there is a significant association between tie strength of formal relationships and knowledge sharing is supported.

A summary of the findings with respect to H2 and the sub-hypotheses is given below.

H2a, which states that a close formal relationship is a predictor of knowledge sharing, is supported.

Similarly, to:

H2b, which states that the frequency of formal interactions is a predictor of knowledge sharing is supported.

However,

H3, which states that there is a significant association between the tie strength of informal relationships and knowledge sharing, is supported.

This is so because,

H3a, which states that closeness of informal relationship, is a predictor of knowledge sharing is supported.

In addition,

H3b, which states that frequency of informal interactions is a predictor of knowledge sharing, is supported.

Table 1.3: Summary of the results of the testing of H2 and H3

Case study	Summary of the results of the testing of H2 and H3	
Significant predictions of knowledge sharing (value co-creation)		
H2a	Close formal relationship	Supported
H2b	Frequency of formal interactions	Supported
H3a	Close informal relationship	Supported
H3b	Frequency of informal interactions	Supported



#### **4. Discussion - Value co-creation (knowledge sharing) in networks**

Knowledge is the fundamental resource in value co-creation (Vargo and Lusch, 2004a). However, given that knowledge sharing can often not be captured or documented, specifically that which is tacit in informal social interaction. Knowledge is identified as the basic operand resource that comprises sharing of multi actors' and consumers' ideas, knowledge and creativity in the articulation and expression of their current and future well-being (Ranjan and Read, 2016). Knowledge sharing was suggested as an interacting and iterative process through which actors are able to align value co-creation (Siltaloppi and Vargo, 2014). The provision of empirical evidence to support knowledge sharing as the primary resource for value co-creation is lacking.

Many studies have adopted a similar view of creation of value involving relationships in network of activities (Gummeson, 2006). In the similar vein, several authors have linked stakeholder value to network perspective to develop the notion of value co-creation (Mele et al., 2010, Mele and Polese, 2011). The qualitative analysis of the research provided evidence that knowledge sharing occurs during integration of actors resources in terms of skills, ideas and experiences for value co-creation of the community-based water supply project. The research determined empirically how different types of relationships among resource integrators, in either closeness of informal relationships, closeness of formal relationships or frequency of interactions determine value co-creation. These highly interesting gaps were uncovered in the research.

Furthermore, within the service system, although value is of concern to all actors in networks (Gummeson and Mele, 2010), however, it will often be one of the actors who acts as principal resource integrators, hence, drives the knowledge sharing (value co-creation) for other actors who take more or less inactive roles in the service system. Alexander and Jaakkola (2011) had attempted to highlight the importance of central roles played by key resource integrators and pointed out the passive recipients of value. There is no known study on value co-creation, which highlighted the specific central actors that enhanced value co-creating activities in service system. This paper improved the study of Alexander and Jaakkola (2011) by discovering the prominent or powerful of actors (central actors) in network of multi-actors of the water service system. This investigation is necessary to enhance value co-creation and aid in designing an effective service system.

Effective knowledge sharing has the ability to enhance a service system's value. Close interactive interpersonal relationships are fundamental to co-creation of value. Social friendship, intimacy and support developed through social interactions motivate knowledge sharing (value co-creation). Therefore, it is important to recognise that sharing of knowledge among actors is advantageous, thus, should be stimulated in service system as opposed to traditional bureaucratic activities. The higher the frequency of interaction and tie strength between resource integrators, the higher the occurrence of knowledge sharing (value co-creation) in service system.

It is further argued here that the identification of prominent actors in service system is in fact helpful to determine who possesses the largest amount of knowledge information being shared. The prominent actors are influential and chief contributors. Therefore, when such knowledge are shared, they contribute to the realisation of the value co-creation goal of the service system. The specific prominent roles taken up by the actors in water service system implies that it influenced the achievement of its goal.

#### **5. Conclusion**

The aim of this paper was to investigate the capacity of SNA to determine value co-creation. The paper explored knowledge sharing as a feature of value co-creation. It was however further analysed in SNA to provide advance knowledge on how value is co-created among multi-actors in networks.

Therefore, value co-creation features are present in effective service system, consisting network of diverse actors for a definite goal. Following from this conceptualisation, was the view that facilities inherent in networks, particularly, social network analysis is able to establish feature of value co-creation (Knowledge sharing) in service system. Based on the theoretical viewpoints, the research emphasised that rural water supply project should not be conceptualised as a good (provision of water facility project). Rather, network activities whose success depends on the intimate joint combination of capabilities and resources of diverse actors in interactive relationships to co-create value beneficial to the community.

The main conclusion of the paper is that the study of multi-actors in social network is significant to establish value co-creation features. In details, the tie strength of informal interactive relationships of actors such as intimate friendships and socialisation enables value co-creation more than tie strength of formal interactive relationships. Similarly, the frequency of informal interactive relationships between actors stimulates value co-creation more than frequency of formal interactions. Specifically stated, the examination of value co-creation features in social network analysis should improve the cogency of value co-creation concept. This study contributes to resource integration and informal networks for value co-creation in the delivery of community-based project. The study is the first to attempt to explore value co-creation in water supply system and make its features determinable in networks.

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