WMG Service Systems Research Group
Working Paper Series

Co-creation in Service Assemblages for Service Innovation: An Empirical Investigation

---

Xiao Ma
Susan Wakenshaw
Ahmad Issa
Jay Bal

ISSN: 2049-4297
Issue Number: 01/17

About WMG Service Systems Group

The Service Systems research group at WMG works in collaboration with large organisations such as GlaxoSmithKline, Rolls-Royce, BAE Systems, IBM, Ministry of Defence as well as with SMEs researching into value constellations, new business models and value-creating service systems of people, product, service and technology.

The group conducts research that is capable of solving real problems in practice (ie. how and what do do), while also understanding theoretical abstractions from research (ie. why) so that the knowledge results in high-level publications necessary for its transfer across sector and industry. This approach ensures that the knowledge we create is relevant, impactful and grounded in research.

In particular, we pursue the knowledge of service systems for value co-creation that is replicable, scalable and transferable so that we can address some of the most difficult challenges faced by businesses, markets and society.

Research Streams

The WMG Service Systems research group conducts research that is capable of solving real problems in practice, and also to create theoretical abstractions from or research that is relevant and applicable across sector and industry, so that the impact of our research is substantial.

The group currently conducts research under six broad themes:

- Contextualisation
- Dematerialisation
- Service Design
- Value and Business Models
- Visualisation
- Viable Service Systems and Transformation

WMG Service Systems Research Group Working Paper Series
Issue number: 01/17
ISSN: 2049-4297
January 2017

Co-creation in Service Assemblages for Service Innovation: An Empirical Investigation

Ma, Xiao
Wakenshaw, Susan
Issa, Ahmad
Bal, Jay

Warwick Manufacturing Group (WMG)
University of Warwick, Coventry, CV4 7AL, UK
E-mail addresses: x.ma@warwick.ac.uk
Susan.Wakenshaw@warwick.ac.uk
Ahmad.issa@warwick.ac.uk
Jay.bal@warwick.ac.uk

If you wish to cite this paper, please use the following reference:

Ma X, Wakenshaw S, Issa A, Bal J (2017) Co-creation in Service Assemblages for Service Innovation: An Empirical Investigation. *WMG Service Systems Research Group Working Paper Series*, paper number 01/17, ISSN 2049-4297.

Co-creation in Service Assemblages for Service Innovation: An Empirical Investigation

Abstract

Co-creation could enhance service innovation (Perks, Gruber, and Edvardsson, 2012). Despite the research conducted on co-creation, the issue concerning how actors could form service system with high density still needs to be addressed (Michel, Vargo and Lusch, 2008). We conceptualized service system as an assemblage and investigated emergence and dynamic process of assemble and dissemble of service assemblages by drawing on theories of co-creation, affordance, task network and modularity and the notion of assemblage (Delanda, 2006). We developed a framework and empirically examined how to map the competences required for actors in a task network and how capacities could be optimally (re)configured as assemblages (clusters) for value co-creation. We demonstrated that the framework developed could be applied to formation, reformation of service assemblages for design of service offerings enabling optimal value co-creation.

1. Introduction

Though much research has carried out on product innovation, service innovation research is scant (Ettlie and Rosenthal, 2011; Perks, Gruber, and Edvardsson, 2012). Previous service innovation research has centred on topics such as the service development process (Zomerdijk and Voss, 2011); service innovation techniques (Bitner, Ostrom and Morgan, 2008); user involvement (Magnusson, Matthing, and Kristensson, 2003; Edvardsson, Tronvoll and Gruber, 2011); service innovation success (Van Riel, Lemmink, and Ouwersloot, 2004); Service innovation typology (Paswan, D'Souza, and Zolfagharian, 2009); collaboration mode for service innovation (Möller, Rajala, and Westerlund, 2008; Michel, Brown and Gallan, 2008). Recently, the notion of co-creation has been applied to service innovation (Perks, et al, 2012; Mahr, Lievens, Blazevic, 2014). Service innovation is regarded as the outcome of behaviour and interactions between the firm and its network of various entities (such as customers, suppliers and distributors) (termed as actors) in the process of value co-creation (Perks et al, 2012). Co-creation entails interactions between actors in a network involving *value co-creation and knowledge co-creation* which could be exploited for the purpose of firm's service innovation (Perks et al, 2012; Mahr et al, 2014). Achievement of optimal value co-creation requires high density, i.e., maximal combination of resources between actors in contexts (Normann, 2001; Vargo and Lusch, 2004; 2008; Michel, Vargo and Lusch, 2008). Due to the variety of contexts, how a service system with high density would be achieved for value co-creation is issue yet to be fully addressed (Michel, et al, 2008). The research conducted on value co-creation in service innovation, the value examined has been the derived value from an individual actor's perspective and as an outcome of interaction and resource integration between actors in the system.

However, value at system level centres on the adaptability of service system in the environment and the emergence of service system with high adaptability to the environment needs to be investigated (Vargo, et al, 2008). In order to address these issues, the following challenges need to be considered: (1) resource integration for the emergence of service system of high adaptability (value); (2) service system diversity and dynamics for high density in a high variety of contexts at the consumers' local environment.

This paper investigates interactions between actors for value co-creation at the system level and develops a framework for the emergence of service system through resource integration in contexts. We adopt the notion of assemblage (Delanda, 2006) to define service system. We deem service system as an assemblage, in which entities/actors work together to form a whole through competence interactions for value creation. Value involves not only the derived value from actor's perspective but also value at the system level i*n terms of a system's adaptiveness or ability to fit in the environment*" (Vargo et al, 2008, p.149). Specifically, the following research questions are posed. First, how potential actors could be identified and selected based on the competences required in the context for value creation. Second, how competences could be integrated to form an assemblage with high density. Third, how the assemblage would respond to the changes in contexts through dissemblage and re-assemblage.

Drawing on notion of co-creation, affordance theory, task network, modularisation theory and assemblage theory, we developed a framework for formation of service assemblage for value co-creation including competence mapping, contextual pruning, assemblage (clustering) and dissemblage (scattering). In order to operationalise this framework, we utilised network analysis and ontological engineering method to identify actors to form the stabilised assemblage with high density in contexts. Empirically, our objectives are addressed through developing a new approach to automate service offering for various patient requirement. This approach revolutionised existing service assemblage process in the sector. By experimenting and evaluating against more than 20,000 real life cases, we demonstrated empirically, how the framework could be applied in real service design for value co-creation.

This paper is organized as follows. First, we described theories we have drawn from to develop the framework. Second, we described the methods we used to implement the framework. Third, we used medical tourism as a case to demonstrate how the framework would enable us to design innovative service offerings to meet consumer needs in their contexts. Finally, we discussed the contributions of the framework theoretically and practically. Implications for future research are discussed.

2. Theoretical Background

2. 1 Value co-creation and service system

Normann and Ramirez (1993) suggested that offerings would (1) play the role of *"enabler"* to enhance customers capabilities for performing tasks and (2) help customers to actively participate in value creation process (3) relationships

between customers and providers are "*reciprocal constellations*"; (4) offerings could be *"bundled"* (*elements being inseparable*) or *"unbundled"* (*elements being separable*) (vii-viii). These notions were further discussed by Normann (2001), which deems value as being co-created through resource integration and transformation in a value constellation via interactions of actors. Value constellation has been referred to as service system, defined as "*value creation configurations*". The notion of value co-creation has been discussed in service system (Normann, and Ramirez, 1993; Normann, 2001; Michel, Vargo and Lusch, 2004; Vargo and Lusch, 2004; Vargo, Maglio and Akaka, 2008). In service system, value is "*co-created through complex constellations of integrated resources" (Vargo, et al, 2008, p.146). In addition to the derived value from individual actor's perspective,* value is also defined from the system level "*an improvement in system well-being, ...measure value in terms of a system's adaptiveness or ability to fit in the environment*" (Vargo et al, 2008, p.149). In order to achieve optimal value co-creation, a high density of resources, "*the best combination of resources [that] is mobilized for a particular situation—e.g. for a customer at a given time in a given place—independent of location, to create the optimal value/cost result*," are required. The term of high density itself "*expresses the degree to which such mobilization of resources for a 'time/space/actor' unit can take place*" (Normann 2001, p. 27, italics in original) (cited by Michel, et al, 2008, p.155). For Normann (2001) technological advancement liberates us from constraints of time, (when things can be done); location/place (where things can be done), actor, who can do what in the constellation (with whom it can be done).

In contrast to firm centric value creation, value co-creation centres on "*co-creation of experiences of unique value in the context of an individual at a specific moment via interactions between firms and consumers in the market*" (Prahalad, and Ramaswamy, 2004, p. 11). Service dominant logic (2004; 2008) asserted their fundamental premises including customers as value co-creator; resource integrator; skill/knowledge contributor (Vargo and Lusch, 2008) and value in use, phenomenological nature of value (Vargo and Lusch, 2004; 2008); emphasizing the notion of value constellation, density, resource integration and transformation in contexts for value co-creation (Michel, et al, 2008).

2. 2 Context and contextual variety

Value is co-created in contexts (Chandler and Vargo, 2011). Context has been discussed and conceptualised from various disciplines. We don't aim to define it but to describe how context might work in our research context. One conceptualization of context have focused primarily on representational issues with the following assumptions such as (1) "a form of information… can be known... encoded and represented" (2) "delineable… define what counts as contexts of activities… in advance" (3) "stable… determination of potential contextual element…once for all" (4) "context and activity are separable …" (p.21-22, Dourish,2004). By focusing on representing contextual elements for activities, scholars have defined context as "that which surrounds, and gives meaning to something else" (Schmidt, Beigl, and Gellersen, 1999, p.893); "*location and the identity of nearby people and objects*" (Schilit and Theimer (1994); ''*location,*

identity, environment, and time'' (Ryan et al, 1997); ''*any information that can be used to characterise the situation of entities… typically the location, identity and state of people, groups, and computational and physical objects*''(Dey et al, 2001); "*context encompasses more than just the user's location, … context includes…, network connectivity, communication costs,… and even the social situation…* " (Schilit et al., 1994). We would define contexts as *information characterising time, location, and actors which can be encoded and delineated for describing ((various context driven) activity and resources links* (Normann, 2001). Contexts entail heterogeneity (variety and uniqueness) which would impose challenges for the design of offerings (product and service) to cope with these heterogeneities (Ng, 2013)

2. 3 Affordance

In order to cope with heterogeneous contexts, the design of offering would need to focus on the enabling possibilities to meet the requirements for various unique contexts. Therefore, we introduce the concept of affordance. Affordance was defined as "*opportunities for actions*" a concept introduced by Gibson (1979), an ecological psychologist to address the interactions between organisms (human, animals etc) and their environment. According to Gibson (1979; 1982), affordance is defined as an "*action possibility available to the individual in the environment in relation to the action capability of the actor, independent of the individual's ability to perceive this possibility*" (McGrenere and Ho, 2000). Thus, the existence or enactment of an affordance (a thing's action possibility) depends on the action capability of the particular actor. For example, a ball that fits into a human hand affords 'throwing' but also affords 'squeezing' for stress release. Thus, affordance frames but does not determine the human actions in relation to the thing (Hutchby, 2001, p.444). Indeed, the properties of the thing could be situationally emerged in the context of interactions between the human and the thing (Rappert, 2003, p.574). In our study, we define the properties of things or resources (human and inhuman) as competences. These competences enacted in interactions would be defined as capacities. These notions have been illustrated in the assemblage theory (Delanda, 2006). We would differentiate competences and capacities in this study in line with the definitions in assemblage theory. In addition, the existence or enactment of a thing's affordance also depends on a series of pre-requisite -- but often unstated -- shared agreement between *people in the environment*, i.e., a mutual reference frame and 'some take-for-granted assumptions and cultural conventions' (Rappert, 2003, p.576).

We suggest that affordances of the offering would entail possibilities, which could be enacted and materialised by consumers with different capabilities in different contexts. An affordance concept entails an ontology – a representation of concepts (actors, time, location, etc) and their relationships. Offerings could be tied up in a relational totality (a configuration formed by a cluster of involved concepts and relationships) consisting of the consumer, other things, other people, and activity links among them in complex sets of a context. Therefore, we need to understand how the offering could fit in the context for the consumer' actions in relation to all the other things and people. We suggest that an offering should be designed to be more dynamically reconfigurable in order to fit in with the diverse and dynamic

interactions of actors in their contexts. We suggest the purpose of resource integration and transformation is to provide affordance to enable consumers create value in contexts. For example, in order to make a cup of tea, we need boiled water, which is the transformed resource. These transformed resources could be obtained through a transformation process in which the input resources are transformed. The transformation process could be contextual and achieved through actions, interactions among actors to perform a task in consumption practices. In order to obtain the same transformed resources, the transformation process could be different taking place in contexts and require different input resources s. For example, in the home setting, water could be boiled with electric kettle. In camping, water could be boiled by wood fire. This also entails a different consumption practices. Then, we would suggest that in order to achieve optimal value co-creation, we need to provide the right resources for the right time, place in contexts for the transformation process to obtain the transformed resources required for performing the tasks.

2. 4 Task network and modularity

In order to refine capacities required and interactions between actors for performing a task/activity in contexts, we introduce the concept of task network and modularity. It could be suggested that practices/activities would be conducted in a network involving actors possessing skills, information, and material; more importantly, involving interactions and the transfer of skills, information and material between these actors. This network can be understood from Baldwin's notion of task network involving the '*nods*' ('task-cum-agents') and '*links*' ('transfer of material, energy and information' between tasks and agents') (Baldwin, 2008). Transactions occur in the task network. Transaction is defined as '*mutually agreed-upon transfers with compensation within the task network*' and '*serves to divide one set of tasks and others*' (Baldwin, 2008, p.156). Baldwin's (2008) conceptualisation of transaction is developed from a '*systems of production*' perspective. This perspective enables us to analyse the (in)-dependencies between consumers and producers, which are matched according to their tasks and ability (p.163). In this system, the basic unit is 'tasks' carried out by producers needed to produce goods and services and consumers needed to fulfil the outcomes in the context. The dependencies are based on the assumption that consumers and producers involved in the production system are characterised with physical and cognitive limitations and no agents have to conduct tasks beyond his or her ability (p.163). We use the act of medical tourism as an example to illustrate transactions.
Medical tourism entails bringing together a series of medical service providers internationally as well as other related services such as travel, insurance and carer in a foreign country. In the current best practice, a specialised medical tourism provider (an agent) can arrange all of that and confirm a service package within a few days. The context of medical tourism entails many practices due to the complexity of the healthcare and the personally specific medical requirement, and there is high dependency between different tasks. In evaluating the context, however, it is quite clear that there is the separation of services such as travel from everything else. By separating the travel from the medical procedures, two modules emerge, that of (1) travelling to the medical service provider; (2) taking

the medical care procedure. By modularising that context, new products of specialised travel package (may include carer and special insurance) can emerge, resulting in greater efficiency for the consumer (in this case the patient) as well as a wider variety of travel packages available for consumers to take up according to the personal condition.

The above example illustrates how modules could be developed in both the producer's and the consumer's domains to match their tasks respectively. Modules consist of a group of elements and these elements could be highly '*interdependent on another*" *within a module*, but only '*minimally dependent on what happens in other modules'* (Baldwin and Clark, 2000, p.63). *'By definition, modules are separated from one another by thin crossing points… they are 'near decomposable'* (Baldwin, 2008, p.166). Thus, producers could possibly design the modules for both the consumer and the producer, by dividing skills and competencies. Individuals could modularise their practices as tasks, which allows for new resource integration to occur. It is important to understand the task network in terms of the tasks (modules), the transactions and the modules in various contexts. With information technology, we suggest that firms and consumers can co-produce offerings through co-modularising their sets of tasks; distributing the competencies and transferring material and information. We argue that offerings designed in this way could be truly dynamically reconfigurable to enable the firm to serve contexts. Interactions and resources in the task network would be divided into the input modules, transforming modules, and transformed modules. Modules could be designed for dynamically configuration in different contexts for performing the task. These modules would become affordances for value co-creation in contexts. We term this process as modularity-in-use. We suggest that this process would enable us to innovate products to serve contexts in use.

Practices/activities, as a unit of analysis for both the consumer and the producer, create an interesting challenge for modularity and product architecture. Modularisations create new modules (tasks) where dependencies of tasks and skills are low, as are transaction costs. Modularisation would also create opportunities for new boundaries where new transactions and markets can be created**.** Yet, novel ways to modularise create opportunities for new offerings just as the person would modularise the medical tourism practice to accommodate the specialised travel arrangement, medical treatment, and a personalised post-surgical care in their task network (

Figure).

2. 5 Assemblage

In this paper, we use Delanda (2006) assemblage theory to materialise the process described above. According to Delanda (2006), social entities work together as a whole to achieve something that cannot be achieved by each individual entity alone. The distinction between properties and capacities is needed to understand assemblage. Here we use competences to describe properties. Properties of an entity is given and form a closed list, whereas capacities are not given and could only be exercised when the entity interacts with other suitable actors and form an

open list (p.10). A whole could be separated into analysable parts with "irreducible properties (competences)" that emerge from the interactions between parts (p.10). A given entity could be a part of a whole through the exercise of its capacities of interaction with other entities in the whole. The unexercised properties (competences) would not affect what the part is. Delanda's (2006) notion of assemblage entails "relations to exteriority" which means that assemblage could be taken apart and these components could exist to be what they are and their existence does not depend on their constitutive relationships with other components in a unity as a system (p.11).

Assemblage is defined along two dimensions. One dimension concerns the variable roles components play from a purely material role to a purely expressive role. Components could play the mixture of material and expressive roles through the interaction of their capacities. Another dimension is about the variable process in which components play in either stabilising or destabilising the identity of an assemblage. The former is termed as 'territorialisation' and the latter as "de-territorialisation". The territorialisation process entails both the real sharpening of "the spatial boundaries of actual territories" and also the 'internal homogeneity … "and de-territorialisation refers to "*any process …destabilise the spatial boundaries or increase internal heterogeneity of an assemblage*" (p.13). By exercising the capacities, components or the same component may r stabilise or destabilise the assemblage. In our research, instead of describing properties, we would focus on affordances and the related competences, the action possibilities and capacities in contexts. According to Delanda (2006), capacities in the assemblages refer to the enacted properties/competences through their interactions with other actors in the assemblage. In our research, we use capacities to describe interactions of actors in the task network to perform the tasks in contexts

2.5. 1 Conceptual framework for service assemblage for value co-creation

A proposed framework for service assemblage for value co-creation. This proposed framework proposed entails four steps. This process would be applied to each module and also consider all the modules at the same time.

a) **Competence Mapping**. Based on the concept of task network and modularisation, we suggest that practice/activity could be modularised in order to facilitate mapping interactions and exchange of skills, capabilities, and resources between actors in order to perform the task. The first step is to map the transformed modules and then to reversely identify the input modules and the affordances required. Affordances would include many possible competences due to the variety of contexts. For example, having a knee operation, the transformed modules would be solving the knee problem. Take the cured knee as a transformed module as an example; the knee could be operated on by doctors in the UK, USA or Eastern European countries. These can be deemed as potential input modules but they belong to one affordance such as enabling knee to be operated. According to affordance theory, service offerings would entail affordance, providing action opportunities and enabling possibilities for individuals for conducting specific tasks in contexts for a specific purpose. Affordances would potentially enable the service offering to cope with the

variety/heterogeneity of contexts. Of course, the exercisability of these action possibilities depends on the action capacities of other actors/entities in service system in contexts. This map of affordances would need to consider the service offerings and the human action capabilities. This mapping would produce an open list. With competence mapping, we would identify large volume of "competences" and actors with these competences.

b) Contextual Pruning. Based on concept of task network and modularisation, we suggest that practice/activity could be modularised in order to map interactions and exchange of skills, capabilities, resources between actors to perform the task. This stage entails the specification of the input modules in contexts for conducting the tasks. In this process, input modules would be identified in terms of service offerings in the domain of human actor's activity. These modules entail capacities required for actors involved in a specific context for this task. Still use the knee operation as an example. The context is different locations of the doctors. One affordance entails enabling knee operation, which could have many action possibilities such as using doctors at different hospitals at different locations. The consumer would need to have a problematic knee. This is capacity required for the customer. If the patient is in the UK and under constraints on travelling budget. In this specific context, UK doctor would be a good fit. Other modules including travelling, accommodation would fit into this context. All these actors work together as an assemblage to conduct a knee operation.

c) **Assemblage (assembling/clustering).** This step involves identifying actors with capacities and interactions between the enacted capacities (we call it capacities) among actors to form an identity for a purpose. This step is a match and select process for high density of resources. With the assembling of modules, assemblage would emerge. The trend (purpose of the task) of the assemblage could be described and the value at system level could be identified. In this process, we need to identify components/modules which could stabilise the assemblage either spatial boundaries or internal homogeneity of capacities in order to understand how to stabilise the assemblage. With the formation and stabilisation of the assemblage, it is necessary to detect the components/modules for de-stabilising the assemblage in contexts (through spatial boundaries and heterogeneity of capacities).

d) **Dissemblage (Scattering).** This step involves contextual pruning for new contexts. When the input modules were transformed by the value co-creation transformation process. These transformed modules would become the new modules in this context. With the accomplishment of the task, the established assemblage would dissemble and components would become parts and await for reassemble to form the new assemblages. Then we would return to stage one, i.e. competence mapping.

The framework would be illustrated by Figure 2.

3. Methodology

The methodology for identifying competencies, clustering based on relationship mining, and assemblage consists of the following three stages.

3. 1 Competence Mapping

The first step is to map competences of service providers and required competences of customers.

3. 1. 1 Service provider Competence Data Collection

An initial literature review on the current service, facilitated by a questionnaire (collaboratively designed with the largest medical tourism service provider – the Taj Medical Group), collected service providers' main competencies and skills, as well as their ability to adjust to different situations. For example, the following are attributes collected from healthcare service providers to confirm well-matched competence mapping.

- Key medical capabilities and processes
- Core Skills
- Awarded standards/certificates
- Operational Flexibility

A subsequent process of normalisation follows the collection. Some data categories, such as the "Level of Skills" require subjective evaluation. Therefore, an expert should verify the collected competences and their validity.

However, this process alone will not satisfy the needs to map the competences for forming service assemblages for the following reasons: (1) most service providers will only define ready-to-deploy assembled services without detailing the competence involved; 2) it is extremely time consuming and costly to fully investigate and validate the detail competences (particularly with the case of healthcare, a large competence corpus such as SNOMED (IHTSDO, 2011) has taken over 10 years in development by medical professionals from 6 countries; and 3) service providers definitions of service offerings and competences are disconnect (not interoperable) with customers'.

Therefore, we designed an automated competence ontology generation mechanism to: (1) Map the competence (entities in the ontology) for both service providers and customers; 2) Enrich the relationships among competences to flexibly modularise the task and derive the related affordances; 3) Allow assemblage and disassemblage when context changes. This process was carried out for service providers in the medical sector and in "supporting" sectors, such as transportation, accommodation, and insurance. This is necessary in order to enable the formation of service assemblages by using these competences for performing a task in context.

3.1.2 Competence Ontology Generation

Competence ontology generation started with a competence corpus construction process. This approach employs a snowball sampling mechanism (Ma et al., 2014; Salganik, and Heckathorn, 2004) in order to nominate possible competences required. It is suggested that the same approach can be used to generate a large collection of related data to construct complex social networks (Carrington, Scott

and Wasserman 2005). It can further produce a statistically meaningful distribution from unclear network structure. This sampling method is capable of building upon a few key competences recognised by major medical ontologies (such as SNOMED and UMLS), then rapidly grew the competence knowledge base by mining the online databases and dictionaries through identifying semantically related competences connected to the seeding ones.

In this work, the sampling process was configured to use paired seeding concepts to derive related concepts. The number of seeding concepts was controlled at 3 pairs of concepts per sampling process, to avoid the related concepts being misled towards unpredictable directions by the seeding concepts. Early experiments for testing the quantity and quality of related concepts showed that paired keywords generated better results than other options. Paired seeding concepts produce more domain-focused related concepts compared to using a single concept, and they also derive more concepts than using multiple concepts (as multiple concepts severely limit the number of the related concepts). Paired seeding words seemed particularly beneficial for the domain description density for both less-focused and more naturally-focused domains. However, despite the advantages of using paired seeding concepts, a seeding pair had a high risk of misleading the related concepts to an unpredictable domain, particularly if the pair was wrongly identified via literature review. To avoid such a scenario, further experiments were conducted to identify the minimum number of seeding word pairs required to provide reasonable fault tolerance. The results showed that 3 pairs of keywords appear to be the optimum requirement in order to better tolerate poor seeding concept choices.

This automated mechanism addressed key challenges that major medical ontology engineering methods have identified, such as labour intensive manual competence mapping processes, and over reliance on domain experts. More importantly, mapping competences through online databases and dictionaries, where concepts and relationships internalise both service providers and customers' perspectives, provided the corpus the breadth and the depth of competence coverage, particularly those customers' contextual driven competences. Therefore, the enriched competences bridge the service providers' and customers' competences, further to contextual use cases.

3. 2 Contextual pruning-network analysis

3. 2. 1 Customer request in context

Customer inquiries provide the contextual interpretation from the customers' perspective for required competences to form the service offering. Inquires' context could be described by the competences. The sampling method mandated that only competences that semantically relates to an existing competence will be identified. This led to a network structure with tight connectivity (rich relationships) of all competences, and yield weight differences between relationship because of the popularity such relationships appeared in the corpus. (social) network analysis methods (Yoo, Lyytinen and Boland 2008) were adopted to facilitate the ontological analysis in understanding the contextual clusters of the competence network. These methods include centrality, closeness and betweenness analysis.

3. 2. 2 Closeness and Conceptual pruning

Closeness analysis would enable us to depict the conceptual clusters around the customer enquiries. It provided a comprehensive description (from providers' perspective) of customers' defined concepts and clarify the relationships among them. Closeness analysis centres on the proportion of connections to a (or a group of) concept from another (or a group of) concept. It is assumed that in the network of derived concepts, certain concepts are more "closely" related than the others in a given context. This relevant power can indicate the "closeness" between concepts. For instance, in the derived medical tourism network, cosmetic surgery was nominated 7108 times by fellow members. Among the 7108 connections, breast surgery originated 428 times, and liposuction contributed 643 times. As a result, this research considers that liposuction possessed more than 1.5 times closeness measure towards cosmetic surgery compared with breast surgery. Closeness analysis further reveal how key/core concepts could have various derivative power towards their neighbouring concepts and give meanings to them. Through closeness analysis, we can identify the relevancy of providers' competences towards a customer defined contextual use case.

3. 2. 2. 1 Conceptual Centrality and Clustering

Once closeness of all concepts towards a conceptual case revealed, Centrality analysis can be deployed to *measure the total number of connections a concept may have in a contextual cluster*. Centrality analysis would identify the highly connected concepts in the target network. A member of the network with high centrality were "derived" (related to the contextual case) more times than others, and this competence could be regarded as more representative (or understood as more fundamental competence) to provide the service offering in the contextual use case, or more "centrally" located. Furthermore, centrality analysis also indicates how competences may be clustered, as representative concepts cluster their groups of concepts (social network members) within the network (Katz, 1953). Centrality analysis would enable us to identify the key competences to define the contextual use case's construct.

3. 2. 2. 2. Betweenness

While two competences may only share a low closeness, the betweenness – identifying a 3rd competence that connects to both concepts with stronger ties, is required to clarify the construct of how loosely connected competences may work together. First, "betweenness" analysis could assist in identifying the bridging elements that connect members in the domain /sub-network through uncovering the overall structure of the network. This analysis would identify those members whose importance may be missed by centrality and closeness analyses, but may bridge the gaps between concept clusters. Second, betweenness analysis would reveal the relationships between individual concepts or groups of concepts through identifying the concurrent members with overlapping concepts. In such cases, the betweenness analysis will provide the brokering intelligence between conceptual clusters.

3. 3 Assemblage: Network analysis-clustering

With Service providers with suitable competencies are identified in this stage to perform the sub-tasks/modules identified in the previous stage, to form service offering (assemblage) as a response to the customer request (a business opportunity). Usually, more than one actor would be required to address the customer request in a service assemblage. The service assemblage formation process has two key stages:

a) **Identification of Possible Service Providers**: Using competencies from the service provider's competencies that are stored in the ontology based service assemblage system's database, the methodology identifies those service providers that have the correct competence/capacity in contexts. At this stage, the user can remove any possible service providers from further consideration. The user can also view the competence profiles to help make this judgement, a task eased by the fact that all competence profiles share the same format.
b) **Assemblage Formation**: The remaining possibilities for the service providers are then scored/weighed by attributes in contexts collected in competence mapping stage. So for example, in consumer contexts, the time, location, consumer budget, distance to the hospital, etc could be form different contextual variety and these elements would be deemed as consumer competences. In performing a task, all the actors' competences would be examined and the right actors with the right competences would be selected to form the service assemblage. When consumer contexts changes, they would need to engage in a new service assemblage, which could result in requiring more than one new competency to establish the offering, then the same matching procedure would be used to identify the new service providers. This re-configuration can also happen during the implementation of the service offering when one or more members of the assemblage could not carry out their part of the service. The methodology can easily reconfigure the assemblage using other service providers with similar competences to the replaced ones. It is important to note that service providers can belong to different assemblages at the same time based on their capacity.

4. Medical Tourism Case Study

The Taj Medical Group (TMG) is a leading medical tourism facilitator, and has arranged treatment for over eight hundred international patients from the UK and other countries. A major problem faced by medical tourism service providers such as TMG was the level of resources required for the process of matching their patients' enquiries with the competences of different medical treatment providers. The business suffered from low efficiency as a result of the resources required for each enquiry and a low conversion rate from enquiries to paying patients. Advertising generated many customer enquiries, which used to be manually categorised and matched to likely treatment procedures. Following this, the available service providers were manually matched against the enquiries based on their treatment profile and competence. This whole process required expert

company resources, and made the business fundamentally unprofitable. We could suggest that TMG has been attempting to achieve high resource integration by matching the patients' enquiries (competences) with the competences of medical treatment providers. This process could be described as formation of service assemblage. We would use TMG as a case to demonstrate how our framework would enable the formation of service assemblage with high density for value co-creation.

4. 1 Competence Mapping

This stage involves mapping the competences of service providers and customers for performing a task. Here the task for medical treatment providers is to treat and cure patients. For patients, it is to have their illness cure and become healthy which could be the transformed modules. In order to accomplish these tasks and achieve these outcomes in general, competences of medical treatment providers and patients need to be mapped and pooled for search, match and select in specific contexts. To enhance the process, TMG proposed a grouping of their service providers and the customer enquiries against the same ontology, so that smart automatic matching could be achieved.

The competences of medical services provided by TMS were categorised and divided into eleven main groups, as

Figure shows:

In addition to these descriptions from service providers' perspective, TMG also used alternative descriptions from customers (thesaurus in most cases) of their proposed concepts in order to capture the customer capacities in their contexts. For instance, "dentistry" is also described as "dental surgery", and "otolaryngology" is also named "head and neck surgery". The inclusion of non-expert terms reflects TMG's efforts to present "patient friendly terminology" in order to connect generic terms to their medical specialist terms. Within each category, more detailed information relating to the medical procedure is structured (50 categories in lower level ontology). For each of these sections, detailed explanations of surgeries and related treatments were also translated into non-professional language so that patients can be better informed before they take any action. A similar approach has

been adopted by the National Health Service (NHS) to provide services to patients for self-help health checks (NHS, 2010).

However, a study that analysed more than 20000 TMG's customer enquiries over a four year period revealed that their old competence ontology derived by service providers was only able to match less than 50% of the terms that appeared in the enquiries, although TMG has tried to collect terms that were used by patients. In addition, the function of bridging the professional terminology and non-expert vocabulary still failed. It was surmised that a lack of a broad coverage of non-expert terminologies led to such a failure. Moreover, There were also many occasions when enquiries were not fully interpreted, and hence, they were not allocated to all necessary categories, sometimes even to the wrong categories. TMG required an ontology that covered the medical domain, largely but not exclusively focused on the "elective" treatments area.

The derived ontology based service assemblage system for this research was built to enable the value co-creation enquiry match in medical tourism for TMG. The corpus construction experiments (discussed above) brought back 1,269 unique terms with 521,754 relationships among them. On average, there were 404 relationships to a single term. The original TMG ontology could only generate 301 concepts, less than 900 relationships, and thus less than three.

TMG proposed a competence categorisation with eleven top relationships linked to a single concept level concepts (first column in Table), these being: orthopaedic, cosmetic, Cardiology, comprehensive health checks, abdominal surgery, Dentistry, vascular, otolaryngology, neurosurgery, paediatric and ophthalmology. Ten of these eleven concepts were proposed by the new ontology as definition zone concepts (in Table, horizontal green background indicated concepts found in definition zone; blue background indicated alternative concepts found in definition zone; red background indicated concepts not found in the top zone. Vertically, the first column included TMG concepts; the second and fourth column included matching concepts in the new ontology in their formal terminology and thesaurus terminology; the third and fifth column included centralities of correspondent concepts).

Moreover, four of the alternative phrases were also found in the definition zone. The only missing concepts - comprehensive health check was captured in the description zone. In addition, the new medical ontology covered more areas by retrieving more top level concepts (Table). Besides the top level concepts, TMG also proposed another 290 further concept descriptions. However, these descriptive terms did not all appear in the new ontology's lower zones. In total, more than 70% of the TMG concepts appeared in the definition zone and description zone. This result may be because these descriptions in TMG were specifically defined medical procedures with a higher relevance for medical tourism. While the new ontology was chasing connections from three pairs of high level seeding words, some detailed terms representing specific procedures were missed. Further experiment revealed that these detailed terms could have been linked to the ontology by involving more specific terms as seeding words.

The internal relationship richness is comparable to some larger ontology such as UMLS and SNOMED CT in the medical domain. The UMLS meta-thesaurus which combined relationships from more than 100 sources only provided 13 relationships

to a concept on average. Although the new methodology extracted fewer concepts (due to the focus of seeding words and only three rounds of snowball sampling) than SNOMED CT, it captured nearly half the number of relationships that SNOMED proposed. SNOMED CT extracted large number of concepts by consulting thousands of medical professionals, while the new corpus was achieved by starting with three pairs of seeding words in a fraction of the time: less than 12 hours were spent on automated corpus construction and ontological analysis in building this new medical domain ontology. SNOMED CT cost more than 10 years of time and required doctors and nurses from six countries to reach the current stage. The original TMG ontology engineering took more than 600 hours of effort (one ontology builder's research time of 500 hours and 100 hours domain experts' contribution), while the new derived ontology generated took less than a day to generate its concepts and relationships.
A practical evaluation was carried out using an information system (

Figure) to assess whether the ontology based service assemblage system would function as an information categorisation filter as desired. Natural language enquiries were fed into the system. As soon as the enquiry was received, the system used the ontology structure to analyse the enquiry and tried to tag the enquiry with ontology concepts. As a result, the tags indicated which category this enquiry should belong to.
It is suggested that consumer nature language request could be translated through the ontology structure which can be used to select service providers with the best matched competences.

4. 2 Contextual pruning and assemblage

The combination of centrality, closeness and betweenness analysis formed a competence network and enabled the automated systematic procedures to select the actors with the right competences (capacities) to serve the consumer context. Take for example A, 14-year old from Dorchester who suffered an injury to his spine in an ice-skating accident in 2004. In order to do the required spinal surgery for free on the NHS, Mr. Knott should have waited a 17-week to see a specialist and a further nine months for surgery. The surgery would have cost £25,000 had Mr. Elliot chosen to do it in UK, which was not affordable by his parents. Mr. Knott was virtually housebound and in pain, so his parents decided not to wait for the NHS and instead a request was sent to the ontology based service assemblage system to see if the care package can be arranged more speedily in another country. The enquiry contained keywords such as "Broken spine" and "lower section of the spine", which were captured by the ontological network at the customer enquiry level. Through centrality analysis and closeness analysis, it traced back towards the main service provider competence - "spinal surgery". Within the network cluster led by spinal surgery, a few other important competences (closely connected to spinal surgery and relatively more centrally located than other competences) such as orthopaedic check-ups, cardiac check-ups, X-Ray, MRI (Magnetic Resonance Imaging) were suggested. Betweenness analysis also identified that spinal surgery patient may require wheelchair and led to a request to competences such as specialised disable care. Such competences where matched against existing

providers, whose competences have been profiled, to propose a few key service providers with their location, cost, and (treatment and record) compatibility to the National Health Service in the UK. When the patient chose the target providers located in India, an international travel context was triggered, and further led to some other related mandatory competences (via closeness and centrality) such as travel insurance for medical tourists, medical insurance, immigration services (passport and visa services), flight ticket, local care providers (specialised facilities and hotels), even translation services (
Figure). Once more, the service providers who have been profiled to have these competences were listed for comparison over price and details of their service packages. However, in this occasion, not all international travel related services providers were selected. As the international travel cluster was proposed by the spinal surgery cluster, it was also influenced by the existing medical case of spinal surgery. As a result, only those international travel related service providers who have been profiled with competences in spinal surgery were proposed to be potential providers. Based on the contexts provided by the patient, such as the budget and preferred countries, the entire assemblage process has identified the best service providers for the required competence. The spinal surgery and associated check-ups were provided by one hospital with the cost of £4,000 (in this case, travel was paid handled separately by the patient's family).

In a similar process, the ontology based service assemblage system was formed for K. Holman, who had a damaged knee, a £1,400 speedy keyhole surgery at a top hospital in India, the same operation was just, to replace an alternative UK private hospital cost of £9,000 in the UK (the case was considered non-urgent by the UK free National Care Service, which resulted a 12 month waiting list.

The keyhole surgery request was analysed using the derived ontology based service assemblage system in order to identify the required competences and match them with potential service providers. No single service provider was able to meet the specifications of her request. However, an assemblage of service providers who have different relevant capabilities was identified by the system to form a team in order to fulfil the customer request. The following competences were identified:

- Knee Surgery
- Medical Check-ups
- International Travel
- International Accommodation
- Passport and Visa Services
- Travel Insurance
- Health Insurance

Through a similar fashion of context pruning and competence matching, this case filtered against more than 200 medical service providers (hospitals and other independent healthcare services providers) and 51 travel related service providers. The assemblage process has identified the best service providers for each competence and the holistic service offering was presented to the customer using the minimum number of service providers possible. For example, both the knee surgery and check-ups were provided by one hospital in India with the cost of £1,400, while the travel and accommodation were provided by a travel agency. In addition, Mrs. Holman was able to check out the potential surgeon's qualifications

on the system (he was trained in Britain) and he e-mailed them with his mobile phone so they could discuss through any concerns.

The assemblage of service providers was successful in meeting the requirements of the customer from the minute Mrs Holman left her home till her return: Visas, passports, tickets and transfers were all handled by the assemblage, which took the stress out of the whole process. This particular case demonstrated that even though a single service provider is unable to meet a demand, by forming an assemblage comprising individual service providers with specific capacities, such demands could be met through the automated ontology based service assemblage system.

In both cases, the post-surgery service context was pre-defined before the medical tourism, therefore, the compatibility of the surgery detail and medical record to NHS were pre-mandated. The post-surgery care requirement was further fed back into the system as a new request to identify required competences, and the system identified locally based services providers (NHS hospitals or patient selected service provider) and formed new assemblages for post-surgery care providers. Such continuously defined new service context led the service assemblages to be formed and de-formed as request. As a result, the system managed to successfully assemble 800 patient cases from nearly 30 countries, involved healthcare providers in 15 countries, and transferred patients back into their home counties.

5. Discussion

Co-creation could enhance innovation. In order to enhance our understanding of value co-creation to improve service innovation, how actors could assemble to form service system with high density need further investigation. This study addresses how to form a service system with high density with the high variety and heterogeneous contexts. In our study, we developed a framework for engineering service system by employing the notion of assemblage (Delanda, 2006), the "relations to exteriority", which viewed systems/assemblage are organised in contexts for external reasons and can be taken apart and assemble by their capacities whenever needed to form an identity for a purpose. This framework would enhance service innovation by providing service offerings for optimal value co-creation in high variety of contexts.

5. 1 Research implications

Our study contributes to service innovation and service system. Consumers and services providers are actors in service system and are both resource integrators, a fundamental premise in SD logic (2004; 2008). Consumer resources are beyond firms' control. Stressing high density for optimal value co-creation, our research developed the framework including *Competence Mapping; Contextual Pruning; Assemblage (assembling/clustering) and Dissemblage (Scattering)* which would enable the selection, the matching and assembling and dissembling of capacities between actors in contexts for resource integration and value co-creation. Value here is not limited to the derived value or outcomes of these interactions but also the value (stability or adaptability to the local environment) at system level in contexts. This study conceptualises and empirically tests a research framework for

a fine-grained investigation of formation of system through capacity assembles for value co-creation.

A second contribution of this study is the empirical implementation of the framework for high density resource integration for value co-creation. By introducing the notion of assemblage, the focus is not on the properties of offerings but on the capacities when they interact with each other and consumers in contexts. Capacities are the enacted affordances and the materialised possibilities in contexts. Only affordances can cope with the heterogeneous contexts by providing the activity possibilities enacted by the actor's capacities. However, the potential possibilities and potential actors for service system could be huge. How to pin down these capacities and actors in contexts for purpose with high density, we introduced ontology and semantic analysis to achieving the best combination of capacities for contexts. The methodology in this study enabled the implementation of the research framework.

5. 2 Managerial implications

The framework and the methodology employed in this study have several implications for firms that expanding their innovation activities through customer co-creation. Before investing in it, managers need to review the specific resource-integration process and service system. It appears that customer resource integration provides most value through its customisation to specific tasks. Such service system tends to emerge in the development of service offerings with firm's current domain rather than in radically new service offerings. In the marketplace, Electronic network of practice (ENoP) (Wasko and Faraj, 2005) has been developed to act as an enabler for collaborative networks for registered service providers. However, E-NoPs that are mainly using the technology to display e-catalogues of their products/services will not be able to support the creation of assemblages to address complex cases similar to the ones discussed in this paper.

Technological development, in particular the digitalisation process would allow data to be liquefied and flow freely between actors. This would eliminate the constraints on information and would further enhance resource integration. The system like the medical tourism investigated in this study would be very implementable with the supply of information of actors regarding their activities, their resources and their capacities in contexts. Practically, firms could manage the service systems, assemblage and dissemblage in contexts for high density for value co-creation. This paper has provided a conceptual framework, which can be tailored to different services and implemented for the personalised services with the potential for optimal value co-creation.

5. 3 Directions for future research

Several limitations of this study may suggest additional research directions. First, this study focuses on the activities and interactions between actors for achieving a purpose by forming a system/assemblage. However, how these activities can be derived need to be further by mean-end analysis form the field of AI addressed. In our research, we suggested using the modularisation, modules and task network to understand the activities as modules and then the interactions between these activities, the exchange of resources and information etc can be further

understood. According to task network theory, the modularity needs to focus on the boundary modules rather than with modules to reduce the transaction cost. These issues are not adequately addressed in our study. Therefore, future research should consider to consider identifying modules with thin crossing point and using these modules for forming the service system.

A service system are embedded in a larger social system. Research on the factors affecting the implementation of service system and the effect of service system on the wider organisational field (ecosystem) would need to be addressed for the success of service system for service innovation. The understanding of how the markets for these service system could be created would have significant impact on the implementation of service system and this framework in practice. If service system could be deemed as actor network and the market for the service system would be the process of actor network building. All the actors engaged in the network would affect the success of the network. For example, during the implementation of this service, Indian government has set up a system to fast-track medial visa in response to the rise in medical tourism. Therefore, a further research is to focus on the investigation of development of the actor network in which the service system was embedded and the role played by actors in the network for the sustainability and adaptability of the network, i.e. the market of the service system.

References

Baldwin, Carliss Y. and Kim B. Clark (2000). *Design Rules, Volume 1, The Power of Modularity*. Cambridge MA: MIT Press.

Baldwin, Carliss Y. (2008), "Where Do Transactions Come From? Modularity, Transactions, And The Boundaries Of Firms," *Industrial Corporate Change*, 17(1), 155–195.

Bitner, M. J., Ostrom, A. L., and Morgan, F. N. (2008), "Service blueprinting: a practical technique for service innovation," *California management review*, *50*(3), 66-94.

Carrington, P.J., Scott, J. and Wasserman, S. (2005), *Models and Methods in Social Network Analysis*. Cambridge, MA: Cambridge University Press.

Chandler, J. D., and Vargo, S. L. (2011), "Contextualization and value-in-context: How context frames exchange," *Marketing Theory*, *11*(1), 35-49.

Delanda, M. (2006), *A new philosophy of society: Assemblage theory and social complexity*. NY: Continuum.

Dourish, Paul (2004), "What we talk about when we talk about context," *Personal and Ubiquitous Computing,* 8(1), 19-30.

Dey, A. K. (2001), "Understanding and using context," *Personal and ubiquitous computing*, *5*(1), 4-7.

Ettlie, J. E., and Rosenthal, S. R. (2011), "Service versus Manufacturing Innovation," *Journal of Product Innovation Management*, *28*(2), 285-299.

Gibson, James J. (1979), *The Ecological Approach to Perception.* London: Houghton Mifflin.

Gibson, James J. (1982), *Reasons for Realism: Selected Essays.* New Jersey: Lawrence Erlbaum Associates.

Hutchby, Ian (2001), "Technologies, Texts and Affordances," *Sociology*, 35(2), 441-56.
IHTSDO (2011). SNOMED Clinical Terms (SNOMED CT) [Online]. Available from: http://www.ihtsdo.org/snomed-ct/snomed-ct0/ [Accessed 22/05/2011].
Klein, D. A. (1994), *Decision-analytic intelligent systems: automated explanation and knowledge acquisition*. Psychology Press.
Ma, X., Bal, J., and, "A fast and economic ontology engineering approach towards improving capability matching: Application to an online engineering collaborative platform," *Computers in Industry*, *65*(9), 1264-1275.
Mahr, D., Lievens, A., and Blazevic, V. (2014), "The value of customer co-created knowledge during the innovation process," *Journal of Product Innovation Management*, *31*(3), 599-615.
Magnusson, P. R., Matthing, J., and Kristensson, P. (2003), "Managing user involvement in service innovation experiments with innovating end users," *Journal of Service Research*, *6*(2), 111-124.
McGrenere, J. and Ho, W. (2000), Affordances: Clarifying and Evolving a Concept. In: Proceedings of Graphics Interface 2000 (Montreal, May 2000), A K Peters, 179-186.
Michel, Stefan, Stephen W. Brown and Andrew S. Gallan (2008), "Service-Logic Innovations: How to Innovate Customers, Not Products," *California Management Review*, 50(3), 49-65.
Michel, S., Vargo, S. L., and Lusch, R. F. (2008), "Reconfiguration of the conceptual landscape: a tribute to the service logic of Richard Normann," *Journal of the Academy of Marketing Science*, *36*(1), 152-155.
Möller, K., Rajala, R., and Westerlund, M. (2008), "Service innovation myopia? A new recipe for client-provider value creation," *California Management Review*, *50*(3), 31-48.
NHS (2010), "Health A-Z - Conditions and treatments," Vol. 2010.
Ng, Irene C.L. (2013), *Value and Worth: Creating New Markets in the Digital Economy*. Cambridge: Innovorsa Press
Normann, R. (2001), *Reframing Business: When the Map Changes the Landscape*. Chichester: Wiley.
Normann, R., and Ramirez, R. (1993), "Designing interactive strategy: from value chain to value constellation", *Harvard Business Review*, 71, 65–77.
Perks, H., Gruber, T., and Edvardsson, B. (2012), "Co-creation in radical service innovation: a systematic analysis of microlevel processes," *Journal of Product Innovation Management*, *29*(6), 935-951.
Paswan, A., D'Souza, D., and Zolfagharian, M. A. (2009), "Toward a contextually anchored service innovation typology," *Decision Sciences*, *40*(3), 513-540.
Patrício, L., Fisk, R. P., and Constantine, L. (2011), "Multilevel service design: from customer value constellation to service experience blueprinting," *Journal of Service Research*, 14 (2), 180-200.
Prahalad, C. K., and Ramaswamy, V. (2004), "Co-creation experiences: The next practice in value creation," *Journal of interactive marketing*, *18*(3), 5-14.
Rappert, Brian (2003), "Technologies, Texts and Possibilities: A Reply to Hutchby," *Sociology*, 37(3), 565-80.

Ross, J. W., and Westerman, G. (2004), “Preparing for utility computing: The role of IT architecture and relationship management,” *IBM systems journal*, *43*(1), pp. 5-19.
Ryan, N., Pascoe, J., and Morse, D. (1999), “Enhanced reality fieldwork: the context aware archaeological assistant,” *Bar International Series*, *750*, 269-274.
Salganik, M. J., and Heckathorn, D. D. (2004), “Sampling and estimation in hidden populations using respondent-driven sampling,” *Sociological methodology*, *34*(1), 193-240.
Schilit B, Theimer M (1994), “Disseminating active map information to mobile hosts,” *IEEE Network* 8(5), 22–32.
Schilit, B., Adams, N., and Want, R. (1994), Context-aware computing applications. In: *First Workshop on Mobile Computing Systems and Applications, WMCSA 1994.* (pp. 85-90). IEEE.
Schmidt, A., Beigl, M., and Gellersen, H. W. (1999), “There is more to context than location,” *Computers & Graphics*, *23*(6), 893-901.
Slutsky, A. (2015), Toward Effective Knowledge Discovery in Social Media Streams (Doctoral dissertation, DREXEL UNIVERSITY).
Van Riel, A. C., Lemmink, J., and Ouwersloot, H. (2004), “High-technology service innovation success: a decision-making perspective,” *Journal of Product Innovation Management*, *21*(5), 348-359.
Vargo, S. L., and Lusch, R. F. (2004), “Evolving to a new dominant logic for marketing,” *Journal of marketing*, *68*(1), 1-17.
Vargo, S. L., and Lusch, R. F. (2008), “Service-dominant logic: continuing the evolution,” *Journal of the Academy of marketing Science*, *36*(1), 1-10.
Vargo, S. L., Maglio, P. P., and Akaka, M. A. (2008), “On value and value co-creation: A service systems and service logic perspective,” *European management journal*, *26*(3), 145-152.
Wasko, M. M., and Faraj, S. (2005), “Why should I share? Examining social capital and knowledge contribution in electronic networks of practice,” *MIS quarterly*, 35-57.
Yoo, Y., Lyytinen, K., and Boland, R. J. (2008), Distributed innovation in classes of networks. In: *Proceedings of the 41st Hawaii International Conference on System Sciences,* pp. 58-66. Los Alamitos, CA: IEEE Computer Society Press.
Zomerdijk, L. G., and Voss, C. A. (2011), “NSD processes and practices in experiential services,” *Journal of product innovation management*, *28*(1), 63-80.

Figures and Tables

Figure 1: Value co-creation process and modularisation

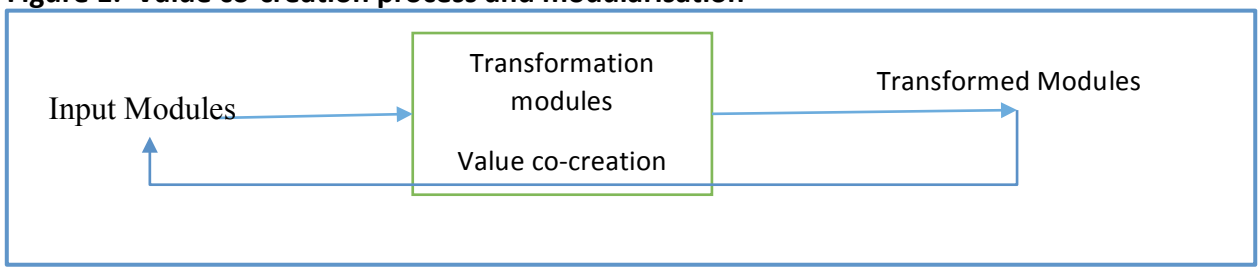

Figure 2: Service assemblage for value co-creation

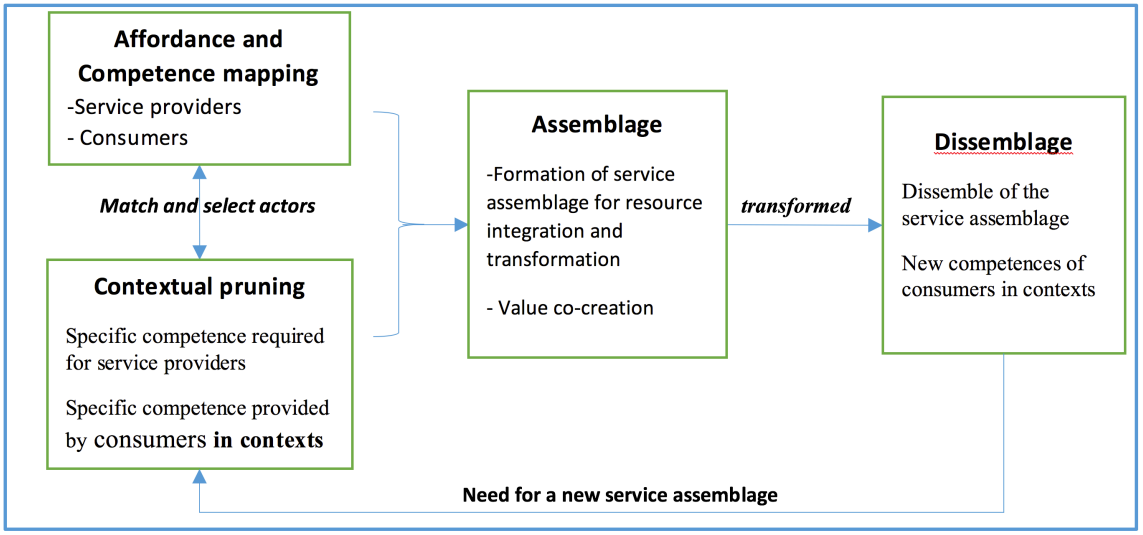

Figure 3: Illustration of TMG's "old" ontology structure

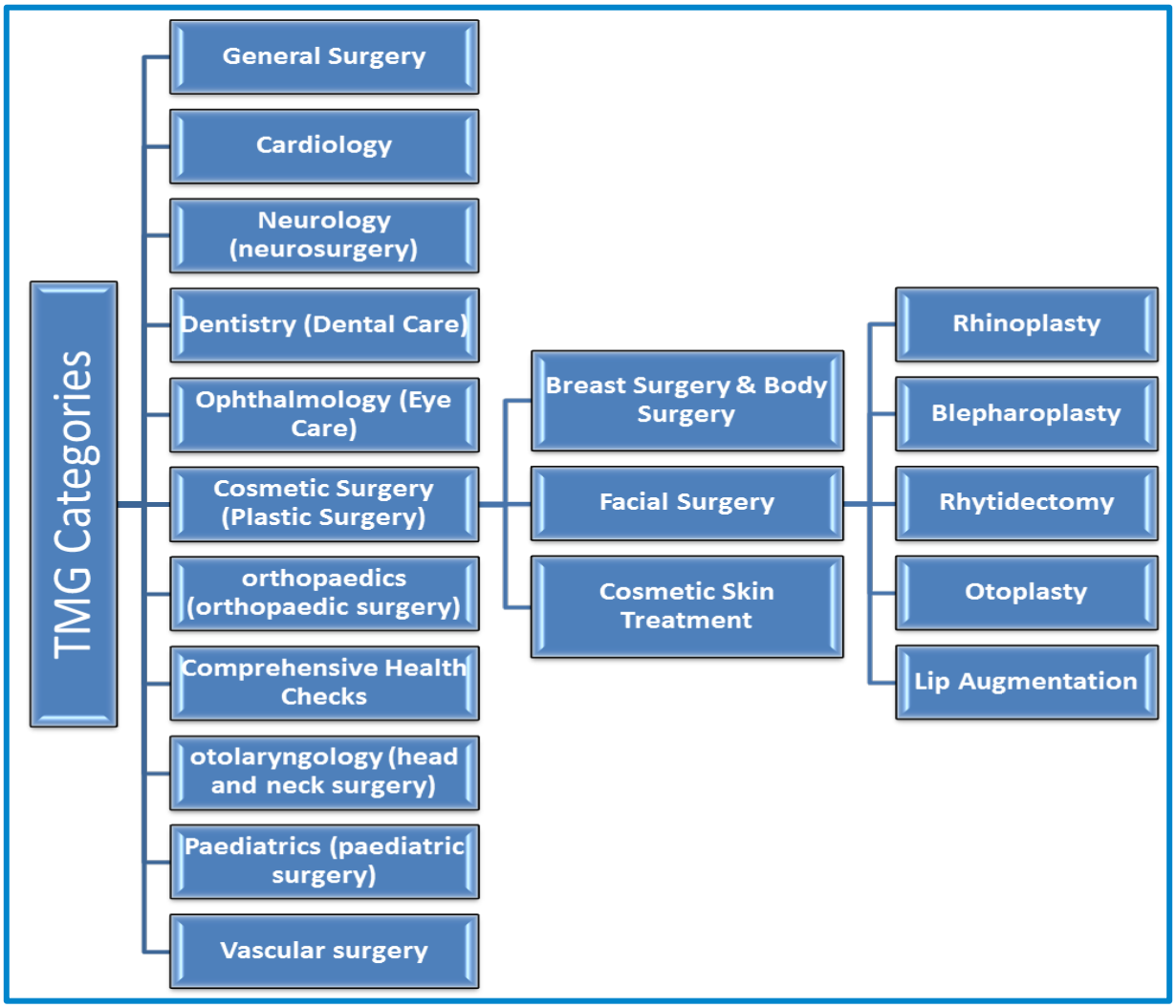

Figure 4: Part of the Derived Medical Ontology

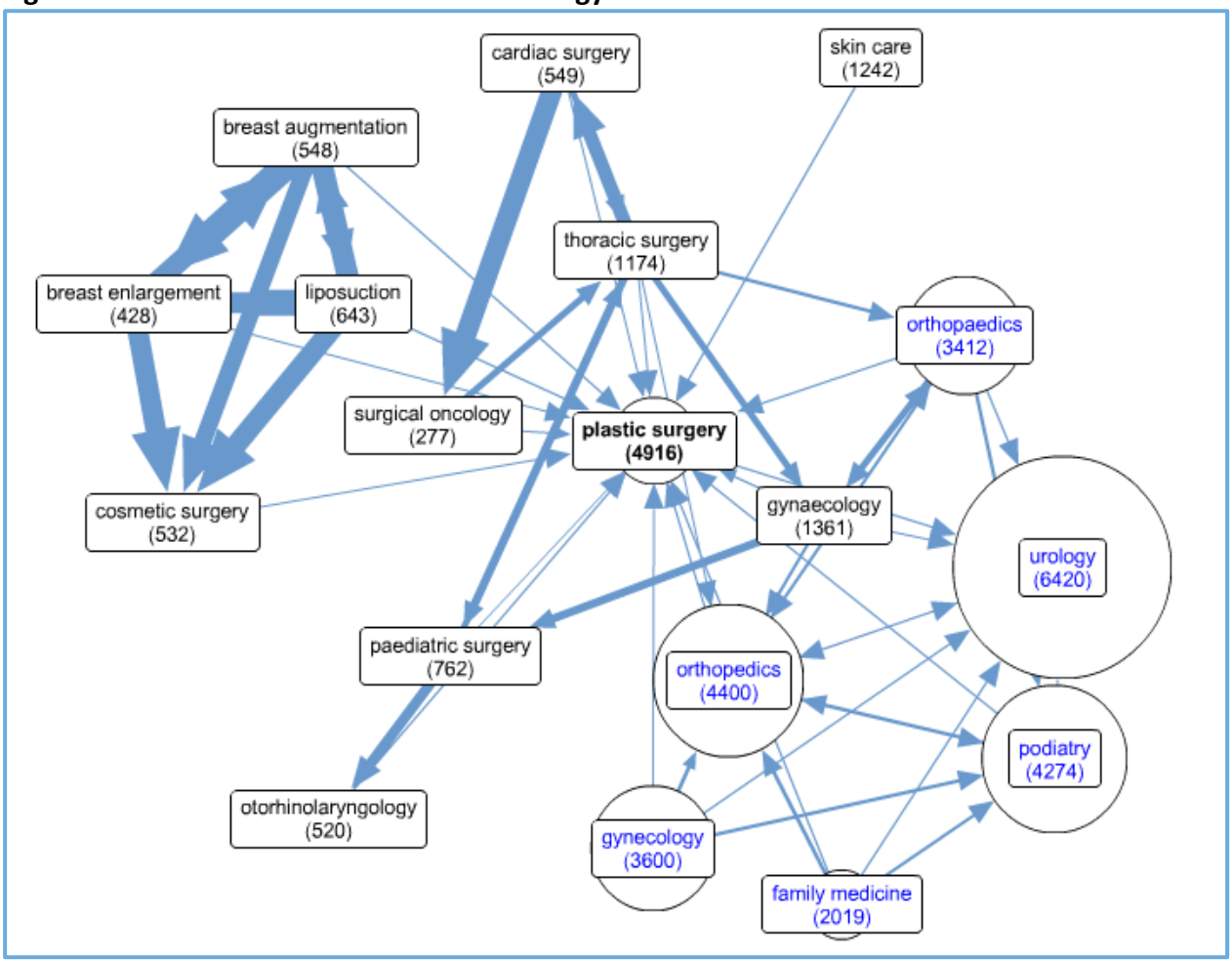

Figure 5: The ontology application environment

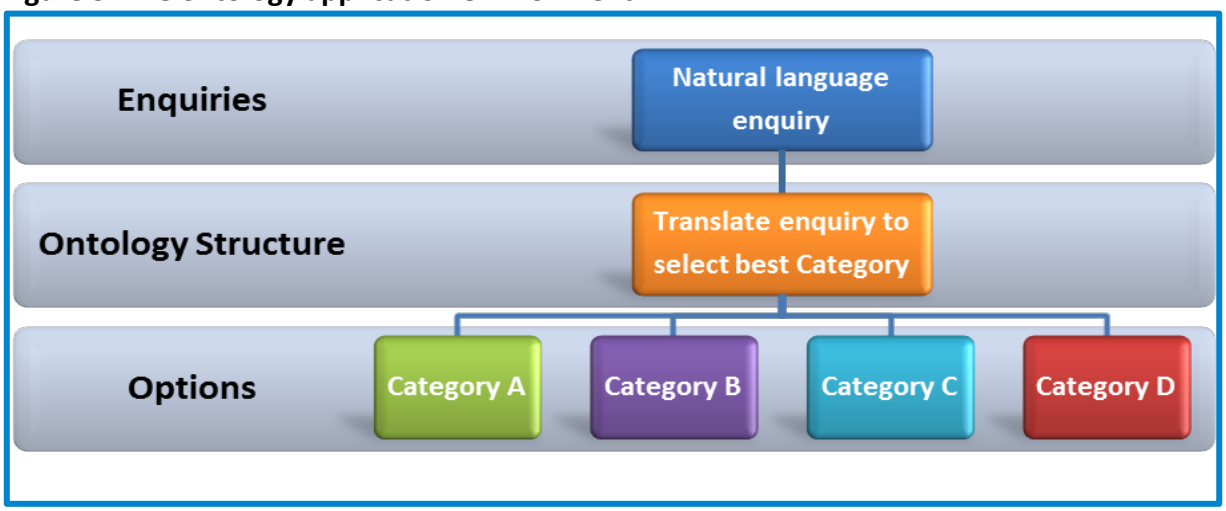

Figure 6: Service Assemblage

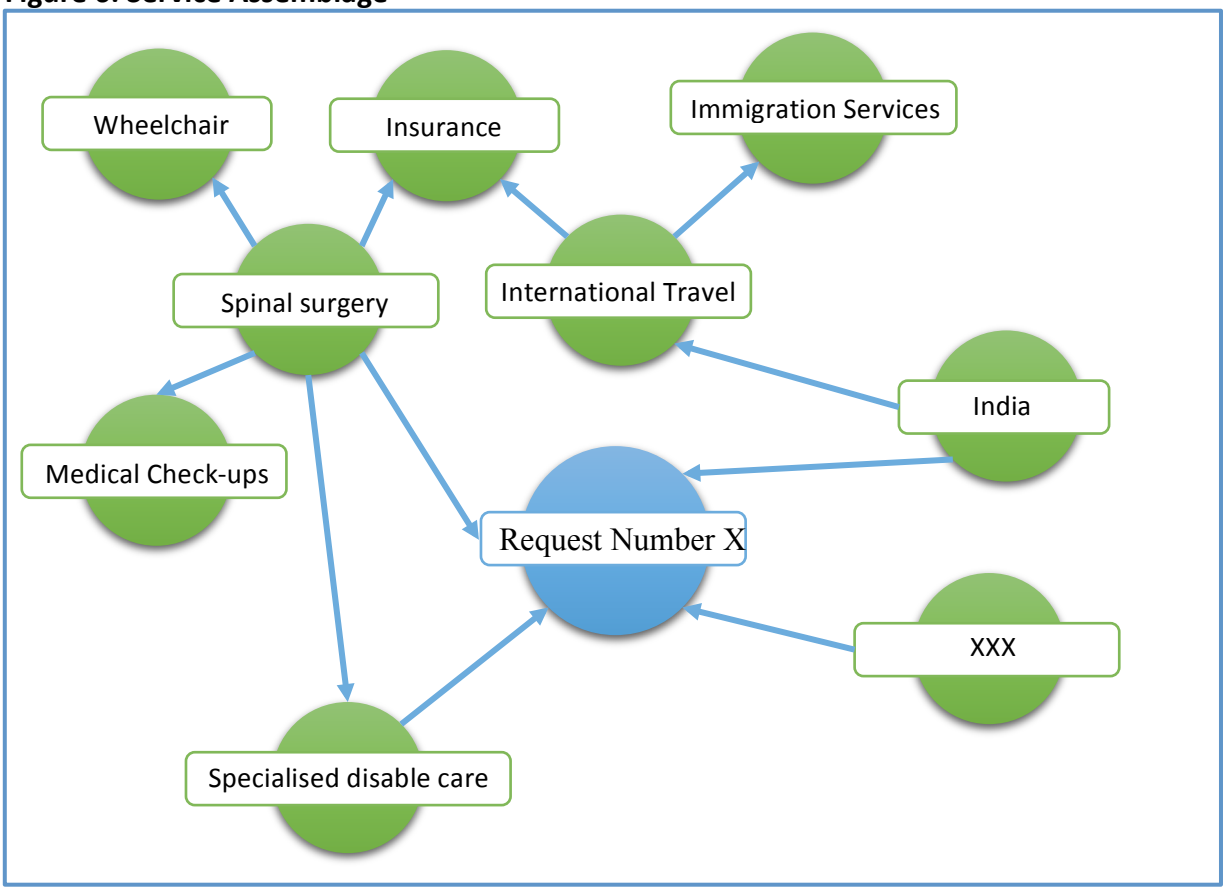

Table 1: Ontology Content Comparison

TMG Concepts	New medical ontology concepts (with centrality)			
General Surgery (abdominal surgery)	General surgery	6280		
Cardiology (Cardiac Surgery)	Cardiology	7398		
comprehensive health checks				
Cosmetic surgery	Cosmetic surgery	7108	plastic surgery	5099
Dentistry (Dental Care)	Dentistry	4465	Dental	2066
Neurology (neurosurgery)	Neurology	6481	Neurosurgery	4598
Ophthalmology	Ophthalmology	7150		
Orthopaedics (orthopaedic surgery)	Orthopaedics	4582	Orthopaedic surgery	5388
otolaryngology (head and neck surgery)	Otolaryngology	4430		
Paediatrics (paediatric surgery)			Paediatric surgery	7119
vascular surgery	vascular surgery	2927		

Concepts Found in the Definition Zone

Alternative Concepts Found in the Definition Zone

Concepts not Found in the Definition Zone

Table 2: Extra top zone members in the medical ontology experiment

New ontology extra concepts with centralities					
internal medicine	7049	Rheumatology	4321	Haematology	2750
Psychiatry	6853	Pulmonology	4287	Pharmacy	2650
Urology	6603	Endocrinology	4180	Geriatrics	2517
Anaesthesiology	5989	Nutrition	4087	infectious disease	2456
Dermatology	5922	Diabetes	3799	family medicine	2198
emergency medicine	5870	Gynaecology	3782	diagnostic radiology	2144
family practice	5566	Orthopaedics	3591	geriatric medicine	2054
Podiatry	4454	pain management	2898	Cancer	2034
Nephrology	4331	radiation oncology	2823	Orthodontics	2005

Table 3: How Medical Costs Compare (Year 2005)

	HEART BYPASS	HIP REPLACEMENT	CATARACT OPERATION
BRITAIN	£15,000	£9,000	£2,900
FRANCE	£13,000	£7,600	£1,000
US	£13,250	£15,900	£2,120
INDIA	£4,300	£3,180	£660