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## **A Knowledge-based framework for Service Management**

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### **Abstract**

The purpose of this paper is to investigate how information and communication technologies are used for service standardisation, customization, and modularization by knowledge intensive service firms through the development and empirically validation of a knowledge-based framework. This paper uses 59 in-depth interviews, observational data, and document analysis from case studies of three service related departments in high-technology, multinational KIBSs. Prior research does not conceptualise the relationships between service customisation, standardisation and modularisation. This paper seeks to overcome this gap by integrating insights from research on the role played by both knowledge and ICTs to construct and validate a framework to deal with this gap. It outlines the implications for service firms use of ICT to deal with increasing knowledge intensity as well as indicating the circumstances under which service knowledge is best customised, standardised and modularised. Further testing in other industries would prove useful in extending the usefulness and applicability of the findings. The originality of the paper lies in developing and validating the first framework to outline the relationship between how service knowledge is customised, standardised or modularised and indicating the associated issues and challenges. It emphasises the role of knowledge and technology. The value of this framework increases as more firms deal with increasing knowledge intensity in the services they provide and in their use of ICTs to reap the benefits of appropriate knowledge re-use.

### **1.0 Introduction**

It is possible to achieve service deployment efficiently through service processes which are standardised (Bottcher and Klinger, 2011, Davis et al., 2007, Sundbo, 2002, Tuunanen and Cassab, 2011). This is not always suitable (Gallouj and Weinstein, 1997), particularly when the services are specialised (Aas and Pedersen, 2013) and necessitate customised solutions (Nordin et al., 2011). Modularisation of services has been suggested as a method of balancing customisation and standardisation (Meyer and DeTore, 2001, Miozzo and Grimshaw, 2005). The lack of detail

regarding how these concepts relate to each other provides a theoretical gap that this paper seeks to address. In addition, this study focuses on knowledge intensive business service (KIBS) firms where the complexity of the underlying knowledge is particularly important (Nordin et al., 2011), used to create value (Leiponen, 2006) and where the underlying services were posited to be more customised than traditional firms (Muller and Doloreux, 2008, Bettiol et al., 2012) as well as being seen to employ standardisation (Tether et al., 2001, Bettiol et al., 2012, Sundbo, 2002) and modularisation (Bettiol et al., 2011, Sundbo, 2000, Peters and Saidin, 2000). Another key site selection criterion was that the firms chosen would employ information and communication technologies (ICT) as this has been identified as enabling customisation through developing individualised relationships with customers (Rust and Miu, 2006) as well as replacing service encounters (Glushko and Nomorosa, 2013, Paluch, 2014) through self-service (Ostrom et al., 2015) by standardising services (Rust and Huang, 2014). It is therefore important that any framework take into account the effects of ICT. This paper seeks to examine the effects of increasing knowledge complexity in knowledge intensive business services (KIBS), the use of information systems by service firms in response to differing views in the literature, develop and empirically test a framework that examines the classification and interaction of standardisation, customization, and modularisation in these ICT mediated KIBS contexts.

This paper is structured in the following way. We begin (section 2) by examining the standardisation, customisation of modularisation in the services literature (2.1) and more specifically in KIBS (2.2) as well as considering the effect of ICT (2.3). Based on this we argue that there is a lack of detail in how these concepts relate to each other and this theoretical gap, conceptualising the linkages between these three concepts and a need to better understand if and how they interact when KIBS employ ICT. We maintain that there is a lack of an existing framework within the literature to identify when different types of systems support is of more or less use. To overcome this lacuna we develop a theoretical model in section 3. The research methodology and case selection criteria are presented in section 4 using 59 in-depth interviews across three case being used to empirically validate the model in section 5. Next we discuss the implications of the validated model in section 6 and outline our main conclusions in section 6.

## **2.0 Literature Review**

### *2.1 The Standardisation, Customisation and Modularisation of Services*

Processes are a central characteristic of services (Lovelock and Gummesson, 2004, Zeithaml and Bitner, 2000). Value is co-created (Edvardsson et al., 2005, Andreu et al., 2010, Shaw et al.,

2011) through an interactive process between client and service provider (Gronroos, 2011) or, alternatively, through the interaction of client and supplier processes (Payne et al., 2008, Carlborg and Kindstrom, 2014). As opposed to designing service processes to be dynamic and flexible, to support co-creation, it is also argued by (Ostrom et al., 2010) that service processes can be rigid and standardized in design, produced for, rather than with, customers. This gives rise to two alternative, and very different, forms of services.

Efficiency in service deployment may be achieved through standardising service processes (Bottcher and Klinger, 2011, Davis et al., 2007, Sundbo, 2002, Tuunanen and Cassab, 2011) This enables services to be transferable across markets (Olivia and Kallenberg, 2003) and reduces the need to produce knowledge with customers (Bettiol et al., 2012). Standardisation is not suitable in certain situations; such as where each service transaction may result in a particular set of circumstances, either in response to a specific client problem or as a result of production on demand, or where some service characteristics cannot be determined a priori (Gallouj and Weinstein, 1997). Specialised services often require interaction with clients due to the inseparability service characteristic (Aas and Pedersen, 2013).

Customized services may result from high levels of interaction with clients products (Vence and Trigo, 2009) or, looked at from another viewpoint, the provision of highly customised solutions requires providers have a better understanding of their customers which enables closer relationships to develop (Nordin et al., 2011). A disadvantage of customised offerings are higher costs due to dedicated resources, customer specific knowledge, and a requirement to continually adjust the offering in line with changes in the needs and situation (Johnson and Selnes, 2004). As customer needs become more diversified and heterogeneous this balancing of standardisation and customisation becomes increasingly difficult (Bask et al., 2011).

A number of researchers have argued that a balance needs to be struck between these two alternatives (Nordin et al., 2011, Olivia and Kallenberg, 2003). It is suggested that this could be achieved using modular approaches that balance customisation with standardisation (Meyer and DeTore, 2001, Miozzo and Grimshaw, 2005). Cabigiosu et al. (2015) argue that the uses of standard procedures are a constitutive element of modular services. Modularity is a compromise that involves reconfiguring components, themselves an assembly of standard products and

services, based on customers' needs (Nordin et al., 2011). Modular services involve building on existing standardized service elements through the inclusion of customer specific value added elements Pekkarinen and Ulkuniemi (2008). In addition to service standardization Cabigiosu et al. (2015) argue that modularity also emphasizes inter-organisational decoupling. Modularisation provides firms with some flexibility when dealing with individual customers, enabling a degree of customisation (Bask et al., 2011). Less complex services require exploitation while new process orientated solutions require exploration (Kowalkowski et al., 2011a).

Research on modularity for software engineering (Dorbecker and Bohmann, 2013) and product modularity is well developed (Cabigiosu et al., 2015, Campagnolo and Camuffo, 2009, Campagnolo and Camuffo, 2010) whereas research into service modularity is in its infancy (Carlborg and Kindstrom, 2014). While the service firm's literature in this area suggests modularisation as a 'compromise' or to 'balance' the alternative' of standardisation and customisation there is a lack of detail in how they relate to each other. Conceptualising the linkage between these three concepts and a need to better understand if and how they interact, is a theoretical gap and one facet this research seeks to explore.

## *2.2 Knowledge and Knowledge Intensive Business Service Firms*

Complexity is particularly high in knowledge intensive business services (KIBS). Such firms differ from other service providers as they incorporate high knowledge content, (Bettiol et al., 2012). Knowledge is important to service firms and can take the form of expertise relating to the technical and service characteristics of goods (Nordin et al., 2011, Gallouj and Weinstein, 1997). Such firms create value through their ability to transform their knowledge for client firms (Leiponen, 2006) and to combining codified technical and scientific knowledge with knowledge that they hold tacitly to create a unique body of knowledge (Amara et al., 2009). Another term, used by Vence and Trigo (2009), was 'knowledge intensive based services' which they found to be intrinsically involved in the use and transfer of knowledge. The services they supplied required more highly qualified knowledge (Bettiol et al., 2012). The knowledge intensity of the firm is dependent, according to Haulknes (1999), on the knowledge demands of the service provider and the related demands of the service procurer. Other factors affecting knowledge demands include: whether the problem is linear/rational or emergent/iterative; how problems are communicated to problem solvers and perceived by them; the degree to which problems are defined ranging from structured to ill-structured problems containing unknown elements to which multiple or no

solutions are possible; the problem solver's expertise and familiarity with similar problems (Nordin and Kowalkowski, 2010).

Knowledge intensity, a relative concept, involves an interplay between knowledge provider and user and this interplay is central to client participation or co-production in services (Freel, 2006). In the case of KIBS firm (Cabigiosu et al., 2015, Bettencourt et al., 2002, denHertog, 2000, Miles, 2005, Miozzo and Grimshaw, 2005) argue that KIBSs involves a joint effort between provider and client, achieved through knowledge-sharing and co-exploration. A reason for this is that clients possess much of the knowledge and competence that is required for the delivery of a service solution by a KIBS (Bettencourt et al., 2002). KIBS generally operate in business-to-business environments which involve them dealing with fewer customers but with long client contact times and relatively close levels of client interaction (deJong and Wermeulen, 2003). Another reason for intensive knowledge and information sharing is to communicate the clients' needs to the KIBS: this is even more important when the relationship is complex (Cabigiosu et al., 2015).

In this research stream the issue of customisation and standardisation is also present. As well as identifying the tendency to deal with business-to-business clients Bettiol et al. (2012) also posit that KIBS are involved in higher levels of customization than traditional service firms. The value of a KIBS is predicated on its ability to provide customised services to clients (Muller and Doloreux, 2008, Bettiol et al., 2012). They do this by matching their service to client demands (denHertog, 2000) so as to differentiate their service. KIBs also tend to offer such customised services to business customers (Bettiol et al., 2012, deJong and Wermeulen, 2003). Customised services have been found to be at the more complex end of a firms offerings (Nordin et al., 2011).

In contrast some KIBS may also provide outputs which are standardized (Tether et al., 2001). Bespoke service provision can reduce the ability to exploit codification related to standardization used to achieve efficiency (Bettiol et al., 2012). From a knowledge management perspective the supplier can invest in codification to exploit the advantages of a high degree of replication of knowledge developed through standard codified services (Bettiol et al., 2012). The KIBS could share their (transforming) resources across a number of clients or dedicate them to a single client (Cabigiosu et al., 2015). By standardising a knowledge intensive service the provider can increase

knowledge exploitation related to its standard input, and offer a standardised service to customers who are not interested in customisation and do not seek interaction (Sundbo, 2002).

Similar to the literature on service firms a modular approach was also taken by KIBS that involves combining standardization with a final service customization (Sundbo, 2000, Peters and Saidin, 2000, Bettiol et al., 2011). Modularisation has the potential (Pekkarinen and Ulkuniemi, 2008) to support cost-efficiency in operations and managed increased client need heterogeneity. The development of modular systems, using reconfigurable components, allows service firms to exploit their knowledge-base across a number of supplier relations while spreading the costs of providing solutions over many customers (Cabigiosu et al., 2015, Davis et al., 2007). Modularity enables firms to use standardized components while also possessing a flexible system design (Davis et al., 2007). The use of modularity has the ability to transform relations between companies (Baldwin and Clarke, 1997). The role of knowledge intensity in KIBS also effects relations. Firms exist, according to the knowledge based theory of the firm (Grant, 1996), because they possess and are efficient mechanisms for integrating specialised knowledge which they provide to a recipient firm. Their existence is predicated on their specialised knowledge (Spender, 1996). In situations where this knowledge cannot be easily transferred then decision rights must move (Kogut and Zander, 1992), in this context to the service provider. This specialisation of knowledge in KIBS explains why, as pointed out by (Kowalkowski et al., 2011b) that it is rare that firms organise service provision only in-house. Not only can knowledge specialisation move some service tasks outside the client firm boundary, creating the necessity for service firms to exist, but in situations where the service firms knowledge base can be enhanced with new knowledge gathered from the client (Muller and Zenker, 2001). This is then integrated into the firm to create a unique body of knowledge (Amara et al., 2009) which can then be applied to other clients (Davis et al., 2007, Cabigiosu et al., 2015) then the situation arises where the resultant specialized knowledge create knowledge asymmetries between provider and client so that when customers have a limited understanding of their own needs that it makes it difficult for them to explain what they need to a solutions provider (Tuli et al., 2007). Asymmetries may be reinforced by the underlying degree of knowledge intensity required. While a key characteristic of knowledge intensive services is client participation, the resultant interaction may also reflect issues around the balance of power between parties, partly involving the exchange of information and knowledge (Gallouj, 2002).

### *2.3 Service Firms and ICTs*

The nature of services and related delivery processes (Bitner et al., 2000) as well as the interaction between clients and providers (Zeithaml et al., 2006) can be altered through the use of ICT. The role of ICT is particularly important given virtually all services are to some extent affected (Monnoyer, 2003) and with service Industries being the most intensive users of ICT (Stare et al., 2006). Given ICTs pervasive nature and widespread effects it is not perhaps surprising that the implications of developing an understanding of the role and implications (Breidbach et al., 2014, Chesbrough and Spohrer, 2006, Ostrom et al., 2010) as well as how technologies can be leveraged to advance service research (Ostrom et al., 2015), has been identified as a key research priority for service research. Kowalkowski and Brehmer (2008) argue that the impact of ICT on industrial service processes has been 'insufficiently examined' because research does not focus on business-to-business relationships. The contribution this paper makes is more specific. We seek to develop a model that examines how ICTs are used by KIBs to manage the concepts of standardisation, customisation and modularity.

IT delivers benefits in terms of cost-effectiveness, (Poulis et al., 2013, San-Martin and Herrero, 2012, Pena et al., 2014). ICT use in service firms have been characterised in a number of ways. The categorisation may be based on who uses the technology i.e. the client, provider, or both (Glushko, 2010); on the nature of those actors interaction with the technology, active or passive (Verhoef et al., 2009); or how it changes the interaction between actors (Zeithaml et al., 2006, Glushko and Nomorosa, 2013). Breidbach et al. (2014) distinguish between exchanges where ICTs enable interpersonal interaction between a customer and a provider (Makarem et al., 2009) and technology generated self-service where no interaction is present (Breidbach et al., 2014, Breidbach et al., 2012). ICTs also have ability to change the characteristics of interaction (Davis et al., 2011).

At one end of the spectrum technology may enable long-term individualised relationships with customers to be developed (Rust and Miu, 2006) enabling develop deeper customer relationships (Rust and Huang, 2014). They can enable the development of social attachments that enhance exchange (Gremler and Gwinner, 2000) strengthening them over time (Adler and Kwon, 2002). In addition to building social contacts information technology can also help identify constantly changing complex client needs (Poulis et al., 2013, San-Martin and Herrero, 2012, Pena et al., 2014). This increased level of interdependence and knowledge regarding the clients preferences and needs through successive interaction results in higher quality services (Bhappu and Schultze, 2006).



Alternatively technology may be used to facilitate 'remote services' where technology is used to connect, access and modify service objects (Schumann et al., 2012, Paluch and Blut, 2013, Ulaga and Reinartz, 2001, DuBay, 2009). Interpersonal interaction during service encounters can be supplemented or replaced (Glushko and Nomorosa, 2013). Indeed customer value and the quality of service were found to be improved using ICT to enable service transactions to take place remotely with no personal interaction (Ulaga and Reinartz, 2001) through self-service (Ostrom et al., 2015). Tasks between the front office and customer, and between the front and back offices can be replaced by technology (Kowalkowski and Brehmer, 2008) eliminating or reducing customer work through moving tasks to the service provider (Campbell et al., 2011). ICT can also be a substitute for service employees (Ostrom et al., 2015, Breidbach et al., 2012). Though such remote technology was designed to reduce interaction (Paluch, 2014) found that customers preferred regular interaction. Similarly it is difficult to replicate the relational benefits occurring through interaction with self-service technology (Bhappu and Schultze, 2006).

ICTs can improve efficiency by standardising and commodifying services by automating manual systems and standardising routines, (Rust and Huang, 2014). Service automation has been facilitated by information technology (Rust and Miu, 2006), leading to more self-service and pushes to standardise services and create mass production (Sundbo, 1994). Codifying tacit knowledge gives the main economic benefit from the reuse of codified knowledge (Cowan and Foray, 2000, Gammelgaard and Ritter, 2005) to providers exploiting high levels of knowledge replication using standard codified services (Bettiol et al., 2012). The chances of improving efficiency through codification, so as to achieve standardisation, are reduced where 'bespoke service provision' exists (Bettiol et al., 2012) or where recurrence it is unlikely (Sundbo, 1997). Many systems no longer need the same dialog and reciprocity between provider and customer once formalised as routines are established (Kowalkowski and Brehmer, 2008). High levels of customer-provider interaction (Gadrey and Gallouj, 1998) means that codification may appear a negative strategy (Bettiol et al., 2012) by reducing the providers ability to react to customer demands. Kowalkowski and Brehmer (2008) argue that in spite of the effects of ICTs that in the case of increasingly complex and advance offerings there is a need for continuous need for services that involve the co-creation.

IT's provide opportunities to renovate services making them more personalised through the use of individualised client information requiring two-way information flow (Rust and Huang, 2014). It is argued (Glushko and Nomorosa, 2013) that it is essential that the information flows to support personalisation should be both ways. As production and consumption become less about objects and more about information and services the internet is the 'ultimate means for delivering services' as it enables customisation and ICT can be used to deliver services to meet customers' desires precisely, (Monnoyer, 2003). Modularity as a strategy can organise both complex products and processes efficiently, (Baldwin and Clarke, 1997). Buyer-supplier knowledge according to the mainstream modularity literature finds that knowledge and information sharing are inversely related to the level of modularity of products and services (Cabigiosu et al., 2015). Standardisation in modules, *ceteris paribus*, reduces the needs for client and provider to engage in knowledge transfer and information exchange, (Cabigiosu et al., 2015).

This paper, seeks to address two identified gaps. First, it seeks to begin to fill both a theoretical and empirical gap in the services literature relating to a lack of detail in how modular approaches balance the alternatives of service customisation and standardisation (Meyer and DeTore 2001, Olivia and Kallenberg 2003, Miozzo and Grimshaw 2005, Nordin, Kindstrom et al. 2011) by conceptualising linkages between these three concepts and examining how they interact. We do this for the case of knowledge intensive service firms. Second, given the role of ICT to leverage service activities (Ostrom, Parasuraman et al. 2015) and its impact on service processes, as argued by Kowalkowski and Brehmer (2008) as insufficiently examined we examine the role played by ICT in the processes of customisation, standardisation and modularisation. Our research objective is to make a theoretical contribution through the development of a model that that classification and interaction of standardisation, customisation and modularisation in ICT mediated KIBS contexts as well as empirically testing this model using case studies of three knowledge intensive firms.

### **3.0 Model Development**

This section will outline a proposed model to aid an understanding of the interaction of customisation, standardisation and modularisation in ICT mediated knowledge intensive settings. One variable used to categorise knowledge intensive service situations is whether the knowledge involved exists in a tacit or explicit form. We take the position that all knowledge creation, including the recombination of existing knowledge or the acquiring external knowledge, initially

takes place tacitly (Nonaka and Takeuchi, 1995). Thus the customisation or recombination of knowledge requires an initial tacit component.

Another factor is the complexity of the new context (as discussed by Handzic et al, 2016) in which knowledge is to be reused for service delivery. The advantage of exploring this is an “opportunity for seamless integration between knowledge management and the business environment”, (Handzic et al, 2016:31). Here the focus is on the complexity of managing knowledge as a corporate resource rather than the complexity of the underlying knowledge. In our model the least complex situations are those that involve the reuse of existing codified knowledge, without modification, either through customer self-service or by service firm staff. Thus while the knowledge contained in the procedure may indeed be highly technical and very complex the situation in which it is used is not complex but commonplace and recurrent. As situation complexity intensifies (Salleh et al., 2010), these situations involve recombining elements of existing codified knowledge in order to create new services and, at the most complex end of the spectrum, the acquisition and integration of external knowledge to achieve this end. Indeed organisations must be aware that from the perspective of complexity theory, “the difficulty of the decision situation is expected to increase with the objective and/or perceived complexity due to decision task, environment and/or decision maker”, (Handzic et al., 2016: 34, Snowden 2004). The least complex situation involves existing knowledge being re-used ‘as-is’ without any modification i.e. there is an existing standard service procedure to the current client’s service requirement, or low task complexity, as discussed by Handzic et al., (2016). The knowledge to be re-used can be both tacit and explicit. A standard response is initially created in a non-codified tacit form (top left quadrant) by employees. It may remain tacitly held and re-used by only one, or a few specialists; though such use has two disadvantages. From the employees’ viewpoint complex and knowledge intensive sequence of actions may be difficult to correctly and consistently follow when it is tacitly held. From the firm’s perspective there is a lost opportunity to make such knowledge widely available to enable more widespread reuse by other employees when the knowledge is amenable to codification.

To allow service firms to gain economies of scale by applying a service consistently across their client base requires subsequent codification, indicating a trend from the tacit (top left) to explicit (bottom left) quadrants of the model. This is typically supported through the use of ICT such as a repository of standard service procedures to be followed in defined instances. 'Standard' knowledge can be supported by ICT in three different ways. Firstly, where firms have not previously used ICTs for knowledge management purposes, a first step for firms may be to identify

what types of knowledge specialist employees possess. What is codified (arrow 1a) relates to the categorisation of who possesses knowledge rather than the knowledge itself. This is quick and requires less codification. It can be useful for specialised knowledge that is difficult to codify and can be used to route customers to an appropriate expert. This form of standardisation focuses on the categories of knowledge used to define people rather than processes. Secondly, (arrow 1b) standardisation can involve explicitly defining the tacit knowledge, i.e. the steps to be taken, that previously existed tacitly within a few specialists. This has the advantage that the procedure can be reused numerous times by less specialised employees. Thirdly, the company may employ a modular system to customise solutions to problems using existing standard components (arrow 1c). Therefore, explicit knowledge reuse may take place using either standardised or modularised procedures depending on how the ICT present are configured. What distinguishes the left quadrants is that the reuse takes place without any change to the procedure: the same procedure is used repeatedly to satisfy client requirements.

It is important to be able to clearly define appropriate contexts in which a procedure is to be used to avoid subsequent inappropriate re-use and therefore it is necessary to codify both the service context and service procedure. This helps avoid re-use in different contexts for which a standard procedure would not meet the service requirements. When the service requirements and procedures are clear and codified, then a key question for the firm is whether to provide clients with self-service access. This reduces service provider costs and moves the task from provider to supplier. If the appropriateness of the service procedure for a particular context needs to be confirmed by a specialist or there are strategic or reputational reasons to withhold details of the procedure from customers, then the service should be performed by the service provider's staff. We therefore draw a distinction between who will implement the codified standard procedure, though how it is re-used is the same. Thus, within the left quadrants it is possible to identify two distinct situations based on who used the codified knowledge. If the company employs a modular system, then tacit standard solutions would be codified immediately in a modular form (arrow 2).

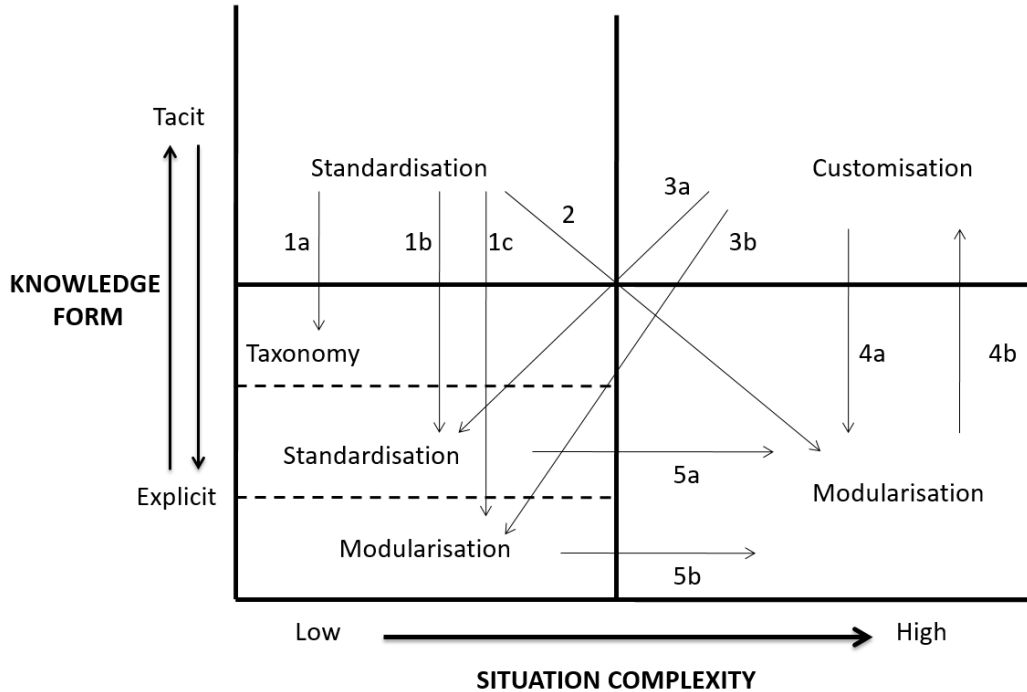
There are also instances when existing knowledge cannot be used, without some modification, to provide client services. The model developed categorises two situations of increasing complexity: (1) modification through recombination, where elements of existing codified service processes are amalgamated to develop a new procedure and (2) where additional external knowledge has to be acquired and integrated with existing knowledge in order to meet new client requirements.

Customisation exists, in the model, as acts of knowledge recombination, acquisition and integration that take place initially tacitly in the heads of employees as they create new customised services for a particular client within a new context. This knowledge may remain tacit (top right quadrant) but this again runs the risk of losing out on the advantages of economies of scale for the firm and so we argue there is a trend towards moving from tacit to explicit over time using ICTs and this may result in a number of alternative trajectories (arrow 4a, arrows 3a, 3b). The new service may be suitable for other clients without modification and so will move, on codification, to the bottom left quadrant: the codification may take the form of a standard (arrow 4a) or modularised (arrow 4b) form depending on the information system used in the firm. Where a modularised ICT system exists then the solution can be divided into components and not only provide a reusable standard solution, similar to arrow 4b, but also provide the underlying components from which to develop similar but distinguishable service procedures through later recombination (arrow 4a).

Arrow 5a relates to the development of the complexity of ICT system types over time as explicit standardised procedure are converted to a modular framework. The use of a modular framework allows existing codified solutions to be formatted so that components can be used for additional solutions (there is no codification from scratch). Arrow 5b relates to a situation where an initial standard solution is created in a modularized format (arrow 1c) components of which are later recombined to develop alternative/similar but distinct processes. This situation allows economies of scale in the codification process itself.

The development of modularised solutions is useful when customising new solutions as the existing components can be drawn upon (arrow 4b) to provide a starting point for the development of distinct solutions which re-use some or all pre-existing service actions. Modularised solutions also provide an existing framework into which newly acquired knowledge can be placed.

**Figure 1: Service Management Knowledge-based Framework**



#### 4.0 Research Methodology

A case study design (Yin, 2002) was employed. It was considered appropriate as the phenomena was to be examined in its natural context (Darke et al., 1998) with an in-depth understanding sought (Cavaye, 1996) to enable further clarification rather than measurement (Riege and O’Keeffe, 2007). They are appropriate for an examination of human action and interpretations surrounding the use of information systems (Walsham, 1995), providing rich detail on how information systems are used (Howcroft and Wilson, 2003). Case studies have been used for knowledge management research to explore how knowledge has been embodied and disseminated (Hazlett et al., 2008), in the development of a knowledge classification system (Walters et al., 2007).

Multiple cases were chosen to provide different perspectives (Creswell (2007), improve theoretical understanding and methodological rigour (Yin, 2002, Eisenhardt, 1989), augment external validity (Barratt et al., 2011) and provide increased robustness (Creswell (2007). Though primarily used for theory building (Barratt et al., 2011, Piekkari et al., 2009) case studies can also be used for theory testing (Iacono et al., 2011) by using previously articulated propositions (Lokke and Sorensen, 2014) which may be validated or refuted (Sarker and Lee, 2003). This makes the “*case is of secondary interest, it plays a supportive role, and it facilitates our understanding of something else*” (Stake, 2000:437). Such testing has been employed where multiple literatures

have been integrated to test the resultant framework (Turner et al., 2014, Nissen, 1999). It has been used to identify framework elements more specifically (Krull et al., 2012), to gain more insights into a framework (Qui and Lui, 2014), as well as providing a 'concrete illustration' of the application of a framework (Pan and Scarbrough, 1999). Case selection required companies to meet a number of criteria: they needed to be knowledge-intensive firms as defined by the OECD (2001); reliant on ICT for service provision and client interaction; be involved to varying degrees in standardization, customization and/or the modularization of services. 150 firms were identified and contact details for managers, technical supervisors, R&D managers, and marketing departments were noted. The criteria for the selection of case firms and case groups within them was a much more prolonged and delicate process, and it developed over time during informal communications with various contacts. To this end, different contexts for groups were identified, which would prove most interesting for the research focus. Of those companies prepared to grant access initial interviews were carried out to identify if, and to what extent, the selection criteria were met. Initial interviews to garner more detail were carried out and a final three cases were selected.

#### *4.1 Data Collection and Analysis*

The data for this study was collected using multiple sources and methods including: observation, semi-structured interviews as well as through corporate documents which included codified service procedures. Pilot interviews and access to organisational documents provided a context to develop a set of questions and probes for the interviews. Interviews lasted from 30 to 90 minutes and were recorded and transcribed. They took place over all levels of experience at all three companies as outlined in Table: 1. Permission to record was sought and anonymity was assured before each interview. While Walsham (1995) argues that recording results in interviewees being less frank this was not found to be the case in this research. Questions focused broadly on how work was enacted in practice, rather than as formally mandated. Further questions sought to identify the nature of the underlying knowledge used by employees and how this was then codified in ICTs. We also sought to surface problems and challenges employees were encountering in using ICTs for service delivery.

**Table 1: Interviewee Level**

	CoA	Co. B	Co. C
Manager	4	2	3
Shift/Team Leader	2	6	3
Experienced 'Knowledge Workers'	13	4	12
Novice 'Knowledge Workers'	3	2	5
Total (59)	22	14	23

Organisational documents relating to work practices were made available and were compared with interviewees' accounts of how they used information systems to complete their work. Another valuable source of data was access to the various information systems that were used, and in some cases developed, by the three case study companies. The electronic documents contained in these systems were useful in seeking to identify how ICT was used to codify service solutions to clients' problems and was compared to users' accounts.

Confirmability was addressed by establishing a detailed collection of all the raw data, field notes, interview transcripts and correspondence in a research audit file using QSR NVivo, to aid what Guba and Lincoln (1985: 320) refer to as the "confirmability audit". The authors used a similar approach to Hawk et al. (2009) to enhance their contextual understanding of their interviews, by examining other data sources such as company brochures, website material, contract and service-level agreements and network design diagrams.

Inductive qualitative techniques were employed for data analysis similar to Orlikowski (2002). Data was iteratively coded as the research developed a number of themes and concepts emerged. The particular themes relating to those work practices surrounding service codification using ICT which were examined in detail for this study. Consideration was given to the context in which the service solution originated, how it was codified from a tacit to an explicit format to enable subsequent re-use and whether later re-use involved modification or not. In addition, interview details were examined to identify associated issues and challenges. Similar to (de Vreede, 2014), we evaluated the experiences in the case organization to identify insights and recommendations. The case studies in this paper are compiled using a between-method triangulation approach, thus enhancing the credibility of the study. Richness of the data was ensured through integrated use of in-depth interviewing, observation and documentation analysis. As with Riege & O'Keeffe (2007) interviewing ceased when a "stable pattern of clear agreements and disagreements on core issues" was reached in each of the three companies.



## *4.2 Research Sites*

**Co. A** is a pioneer in the fields of orthopaedics, spinal care and neuroscience therapies. It established a manufacturing facility in Ireland in 1998 with an Innovation Centre established in 2008 to support advanced product and process development for the next generation of orthopaedic solutions. This Centre focuses on (1) Advanced Manufacturing Technologies (2) New Product Development and (3) Quality Management. There were three primary drivers that prompted Co. A to begin the process of codifying knowledge: (1) the need to quickly locate specialists' tacit knowledge in response to customer needs, (2) to make its product development process in the Innovation Centre more efficient, and (3) to achieve savings associated with the replication and reuse of codified knowledge. A challenge for the firm was that 60% of employees in the innovation centre were contracted for a short periods of time, so that when that portion of the project is completed, the expert leaves and “that knowledge is gone” (Experienced Knowledge Worker).

**Co. B** is a global leader in the supply of metal shafts for cardiovascular applications. It has won awards for innovation as well as for being the fastest growing company in the European Union. This growth was driven by customers' perceptions of the company as being willing to modify its work practices and its flexibility to ensure their requirements were met, particularly for innovations in new product development enabling a contract design business to be established. Another key service provided to clients is the ability to fulfil increasing portions of their supply chain requirements. This enabled it to become a strategic supplier to a number of large multi-national companies and win supplier awards for quality and service.

**Co. C** is billion-dollar Corporation providing storage hardware and associated software to large corporate customers. The services provided to clients were detailed in formal service level agreements that committed it to resolving clients' problems with its products within strict time limits. The work involved resolved knowledge intensive and highly technical problems, and was heavily reliant on the use of a knowledge management repository that categorized and stored service procedures to be followed.

## **5.0 Empirical Testing of Model**

### *5.1 Co. A.*

There were two primary drivers that prompted Co. A to begin the process of codifying knowledge: the need to quickly locate specialists' tacit knowledge in response to customer needs and secondly, to achieve cost savings associated with the reuse of codified knowledge. A challenge for the firm

was that 60% of employees in the innovation centre were contracted for short periods of time and for specialized tasks, so that, when that portion of the project is completed, the expert left and “that knowledge is gone” (Experienced Knowledge Worker).

“If John Lynch, who was my previous boss, had left in the morning and I took over, there was stuff there I just wouldn’t have.” (Shift Lead).

In an environment that fosters an informal approach and relies on knowing who knows what, longer-term employees have an advantage. “*I’m here seven years, so ... I know who’s who*” (Shift Lead). Much of the knowledge is learned from people in an informal way, and thus the interpersonal network is very informal so that time is wasted in locating expertise and secondly, there is a lack of proper use of some of the formal systems provided. Many employees end up spending much of their “work time” navigating the informal network, only to lose sight of the knowledge they seek to acquire, delayed in the task of acquiring it.

The company used its ‘Talent Navigator’ and ‘Link’ information systems to codify and categorise tacit knowledge, increase expert visibility, and locate specialists possessing such tacit knowledge.

“It would save myself time, trying to track down whoever I could ask about that or will save them time as well” (Novice Knowledge Worker).

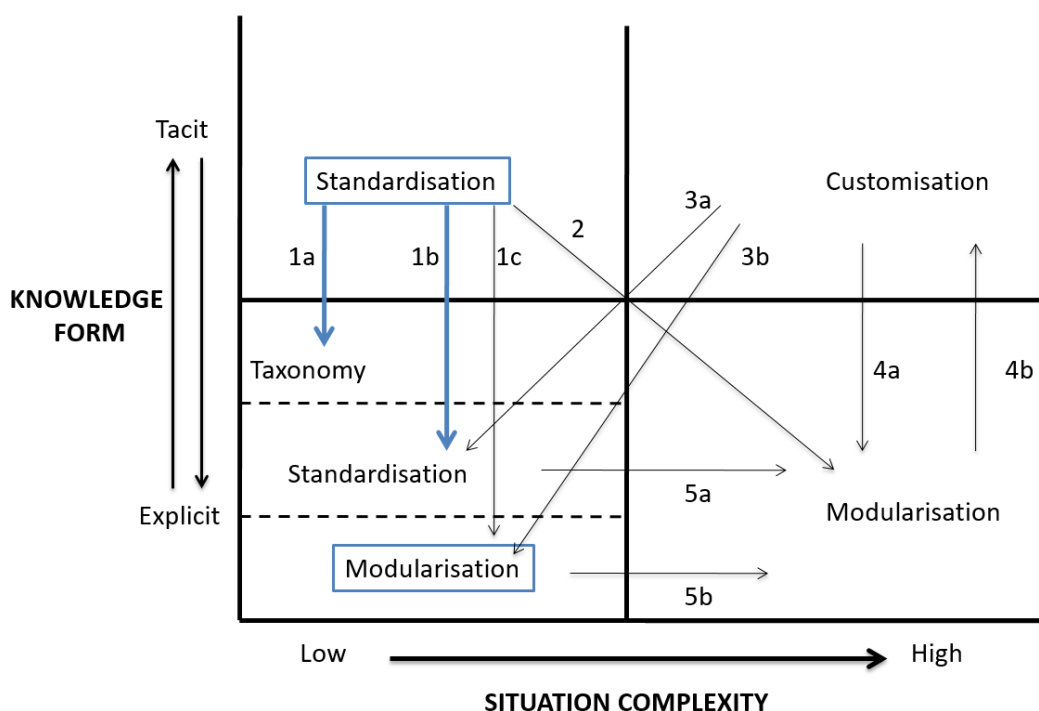
Talent Navigator was a Web-based knowledge location tool used in the Innovation Centre to provide individuals with a way to explore gaps that existed between the current level of skills, qualification and experience and the level required by the customer. Link was a web-based system that acted as a social network, similar to Facebook or LinkedIn. It was a “*kind of knowledge network, the kind of sharing ideas, people post things on there. If you say, ‘I’ve got a problem with X, can anyone help?’*” (Experienced Knowledge Worker). These systems enabled Co. A to identify which employees possessed specific categories of knowledge, relying on a move from tacit to explicit using taxonomies and ontologies as posited in the model (arrow 1a). As a consequence, Co. A developed greater credibility with customers through improved efficiency as a result of expert location.

Co. A was largely dependent on a small group of subject matter experts. This meant that engineers could deal with a problem but without properly documenting their actions. This provided the

impetus for the move toward standardisation of knowledge within information systems such as their new Agile system (arrows 1a, 1b). Through expert location, using the systems described, this situation had improved.

After Co. C developed formal systems to locate expertise then began to codify and standardise knowledge (arrow 1b). Systems to support knowledge re-use existed, but were in the early stages of development. “We don’t have a proper system for knowledge sharing.” (Experienced Knowledge Worker) however, Agile provided basic capabilities and was “very handy for certain things. Like for me, all the raw material specs for R & D are up there” (Experienced Knowledge Worker). It also provided access to “standard operating procedures that they need to understand” (Manager). Co. A’s eventual goal was to move toward systems that would have a standard base of accurate solutions and eventually could solve problems without the need for a constant rotation of specialists.

**Figure 2: Co. A**



5.2 Co. B.

Management had acknowledged that the lack of knowledge standardisation was “definitely a problem for us” (Experienced Knowledge Worker). Co. B. wanted to speed up service delivery to a consistent standard without a reliance on short term knowledge specialists. This objective faced

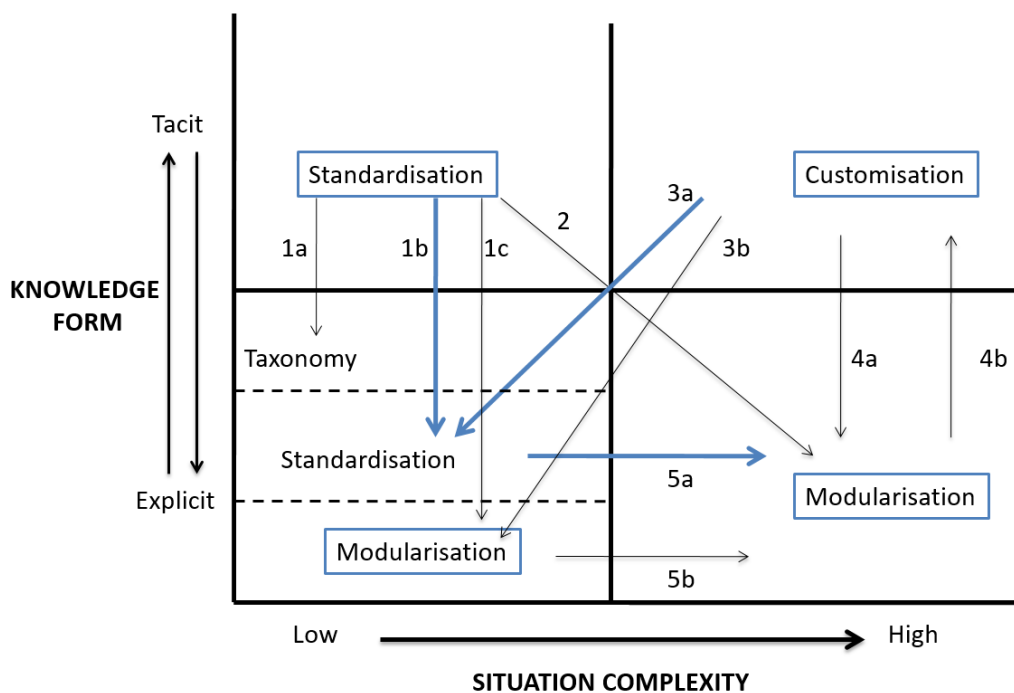
two main barriers: (1) Knowledge standardisation and (2) Knowledge reuse to enable problem solving. Sometimes, when searching for a particular piece of explicit knowledge employees, particularly those new to the firm, could not locate it. Therefore, Co. B wanted to standardise knowledge. Many of the engineers claimed as much; “They find it difficult to find out...who knows about [particular process] - Who's our guy?” (Manager). Standardisation would help make dissemination of tacit knowledge possible across the organisation. “If you have a database full of solutions and people even know what kind of things you’re looking for...they wouldn’t even know where to begin to look right now” (Shift Lead). For the clients, the procedures at Co. B were made available in an explicit format, though some problems arose regarding how to locate the explicit knowledge. *“You’d have to know the procedure number or do a word search and be lucky with your word search”* (Novice Knowledge Worker). As a consequence, a disproportionate amount of time was spent searching for explicit rather than tacit knowledge.

The knowledge management system employed by Co. B was called 'User Productivity Kit' (UPK): it began with the standardisation of already located tacit knowledge and developed a system used to capture problems, process, locate tacit knowledge solutions, and document these centrally to enable reuse (arrow 1b). As a result, knowledge solutions were standardised and made available more quickly, employees were able to locate and reuse knowledge, some of which had been previously hidden, did not have designated ownership, or was not known about, and these changes led to clients having increased confidence in the service delivered to them (arrow 1b).

At Co. B knowledge was becoming increasingly embedded in informal employee networks; “it’s not exactly a very good way of doing it because...it’s just word of mouth” (Shift Lead). Co. B needed to improve knowledge reuse so that the system then “gives you the process overview in a flow chart that’s standardised amongst all the areas”, which provides the employee with a catalogue of who knows what and where they are. “The guys who are given the job would be able to up-skill themselves on the particular knowledge that they may not have” (Manager). For Co. B, its information systems improved the reuse of past knowledge around a particular procedure or problem. Co. B moved further along its implementation of knowledge management systems and was successful in developing systems to standardise specialist’s knowledge using UPK, and also explicitly form a body of reusable standardised knowledge from the tacit pool in the organisation (arrow 3a). For example, this was as simple as talking with the subject-matter experts, the “blue jackets”, and recording exactly their solutions to client problems step by step. Many employees

used these systems as a way of moving to a more standard approach to meeting client requirements. The end result is that the engineers at Co. B, through the dissemination and retention of informal knowledge knew more than the client. This standardised knowledge was then codified for high levels of reuse (arrow 5a). This had been the first goal of Co. B, to use their deep pool of subject-matter expertise, and create a standardised base that could be reused throughout the organisation. Standardisation, by increasing knowledge asymmetry, acts to increase epistemic boundaries between service provider and client which make interaction more standardised making it increasingly difficult for types of interaction that lead to co-production of knowledge.

**Figure 3: Co. B**



### 5.3 Co. C.

The case company environment in which services were provided involved problems arising from clients' implementation of both Co. C's and external vendors' products which gave rise to new and unique sets of circumstances. As problems were typically recurrent across the client base a key knowledge management objective for Co. C was to benefit from economies of scale by reusing explicitly codified solutions to provide services.

It engaged in what it termed 'Knowledge centred support' which it defined as involving:

*"A focus on creating and sharing knowledge articles.  
 Knowledge is the key product of a support organization.  
 Knowledge articles are created and maintained by those most in the know - the people working on the service calls"* Internal Company Presentation

It implemented this using an organisational repository, the objectives of which, as outlined in an Internal Training Document were:

- Improve service levels to customers
- Gain operational efficiencies
- Call avoidance
- Increase Global Services' value to [Co. C.]
- Improved job satisfaction of Customer Service personnel

A large proportion of knowledge regarding technical problems were codified using very structured solutions as outlined in Table 2. These included sections detailing the problem context in terms of taxonomies of errors, technical configurations and the service procedure, which could contain a number of action sets, to be followed in the 'Fix' section. The solutions were modular in form as contextual elements were defined by reusing existing categories, and service procedures were developed by drawing on existing standard sets of actions whenever possible.

*“Solutions can be seen as “modular” in that each statement stands apart, and care must be taken in creating them.”* Internal Training Document

*“The base unit for storing information is the concept. A group of connected concepts forms a statement. A group of connected statements forms a solution”* Internal Document

**Table 2:** Sections of a Modular Repository Solution

<b>Section</b>	<b>Description</b>
Goals	The actions performed and documented in the fix
Facts	Clients configuration using terms in the 'environment tree' to specify the case context
Symptoms	Describe problem characteristics and are objective statements detailing occurrences
Changes	Changes instituted or attempted by the client
Cause	Links symptoms (effects) to actions (changes)
Fix	Outlines the procedure to follow and involves explicitly documenting the sequence of actions taken

Co. C installed monitoring software on client systems to automatically identify and report problems. Given the modular nature of Co. C's repository, all tacitly developed solutions by employees, regardless of their complexity, were immediately codified explicitly in a modular format (arrows 1c, 2, 3a, 4a). Sometimes the information collected by the monitoring software

was sufficient to identify a solution. An examination of repository solutions identified instances where standard procedural responses to clients' problems were codified (arrow 1c).

*“People had put in solutions, they saw a problem once and then they put in a solution there just in case it happened for someone else which was ideal”* Shift Lead

The repository *“is good for finding out if there actually are specific solutions for the problem... I think there's about 40,000 solutions you see”* Experienced Service Engineer.

The cause and effect of such problems were known to the extent that, once identified, the fix could be guaranteed to work without modification. Re-using existing solutions was supported by the structured nature of the knowledge management repository and standardised taxonomy of errors and client configurations.

*“If you go putting in text it can throw anything back at you, you know but if you're putting in a specific error code it will take you there... it will actually bring you up the exact solution”* Experienced Knowledge Worker

As there was no risk of inappropriate reuse of solutions in this situation the firm made these available through an internet-based customer self-service portal. In more complex situations, where it was expected with a high degree of probability but not certainty, that the solution could be used without modification, then a Co. C. employee confirmed the applicability of the solution before following the procedure outlined. Thus in the model developed we find evidence of movement from tacit standardized to modularized services where no further modification was required, and which was used in a self-service manner by clients as well as by provider staff (arrow 1c).

Integrated information systems meant that the details of a problem and its defined context could be transferred to the correct sections of the knowledge management repository. In more complex situations employees found that while no solution existed to a current problem employees were often able to identify when parts of existing solution(s) could be applied to the current problem. This involved checking if a set of actions would work in a new context. It was possible for workers to recombine components (standard sets of actions) from a number of solutions (arrow 5b).

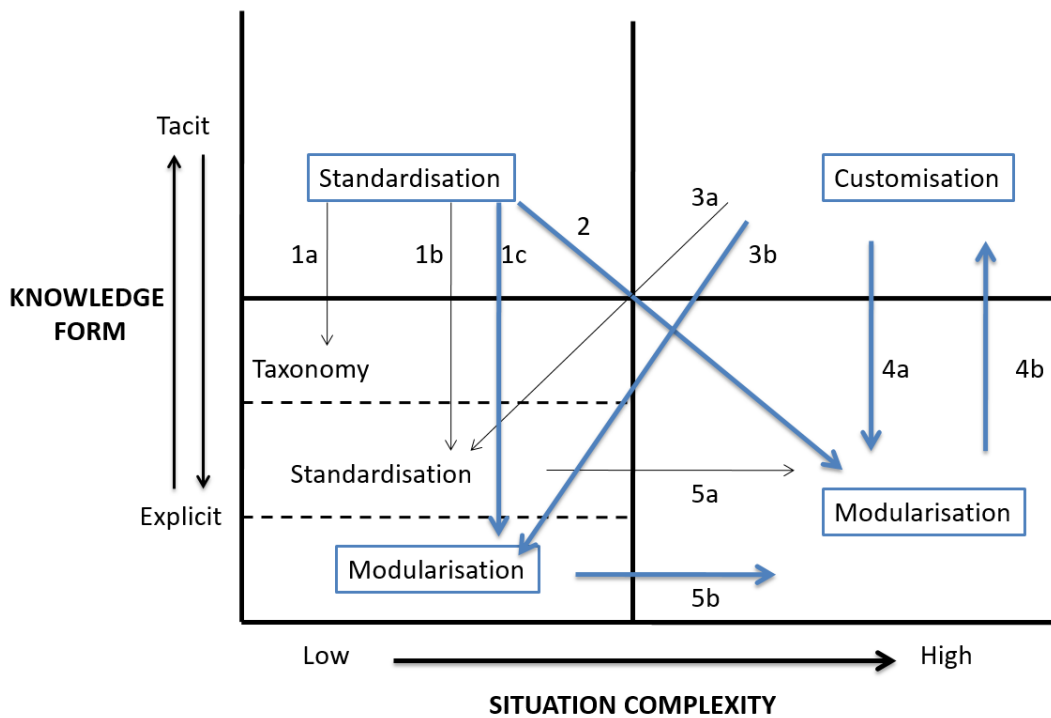
“You’d have 50% alright you would yeah like a solution where you would find it alright... See a lot of the solutions would be for a certain [Problem type] you’re above that [error] code then only half a solution would apply.” Experienced Service Engineer.

When even this was not possible then employees could find that existing solutions gave them ideas on how to approach developing a new, customized, service.

“... it definitely gives you a head start. It will point you in the right direction and a lot of the solutions are written up anyway and have links to documentation in the interface and even sometimes looking at [Knowledge Management Solution Repository] will give you an idea and point you in a specific area.” Team Lead

The most complex set of problems faced by employees were those that occurred as a result of Co. C’s products interacting with those of third part vendors. This required employees to acquire external knowledge in order to develop a customized solution and identify how to apply this external knowledge in order to create a customized solution (arrows 4a, 4b).

**Figure 4: Co. C**





## 6.0 Discussion

An important similarity between the case companies was that they were all involved in services where work undertaken for one client could be utilised across the client base. By starting from a position where a large degree of knowledge was tacitly held then, in the short-term, a first step was to identify what knowledge existed and where it was located. While some (Vence and Trigo, 2009; Nordin et al., 2011b; Bitner et al. 2008) argue that service firms are involved in increasing levels of client interaction and participation, others (Sundbo, 2008; Rust and Miu, 2006; Davis et al. 2007; Den Hertog et al., 2007) suggest that information systems are being used to standardise and leverage, or modularise (Peters and Saidin, 2000; Sundbo, 2002; Nordin et al., 2011) what were initially unique customer interactions. We draw on three case studies of service focused departments in three knowledge intensive multi-national firms to examine and develop a model to explore standardization, customization and modularization in ICT enabled KIBS contexts. The three cases enabled a broad developmental trajectory to be identified across the companies as firms implemented more complex information systems. Though there were consistencies across the firms, it was also clear from our research, that while all three companies were seeking to develop information systems to support their activities, they were at different stages of development. As a consequence, and based on the data collected, we developed a model, as outlined earlier, that aids an understanding of how information technology supported knowledge intensive service firms.

Knowledge intensity is an important concept. However, in this study, it does not relate to service co-production as the concept was used by Freel (2006) but rather to the intensity of the work, involving knowledge transformations, undertaken by employees and facilitated by ICTs , (Doloreux & Shearmur, 2012; Hipp et al., 2015). Knowledge intensive business services are defined in terms of creating value through transforming their knowledge for clients (Leiponen, 2006). Our findings outline theoretical and empirical support for the categorisation of a number of types of knowledge transformation. (i) From tacit standard to either explicit modularised (arrow 1c) or to explicit standardised (arrow 1b), (ii) tacit customised to either explicit standard (arrow 3a) or to modularised (3b). Transformation through combination, as suggested by Amara et al. (2009), is also present in our research when external knowledge is acquired and integrated with existing knowledge. In addition to combination, we also identify the presence of knowledge recombination during modularisation where existing standard components are used to create new knowledge.

Instead of clients possessing much of the knowledge and competence required for service delivery (Bettencourt et al., 2002) instead our findings provide support for Tuli et al.'s (2007) argument that customers' limited understanding leads to knowledge asymmetries between service provider and client. In the KIBSs we examined, customisation did require a better understanding of customer needs than for standardisation but this did not, unlike Nordin et al. (2011) and deJong and Wermeulen (2003), require or enable the development of closer relationships. This was a result of the high knowledge specialization and the use of ICTs of service providers. While agreeing with Rust and Huang (2014), that ICT enables services to be renovated to make them more personalised, in this research, the services were made more personalised to a particular situation or problem rather than to a particular customer: thus unlike Rust and Huang (2014) and Glushko and Nomorosa (2013) we did not identify a need for an individualised two way flow of information. We go beyond the view is posited by Cabigiosu et al. (2015) that standardisation of modules reduces the need for clients and providers to engage in knowledge transfer and information exchange finding that knowledge asymmetry and modularisation also reduce this need. Also, while Cabigiosu et al. (2015) argue that clients' needs are communicated through intensive knowledge and information sharing we identified instances, in Co. C. the most complex environment, where this took place through automated information systems without any human contact. We therefore disagree with Kowalkowski and Brehmer (2008) that there is a need for co-creation in the case of increasingly advanced and complex offerings. A key reason for this is the role of knowledge sharing and co-exploration (Cabigiosu et al., 2015, Bettencourt et al., 2002, denHertog, 2000, Miles, 2005, Miozzo and Grimshaw, 2005). Existing research sees standardised service processes as reducing the need to produce and co-create knowledge with customers (Bettiol et al., 2012) while modularisation encourages co-creation (Ostrom et al., 2010) we find in contrast that in ICT mediated environments, both modularisation and standardisation, act to reduce the need for co-creation. While Cabigiosu et al. (2015) argue that inter-organisational decoupling is emphasised through modularity we find, even in a business-to-business context, that decoupling is also a result of the use of ICT for codification and due to knowledge asymmetries. Our findings with respect to the standardisation of services were consistent with Davis et al. (2006), that those who re-use knowledge were better at converting knowledge from service interaction into re-usable components that simplified future activities and the codification of standard services could be employed when there were high levels of knowledge re-use (Bettiol et al., 2012). Our findings differed from those arguing that it was not possible to completely codify or standardise services (Gallouj and Weinstein, 1997) with the ability to improve efficiency via standardisation being

reduced where there was bespoke service provision (Bettioli et al., 2012). The reasons for these differences is the deterministic nature of the contexts in which our case companies were located, being more amenable to precise codification, as well as the reliance on information systems to support service delivery. For customised services, our firms did, like Kowalkowski et al. (2011a), seek to exploit less complex services and explore new process-orientated solutions though for our firms, on the latter point, the results of exploration were to be codified and seen as a precursor to exploitation. We found it was possible to achieve highly customised solutions for clients without, as argued by Vence and Trigo (2009a), high degrees of interaction with clients.

Our results, like Rust and Miu (2006) and Rust and Huang (2014), also identified that ICTs improved efficiency through automation of standard routines (for Co. B) though some of these standard routines were codified in the ICT in modular form (Co. C). The case companies studied involved instances where ICT changed the interaction between actors as has previously been identified (Zeithaml et al., 2006, Davis et al., 2011, Glushko and Nomorosa, 2013). They did not however enable interpersonal interaction between client and provider as examined by researchers such as Zeithaml et al. (2006) and Glushko and Nomorosa (2013). There were limited situations, where the changes involved technology generated self-service (Breibach et al., 2014, Breibach et al., 2012) moving work to the service provider like Campbell et al. (2011), but for the most part the changes involved replacing interpersonal interaction during service encounters, a move identified by Glushko and Nomorosa (2013). We did identify (in Co. C.) the use of remote services objects like previous studies (Schumann et al., 2012, Paluch and Blut, 2013, Ulaga and Reinartz, 2001, DuBay, 2009). The companies we examined were examples of clients choosing to outsource service provision due to efficiencies from provider economies of scale making outsourced service provision more cost effective. We also agree with Cheng and Krumwiede (2012) that the nature of services requires credibility be established with customers. One way of identifying this credibility could be achieved, identified in our research, was through the use of information systems for service provision. We do not agree with authors that argue that the degree of interaction with clients is a key distinction between services and manufacturing (Gallouj and Weinstein, 1997) and, consistent with our earlier findings, close and continuous interaction (Kindstrom and Kowalkowski, 2009) was not required. Thus the knowledge complexity of the firms coupled with having specialised knowledge, gives rise to knowledge asymmetries. This had identical effects on all three firms in terms of how standardisation and customisation and ultimately client interactions were concerned.

While higher costs associated with customised offerings (Johnson and Selnes, 2004) are necessary for initial knowledge creation we find that cost efficiencies, through reuse economies, can be reaped through the use of ICT for both standardisation and modularisation. In line with IT cost structures in general these require a high upfront cost but low marginal costs. Primarily, benefits are achieved through the codification of tacit knowledge as previously found (Cowan and Foray, 2000, Gammelgaard and Ritter, 2005) though in the companies we examined this was achieved in a number of ways (moving from top-tacit to bottom-explicit quadrants of the model). The firms who did this (Co. B, Co C.) were able to exploit codification through replication, as advanced by Bettiol et al. (2012). While standardisation is typically associated with efficient service deployment (Bottcher and Klinger, 2011, Davis et al., 2007, Sundbo, 2002, Tuunanen and Cassab, 2011) modularisation provided efficiency through reuse and also through making the codification process more efficient by providing a mechanism for reconfiguring standard components. We were able to identify two types of efficiency, a distinction not present in the literature: exploitation by standardising the process (Co. B) and exploitation of the codification process through modularity. For the former case the objective is to standardize a process immediately and in the latter, to provide for greater flexibility in the future as new instances of a problem or new customer requirements emerge.

The research findings suggest that the focus of customisation to meet clients' demands (denHertog, 2000, Muller and Doloreux, 2008, Bettiol et al., 2012) particularly business customers (Bettiol et al., 2012, deJong and Wermeulen, 2003) to create a point of differentiation (denHertog, 2000) could usefully be reconceived as ICTs become more pervasive. Services (Co. C.) are being matched not so much to clients as to sets of codified requirements, with services providing actions to meet requirements. Differentiation may be on how agile, typically supported using ICTs, a firm is in responding to customer needs. As information systems are increasingly used to support knowledge intensive service firms there may be a move to think in terms of knowledge requirements rather than the client requirements- i.e. at a higher level of abstraction. This also raises questions regarding the nature of 'bespoke' service provision as reducing the ability to exploit codification (Bettiol et al., 2012). Based on our framework we argue that an alternative view of bespoke service provision, compatible with knowledge codification for reuse, is possible. Bespoke service provision is necessary and valuable where a codified service does not already exist in a firm in response to a client request. Consideration should first be given to whether any

elements of existing knowledge could be reused. While Sundbo (2002) sees standardisation as increasing exploitation for clients that are not interested in customisation we see the development of a bespoke service should be seen as a precursor to codification- so that newly developed service is available for exploitation across the client base where there is likely recurrence. This view contrasts with Bettiol et al. (2012) who sees bespoke service reduces the changes of codification for standardisation.

In contrast to previous conceptions of modularisation as providing a needed balance between customisation and standardisation (Nordin et al., 2011, Olivia and Kallenberg, 2003, Meyer and DeTore, 2001, Miozzo and Grimshaw, 2005) our conceptualisation of these concepts sees them as (i) a progression from either customisation or standardisation towards modularisation (arrows 1c, 3b, 4a, 5a) or (ii) interaction between customisation and modularisation (arrows 4a, 4b). In addition, we find instances where it is possible for customised service actions to be transformed into either standardised or modular forms (arrows 3a, 3b)). We also find that it is efficient for modularity to be used for standard solutions (arrow 1c), by drawing on standard components (Davis et al., 2007). Rather than seeing a modular approach as involving the combination of standardisation with a final service customisation (Sundbo, 2000, Peters and Saidin, 2000, Bettiol et al., 2011) we see modularisation as being able to draw on standardised components, like Davis et al. (2007), in order to create a new service that is explicitly codified for a certain context rather than a certain customer. While modularisation does provide flexibility, unlike Bask et al. (2011), the objective is not to enable a degree of customisation for individual customers but rather to a problem or requirement, thus abstracting from the particular to the general and in so doing increasing the degree of flexibility.

## **7.0 Conclusions**

The proposed model contributes to the literature on service firms in a number of ways. It outlines how the increasing specialisation of labour and knowledge intensity of service providers leads to increased knowledge asymmetries between providers and clients. It illustrates not only how

different types of information systems can be used to support different types of knowledge but also suggests how associated problems, encountered with each phase, can be overcome as more sophisticated systems are implemented. The model as presented suggests that while a consequence of using information systems is the standardisation of service elements to leverage existing knowledge, that this need not be an end in itself. Firms can use information systems to modularise and segment knowledge, elements of which can be subsequently combined to employ unique client circumstances while also leveraging existing knowledge.

The conceptual model we outline offers managers a lens with which to examine their organization. As a starting point, firms can use the model to identify and evaluate their current stage of development, identify associated problems, as well as potential system configurations that would support future developmental activities. When tacit and explicit sources of knowledge are identified, along with the nature of knowledge complexity, it is possible for managers to use the model presented to analyse the trajectory of their organization with regard to standardization, modularization, customization and their service innovations using their ICTs. This is particularly important in situations where clients are currently engaged in co-production, and activity which could be rendered more difficult by the presence of knowledge asymmetries. A critical issue for managers in knowledge intensive firms is the importance of understanding how to manage the role played by information systems in delivering the benefits of leveraging knowledge, and the value added by efficiently recombining codified knowledge modules to efficiently construct service responses to clients' needs.

We believe that this paper provides an added dimension to the existing literature in terms of (1) the focus on knowledge intensive firms in contexts with complex knowledge and (2) on their use of information systems. Bettioli et al., (2012) posit that KIBS are involved in higher levels of customisation, which is only true in certain situations and may depend on knowledge complexity rather than the firm being more a “traditional service firm”. The paper also shows that by standardizing a knowledge intensive service, the provider can increase knowledge exploitation related to its standard input, and offer a standardised service to customers who are not interested in customisation and do not seek interaction (Sundbo, 2002). Again this is true where there is no need for interaction, in the cases shown. As the firms chosen in this study were dealing with somewhat deterministic knowledge, research in industries where the underlying knowledge is more socially constructed would be beneficial. The research found that there were operational

advantages in self-service technology for work performance and overall customers regarded the gains and increased credibility as posited by Bhappu and Schultze, (2006). This research opens up some additional avenues for future studies. Research in this area could benefit from a more explicit treatment of knowledge as an organisational resource that is drawn upon for service provision. Also the role of information systems in codifying knowledge, its use by the service provider, and how it might provide a computer mediated environment through which customer interactions take place could be included in future work.

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