

Conceptual Model for the Use of ICT Systems to Facilitate Manufacturing SME Servitization

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Abstract - *This paper presents a conceptual framework on which to base further empirical research into Manufacturing SMEs' (MSMEs) deployment of ICT systems to achieve successful servitized manufacturing strategies. The development of manufacturing servitization theory and research surrounding SME organisational characteristics are synthesised with insights from a single case company to propose means for MSMEs to overcome servitization transformation challenges recognised in the literature and in practice. This work is founded on a review of the literature and experience in a single case MSME, so whilst presenting a valuable platform, requires further research to be validated. This research contributes to a developing facet of an emerging topic in Operations Management by providing a model which considers manufacturing servitization through the lens of ICT systems, as well as in the underdeveloped research context of MSMEs.*

1.0 Introduction

Servitization represents the transformation journey of traditional manufacturers looking to infuse service operations into their value proposition [1], with ICT systems underpinning multiple levels of the transition [2,3]. ICT systems such as ERP, CRM, and asset tracking mechanisms offer manufacturers the ability to automate key internal processes involved with manufacturing, accounting and customer engagement. Thus resources can be redeployed to the development and maintenance of new, value creating product-service operations which increasingly dominate traditional manufacturers' revenues [4]. Similar to large organisations, MSMEs are increasingly exposed to international customers and competition as well as the need to streamline existing processes to protect profit margins [5].

Effective use of ICT systems is recognised in the literature as integral to the development of Product Service Systems (PSS); [6] describes the service and technology revolutions as inextricably linked because service design and operation requires customer information which is gained, stored and acted upon through technology. However, the research that exists within this stream is largely focused on large organisations which differ fundamentally from smaller firms in both their adoption and usage of ICT in strategic change [4].

As such there is a gap for empirical research seeking to develop a practical understanding of how ICT can be used effectively by MSMEs to create new PSS.

The aim of this research is to explore the ways in which MSMEs could use ICT systems to overcome challenges associated with expanding their offering beyond physical products alone. This emergent topic in Operations Management is tackled by synthesising existing servitization and PSS literature with observations from a British case study manufacturer in the early stages of a servitization transformation. A conceptual model which theorises how MSMEs can develop the infrastructure needed to deploy PSS is created to guide future empirical research into how SMEs can utilize ICTs to facilitate the addition of services to their value proposition.

2.0 Research Methodology

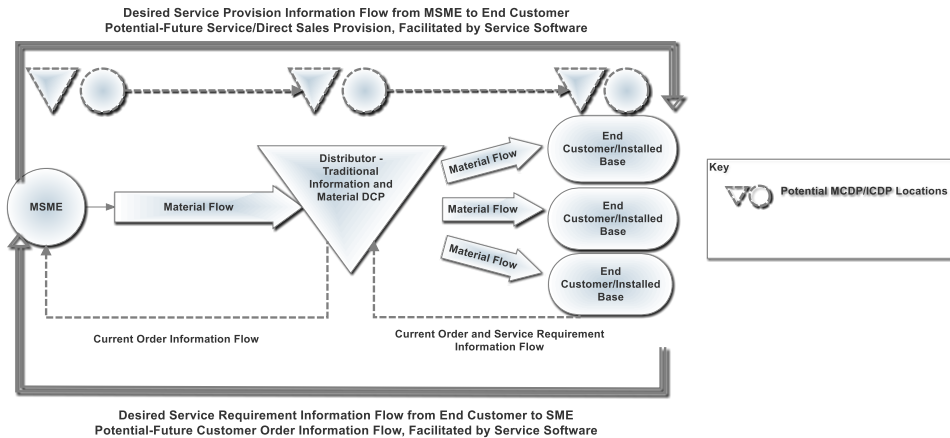
A framework for ICT as an enabler of servitization in MSMEs is built upon a review of the extant literature, combined with findings from an ongoing research collaboration with a MSME, to be validated as design propositions [7] as a basis for academic and practitioner relevance. [8] posits that qualitative studies such as interviews and literature reviews are appropriate when the researcher seeks to gain insight into how the subjects attribute significance to situations and occurrences, and understand these in their specific context. Primary insights for this study are drawn from the researcher's involvement in a two year project to develop systems capabilities within a British manufacturer 'AA Lifting' (AAL).

Analysis of the literature and observations made during the servitization project have produced the following conceptual model (Fig. 1) to portray a potential framework, upon which to base future research into deployment of ICTs to facilitate servitization. Fig. 1 is based around a traditional supply chain construct in which AAL supplies its products to large resellers, who then sell products and services to multiple end customers. In a typical arms-length relationship there is little access to undistorted demand or product usage data from the end product consumer with which to develop service offerings; this is reflective of one of AAL's key supply arrangements. Within this construct the beginnings of a future state where the MSME can deploy ICTs to reverse the current information asymmetry on its end customers and the use of its products in the field.

Semi-structured interviews with members of the case company and observations made by the researcher during ERP systems scoping sessions have been used to gain insight into an area which is novel to both the researcher and to a large degree, the field of Operations Management [9].

The first stage of the research is a review and discussion of the literature surrounding the servitization of manufacturing towards PSS and the differences in how traditional (large and small) manufacturers pursue this aim.

Fig 1 – Conceptual Model to Show Current and Future States of MSME Service Information and Product Flows Through Use of ICT Systems



The criteria for identifying sources for the literature review were papers identified through the EBSCO database containing the terms ‘servitization’, ‘product service systems’, ‘ICT in manufacturing’, ‘manufacturing SMEs’ and ‘ERP implementation’. Based on the literature to pursue servitization, its challenges and requisite infrastructure (focusing on ICT systems) the following broad research questions were developed to guide the direction of the semi-structured interviews:

- RQ 1 – In the context of MSMEs, to what extent do ICT systems enable a successful servitization transformation?*
- RQ 2 – What impact does ICT have on British MSMEs managing the increased structural change and complexity inherent in a servitization strategy?*
- RQ 3 – How does ICT enable British MSMEs to develop and maintain the relationships needed for successful service infusion?*
- RQ 4 – What barriers prevent British MSMEs from exploiting ICT to offer bundles of products and services?*

In total eight one on one interviews ranging from 45 minutes to an hour in duration were conducted with top company management staff, directors and key operators of an incoming ERP system. The interviewees were selected to represent concerns from each of the company’s six main departments – Engineering, Manufacturing, Sales Order Processing (SOP), Sales and Operations and Accounts. Additionally by interviewing top management at the company, this research sought to draw insights from those who are responsible for key decisions, therefore capturing the concerns and motivations which underpin the use of ICT to move towards PSS.

Semi-structured interviews were chosen instead of conducting a staff survey for several reasons. Primarily the levels of experience and competence with ICT systems varied across respondents in the company.

This makes semi-structured interviews with the researcher ideal for clarifying issues which could affect the interpretation of the answers given, i.e. ensuring that any specialist terminology being used was understood in context. In addition the use of semi-structured interviews allows for new directions for research to be proposed by respondents in a manner which tightly constructed surveys may not. Due to the exploratory nature of this research in a MSME context, such insights serve to lay the foundation for future work in which surveys could be better used to provide confirmatory results on a larger scale in a range of companies [10].

The framework presented is grounded in existing theory from the literature and interviews in a manufacturer in the midst of a servitization transformation, however further empirical research will be needed to validate the model.

3.0 Literature Review

3.1 Product Service Systems (PSS)

A product service system is the end goal of the servitization transformation and seeks to transcend the traditional product-centric offering of manufacturers to facilitate service provision. PSS is defined by [11, p1] as an integrated “market proposition that extends the traditional functionality of a product by incorporating additional services” with much mainstream research exploring “function oriented business models” [12] Such models detail a combination of products and services being deployed to achieve specific customer aims and may include product design, maintenance, repair and end of life services [13, 14].

Motivations for traditional manufacturers pursuing sustained competitive advantage through PSS include differentiation from competitors [14,15], the increasing commoditization of manufacturing methods and products [4], the globalized marketplace encouraging increased international competition even at an SME level [3,5,16] and customer desires for full product solutions (i.e. pre and post-sales support). The changing nature of customer needs, technological development and market forces have led many traditional manufacturers to protect existing margins and pursue higher revenues through servitization [17]. As such by pursuing service strategies, firms are able to differentiate themselves without just competing on product price.

As the servitization phenomenon comes under increased academic scrutiny, more layers and definitions within PSS have been identified. Each of them have different implications for factors such as organisational structure, relationship management, service design, service provision and risk and uncertainty. Contributors seem to be in agreement that there are currently three acceptable classifications of servitized offerings based on the early work of [14,18]. These authors identify services that support the physical product (SSP), services which support the customer’s internal processes (SSC) and services which extend past the end customer to support their network (SSN) (i.e. systems integrators).

SSP refers to traditional post sales services such as spare parts and training, with [19] indicating that as industrial service offerings become more commoditized, SSP serves chiefly as a market qualifier [20] as they do little to distinguish the manufacturer's offering from their rivals. Advanced services (SSCs) involve the manufacturer moving downstream into the customer's value chain by offering services linked to product use, such as remote monitoring of products in the field by the customer [21] and end of life strategies (i.e. disposal) being mooted as more 'proactive' offerings with a higher potential of winning new business for the organisation [17,23]. [18] expands upon the idea of SSC by defining a second level in which services which are not connected to products that they have provided the customer, but nevertheless support the customer's internal processes (i.e. waste removal).

Despite each distinctive level of servitization representing a different level of integration with the customer, the overarching commonality is the requirement to outgrow the traditional, transaction based manufacturing worldview. As an alternative, literature suggests partnership relationships where customers and suppliers seek to co-design and co-produce favourable service outcomes, whilst sharing the pains and gains of new supply chain structures.

3.2 Servitization of Manufacturing

Servitization refers to the transformation from pure product manufacturing to the integration of services into a company's value proposition, as first forwarded in the work of [1]. The majority of research theorises transformation along a continuum [13,14,17] from pure production to a pure service model with firms at varying degrees. [3]'s literature review proposes a framework of general structural (i.e. process and technology), and infrastructural, characteristics of product-centric servitized operations. [19]'s longitudinal survey into a single Finnish Forklift manufacturer found organisational restructuring and effective coordination to be critical to successful servitization in an early decoupling of product and service units.

The past decade has seen development in the understanding of the real world practicalities of the development of PSS, with knowledge surrounding the challenges beginning to appear, albeit often in the form of single case studies. [24] presents a set of potential inhibitors in the paradigm shift from production dominance to servitization spanning marketing, production, delivery, product-design, communication and relationship challenges. [25] propose five categories of challenges that the servitizing manufacturer must consider when navigating strategic, operational and social tests that organisations face during the transformation (embedded product-service culture, delivery of integrated offering, internal processes and capabilities, strategic alignment and supplier relationships).

Although it is arguably more problematic to make generalisations based on the single case approach of these studies, there is support for [24,25] findings from surrounding research. The need to establish a culture where services are not solely seen as add-ons to physical products is endorsed throughout the literature [3,13,13], as is a

behavioural shift from traditional transaction-based to relationship-based approach to customers/suppliers which values co-production and co-delivery between suppliers and customers of product service systems (PSS) [15,26,27].

Much of the empirical focus in Servitized operations literature has been conducted in large firms [28,29] however retains a “paucity” of knowledge and practical guidance for traditional manufacturers wishing to servitize [3, p.562]. This absence is more pronounced in the neglect of investigations from an SME perspective [23]. As such, thought must be given to the differences between MSMEs and large manufacturers which may logically impact important facets of the servitization process as have been indicated in contemporary research.

3.3 ICT in Servitization

ICTs are a prevalent enabling factor across the spectrum of modern manufacturing systems with the potential to positively affect the bottom line by streamlining product design and delivery processes [30]. In the context of servitization, [6 p. 24] asserts that “the service revolution and the information revolution are two sides of the same coin”. (Baines and Lightfoot, 2013)’s case study of four successfully servitized large manufacturing firms corroborates the findings of [14,25,31] that ICTs such as CRM and ERP provide the requisite control mechanisms to ensure efficient production operations upon which to develop increasingly complex service operations.

In order to develop service offerings that are relevant to individual customers, smart database technologies such as CRM are coupled with communication technologies such as video/telephone, email and remote monitoring software/hardware to act as an interface between the focal company and relevant stakeholders. [15] illustrate a common ICT architecture amongst the case servitized manufacturers which facilitate advanced PSS along the following five functions - Monitor, Transmit, Store, Analyse, Respond. By using remote monitoring systems to collect data on usage and ‘health’ of the installed base (products already with customers in the field [13], servitized manufacturers can combine ICT data systems and market knowledge to develop future product design improvements and manage maintenance and repair contracts. Key to the operation of [15]’s model is the availability and exploitation of real time information to forge new, more complex business models which involve leasing of products instead of outright purchase [32].

Despite the aforementioned potential for ICT to act as an enabler for value creation through servitization, various areas of the literature suggest challenges in realising optimal results through such an approach. [30] assert that to combat negative customer service outcomes due to often poorly skilled staff with high levels of variation in behaviour, ICT process standardisation should be embedded within the company to strengthen the reliability of such processes. Such recommendations for implementation of best practice are made by various authors [18,33,34], however there is a gap in prescriptive knowledge in current literature on how this can be achieved.

3.4 Servitization in MSMEs

There exists a wealth of historic empirical research distinguishing organisational and strategic characteristics of large organisations from MSMEs. The work of [35,36] asserts that compared to their larger counterparts, SMEs are sluggish to adopt appropriate lean and total quality management strategies which are cited as helpful to the development of a service competency [32,33]. Based on a small sample of survey respondents from Colombian SMEs, [37] indicates that SMEs increasingly perceive that ICTs ranging from email and ERP to remote monitoring software and hardware can positively contribute to sustainable PSS development. However the author found that the majority of ICT systems SMEs were using were to streamline existing processes, rather than pursue PSS specifically. Subsequently it is difficult to ascertain from the available evidence how many MSMEs are investing in large scale systems (ERP and CRM) with the expressed intent to facilitate PSS delivery.

[23] highlight that in comparison to large firms, there are several barriers which prevent SMEs from servicing the installed base. Factors such as disconnection from the end customer by larger customers and distributors [38], scarce resources to invest in high quality service staff and difficulty investing in and integrating ICT support systems [39], all affect the transferability of previous research into servitization strategies for SMEs. To overcome these challenges, relationships with other firms in their network are proposed as the most critical resources for SMEs differentiating by servitization [39]. [22]'s multiple industry case study of Swedish SMEs (each servicing international MNEs) presents a framework of generic 'value constellations', through which SMEs enter partnerships to create and provide new product and service propositions. [23,24] assert that it is crucial to cultivate relationships within the network at an early stage of developing service based orientation (SBO). However, there is a need for further insight into how SMEs can achieve this, as well as scope to research how SMEs maintain and derive value from 'constellations' in a different national setting.

There are areas of contention with regards to the structural challenges faced during MSME servitization as well as the documented approaches taken to address them within the extant literature. Despite traditional thinking being that a gradual transformation process is more prudent for the servitizing SME [14,22,40], [24]'s findings propose a paradox in that gradually adding services to their value proposition could be "hazardous" (p 142), with a more radical set of organisational changes being the favoured change management approach. In addition, [41]'s survey of UK manufacturers' use of servitization strategies indicated that contrary to previous case study findings [3,22,24], the majority of servitizing organisations did not perceive the need for radical restructuring of the organisation or make a large capital investment to support the provision of services as well as products. However, this is tempered by the difference in forms of service offering, with provision of spare parts and training requiring less intensive organisational preparation than so called advanced services [33] which seek to integrate into the customer's own operations.

As such it could be postulated that before embarking upon any level of servitization transformation, MSMEs should have a clear idea of how advanced the service offering aims to be. Should this be done, it stands to reason that the necessary levels of restructuring and investment in technology can be scoped before any organisational change is instigated.

4.0 Presentation of Interview Findings and Discussion

The results of the semi-structured interviews with key management and operating staff will now be discussed in comparison to the literature to draw conclusions in the context of the research questions. Summarised, anonymous accounts are used to ensure the confidence of respondents and are presented in Table 1.

Table 1 – Summarised Interview Responses from ‘AA Lifting’

Research Questions (Basis of the Interviews)	Summarised Responses from Interviews
<i>RQ 1 – In the context of MSMEs, to what extent do ICT systems enable a successful servitization transformation?</i>	<ul style="list-style-type: none"> - Pre-implementation data gathering, cleansing and reprocessing of business functions perceived as equally valuable as the desired service outputs. - Facilitate solicitation of up-to-date information which can be monitored (i.e. installed base inspection data) and analysed through ERP reporting capabilities.
<i>RQ 2 – What impact does ICT have on British MSMEs managing structural change and complexity inherent in a servitization strategy?</i>	<ul style="list-style-type: none"> - Breaks down ‘silo’ information structures i.e. the ability to pull reports from various sections of the business through CRM dashboards allows more efficient responses to pressing issues. - Automation allows staff to spend more time on value adding, customer facing tasks. - New systems mean reassessing who is involved with customer facing activities and how customer communication is handled. - ICT cannot make final decisions for the company, should be viewed as a management tool with which services are developed.
<i>RQ 3 – How does ICT enable British MSMEs to develop and maintain the relationships needed for successful service infusion?</i>	<ul style="list-style-type: none"> - Email and telephone are established ICTs. However until post-ERP, CRM and inspection software implementations it is not possible to capture a host of desired data. - Assessing possibility of having interaction with a front end portal on the company website to register products for service provision (i.e. warranty). - Allows more proactive interaction with the customer to offer services that were possible before in to a limited capacity, but not to the scale of a service specific business (i.e. spares, refurbishments and inspection).
<i>RQ 4 – What barriers prevent British MSMEs from exploiting ICT to offer</i>	<ul style="list-style-type: none"> - Lack of investment capital; human resources to devote to transformation activities; long term planning capabilities; experienced technical staff.

<p><i>bundles of products and services?</i></p>	<ul style="list-style-type: none"> - Traditional manufacturing ethos focuses time and money on developing products instead of product service systems. - Difficulty understanding pros and cons of available systems and prospective third party providers/integrators. - Uncertainty about whether servitizing could negatively affect strategic relationships by turning customers into competitors.
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RQ 1 The majority of respondents found it difficult to communicate the extent to which ICT enables successful servitization. This is likely to be because during the research period AAL were at the early stages of an ERP implementation to lay the foundation for PSS development. This being so, various positive responses indicated that ERP is perceived as critical for expansion into PSS, initially through extending internal processes to pursue service revenue streams. In AAL’s case this would begin specifically through field inspection and refurbishment operations of the installed base.

It was recognised that implementation and maintenance of new systems requires data collection and cleansing across all departments (such as bills of materials and customer contact details), as well as reprocessing of current procedures. Each of the respondents agreed that the process of preparing for ICT implementation is arguably as valuable as the potential benefits. Sales, engineering and operations staff focused on benefits of enriched customer interaction, data collection and storage and reporting capacity which would be made possible through the ERP implementation and through the subsequent acquisition and deployment of field inspection software. Due to the planned servitization being in the early stages, these views can only be treated as opinions based on changes they expect to see as a result of ICT implementation. However they reflect the findings of [14,37] that MSMEs find real value in the antecedent processes to installation of ICT systems, which will underpin service operation deployment.

RQ 2 ICT was perceived to have a largely positive impact on MSMEs’ ability to manage structural change within the company as a result of servitization. Positive responses revolved around eroding some of the ‘silo’ mentality surrounding information which has previously hindered responsiveness to service opportunities. For example, the ability to pull reports from various sections of the business through CRM dashboards allows more responsiveness to unforeseen and emerging customer issues. The perception forwarded by AAL is supported by [42]’s case study which asserts that SMEs can become more responsive to changing customer needs with well implemented manufacturing control systems such as MRP, CRM and ERP. Additionally [17] note that the most innovative, and profitable types of services frequently require the manufacturer to develop technological systems to actively monitor the installed base – a key tenet in the transfer of risk from customer to manufacturer characterized in usage based contracts and relationships [1215,43].

AAL respondents perceived that implementation of ICT systems would lead to internal restructuring of job roles and responsibilities to cater for the provision of

services, however there was recognition that there could be issues with this. ERP, CRM and stock management modules have been identified by experience of working with AAL and relevant literature [14,31] as key to improving responsiveness to customer problems (i.e. complaints), basic service requests (i.e. for spare parts) and formalizing the ad hoc nature of service breakdown recovery inherent in SMEs [27,28]. However as noted in literature such as [5,21,32], the software itself potentially presents a myriad of issues due to the organisational changes it. This could feasibly lead to internal resistance due to fear of role change or removal, misunderstanding of the actual benefits of new product-service offerings and the need to develop new, distinctive behaviours from solely manufacturing based organisations [13]. Again, the early stage of AAL's servitization transformation inhibits insight into the aforementioned challenges owing to reconstruction. As such this could prove an interesting route for future empirical research subsequent to the new systems implementations.

RQ 3: As observed in the case company, one of the key drivers to invest in inspection software is to capture product usage data at the customer end, to inform pre-emptive activities such as product inspections and replacements. AAL's respondents showed familiarity with established ICTs such as email and telephone, however indicated the need to further facilitate ways in which customers can transfer information the installed base of products, namely via a portal on the company website which is integrated with the CRM system and product inspection software. Theoretically this allows the information decoupling point (IDCP) [44] to be shifted downstream to the end customer to monitor product usage and forge closer relationships with actual users of AAL's products. Logically, this could also have implications for the position of the material decoupling point (MDCP), creating higher profit margins per unit and increasingly familiar customer relationships, by selling directly to the customer without the level of discount applied to goods sold by an intermediary.

As illustrated in Figure 1, the current customer order and service requirement information flows are decoupled at the retailer stage, restricting access to real-time customer consumption habits and service requirements data. ICTs such as remote monitoring, ERP and CRM are means to bridge existing supply relationship information asymmetries and further develop goods and services that are more relevant to customer needs by creating critical feedback loops [18].

RQ 4: Risks related to demand amplification and the bullwhip effect [45,36] become apparent in supply chains which lack the visibility provided by integrated EDI systems and a partnership approach to supply chain management. Taking AAL as the focal point in the supply chain (Fig. 1), interviews suggested that the technological innovations meant to encourage transparency and service innovation could prove difficult to implement initially. The interviews support the highlighted literature which details barriers to adoption of advanced ICT systems by MSMEs [5,38], citing tight resources in terms of money, advanced systems knowledge and long term planning capabilities.

Interviews showed that the ICT systems that are currently within the firm (including advanced engineering software) are largely used for the purposes of product production and development, with little focus on product-service innovation. As such it could be argued that beyond buying in advanced ICT systems, MSMEs must emulate their larger counterparts in adopting a service driven mind-set beginning product development and system planning/operation stages [3,23].

Taking Fig 1 as a reference, securing buy-in from larger supply chain partners has been identified in the interviews as a barrier to exploiting ICTs to offer PSS. Responses expressed concern that existing, strategic supply chain relationships could be impacted. This is supported in literature which suggests that large partners providing services to end customers could be unwilling to upset the current power balance built upon undistorted end customer demand data; or revenue streams which upset existing material, information and cash flows [38,47]. Short term negative outcomes suggested by AAL staff were intermediaries switching to rival products/suppliers; cheaper competing services from distributors exploiting economies of scale; blocked access to the installed base. To negate this, MSMEs may consider working with their larger distributors to leverage their proprietary product knowledge and the distributor's knowledge of the installed base to co-produce new services to be delivered with the cooperation of both parties [13,14,23].

Interviews identified difficulty understanding the pros and cons of available systems and prospective third party providers/integrators largely owing to the traditional MSME deficiencies (namely resources to devote to new systems planning). Recent literature implies that there is increasing support for MSMEs due to factors such as the scaling down of ERP [5,31,41] and remote monitoring systems [21,48], with increased technical and project management consultancy available to MSMEs who wish to incorporate innovative technology [5,37,39]. In the case of AAL the researcher has assumed the lead role in selecting the requisite service ICT systems and coordinating the MSME and external system integrators, thus relieving the highlighted resource dependencies. Based on this, future research could explore the impact of MSMEs using external consultancy for the purpose of developing ICT capabilities to underpin planned PSS, comparing the experiences and success of those which adopt consultancy and those that do not.

5.0 Conclusions

The aim of this research has been to develop a conceptual model on which to build future research into MSMEs' deployment of ICTs to facilitate servitization. Primarily, the model presented in Fig. 1 asserts that by adopting advanced ICT systems (i.e. ERP and CRM) which mobilise up to date information on the installed base, MSMEs can overcome traditional barriers between themselves and development of PSS.

Interview findings from AA Lifting (Table 1), guided by a review of the literature have yielded some interesting conclusions to the four research questions.

Primarily, MSMEs in the early stages of adopting advanced ICT systems perceive the requisite business reprocessing and data cleansing of similar importance to the PSS these systems are aiming to facilitate. By tightening up business critical data such as bills of materials and customer contacts, MSMEs can begin to emulate the system discipline which helps their larger counterparts manage larger scale service operations.

ICT was largely perceived as having a positive impact on MSMEs' management of structural change and increasingly complex PSS operations. Internally, this was largely due to the need to address existing information silos and improving responsiveness to external customer service needs (notably through the synthesising effects of a CRM system). However it was also noted that automation of tasks would not in itself mean a successful servitization transformation, with both literature and interviews emphasising the need for human intervention in PSS strategy and decision making.

ICTs were found to have an important role in developing and maintaining the partnership relationships which the literature describes as vital to managing PSSs, especially in the context of MSMEs. By facilitating the solicitation, storage and analysis of up to date customer and product usage data, ICTs help MSMEs to take proactive approaches to service provision.

Overall the interviews highlighted many similarities to the literature in discussing barriers to exploiting ICTs to deliver PSSs (i.e. resource constraints and underdeveloped understanding of available systems). However, concern was also raised over possible reactive measures of current customers who also offer services. As with many of the conclusions drawn from this case study these are based on staff perceptions within a single case company before an advanced ICT systems implementation. However, the unknown effects on existing relationships due to ICT driven servitization is an interesting area for future research which could logically concern other MSMEs on the cusp of making investments in such systems.

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