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Perspective of Servitization of a Mature Public Transport System
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INDUSTRY 4.0: EXPLORING COLLABORATIVE SUPPLY NETWORKS FROM THE PERSPECTIVE OF SERVITIZATION OF A MATURE PUBLIC TRANSPORT SYSTEM

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ABSTRACT

Purpose: Digital transformation in the era of Industry 4.0, with its revised, prescribed frameworks of practice, include those which are redefining the contextual characteristics that strongly advocate collaboration within the supply chain; and in doing so, see this element of the operations function as being an increasingly critical contributor to operational performance. We deepen the understanding of the concept and operationalization of the collaborative supply network in terms of it being a value ecosystem wherein value is captured and exploited within servitization practices (Baines & Lightfoot, 2013), as present within a mature public transport system.

Design/Methodology/Approach: So, we take a qualitative approach through the critical review of the business unit level perspective as this provides an understanding of the implied intention of the digital transformation of the organisation, as associated to its the operational capability. Through joint interview discussions with the strategic and technical business unit leaders, we determined the realities of implementing a collaborative approach towards supply network relationships and the ability to exploit a range of Industry and Service 4.0 technologies, particularly when external suppliers seek to apply technology push to enable operational improvement.

Findings: We conceptualised the perspective of 'value contribution' and 'collaboration' as present between the strategic and technological/operational business units, within a mature public transport system during a period of cost reduction and at a time when they are heavily impacted by the technology push from external suppliers. We touch upon the merging and interdependence of the two business units, which have forged strong collaborative relationships between the strategic intention and operational design and capability. We were able to determine the current joint efforts to exploit value within the supply network, such as the requirement for efficiency of customer processing machines and the quality of customer experience for escalator services. Servitization is shown to be present through the manner in which the two business units have made the decision to apply technical capabilities to install sensory devices to collect customer usage data that brings precise, reactive planned escalator maintenance in the form of servitization of transportation products; despite the business units being unaware of it as being a representation of servitization practice (Crowley, Burton, & Zolkiewski, 2018).

Originality/Value: By exploring the contribution, in relation to the level and extent of the strategic intention of organisations; and the associated development of its [digital] operational capability, we argue that, the performance of the operation is critically linked to the collaborative supply network strategy, and as such, the future approaches taken by the organisation will benefit from research that supports the understanding of the current realities and the their deployment of servitization practice, which inherently require close collaboration between supply networks. In the era of Industry 4.0 with its progressive digital transformation, this research brings the possibilities to generate deeper understandings that inform future developments in collaborative supply networks as value ecosystems. The research seeks to bring servitization beyond conceptualization and into the forefront of practice and to be able to have it more clearly understood from an organizational and strategic perspective, in order that it can be applied to capture and exploit value at the operational level.

KEYWORDS: Industry 4.0, operations strategy, collaborative supply networks, value ecosystem, servitization in public transport

1. INTRODUCTION

We are interested in how the strategy for digital transformation effects and impacts on the supply network aspects of the operation (such as internal business to business unit supplier collaboration and engagement in the planning, designing and day-to-day service delivery). We understand that cyber-physical systems, as present in the Industry 4.0 era, have facilitated a paradigm shift that exploits

technological capability and that it enforces a more collaborative approach to supply network relationships and competitive dynamics. We are aware that the strategic intention and [digital] operational capability of an organisation is intrinsically linked; and that more can be learnt about the realities of practice through explorative case studies. Service provision in the Industry 4.0 era, is increasingly adopting manufacturing-based frameworks of practice to be able to exploit the benefits that these offer in terms of operations efficiency and effectiveness. For example lean processing and just-in-time (JIT) production are continuing to make significant differences to healthcare provision in some regions such as Sweden (Kohlberg, Dahlgaard, & Brehmer, 2006) where lean was seen able to support the flow of service activities to support the overall [efficient and effective] processing of patients. More recently, health care contextual research (Maijala, *et al.*, 2018) has found that leadership traits play a critical role in the successful implementation of lean. They state that those strong in successful lean leadership tended to include a demonstration the following capabilities: problem solving, making change occur, empowering, communicating, coaching, supporting, facilitating, and being democratic. In the *Journal of Public Money and Management*, there has been further debate on the changing to lean in public services (Holmemo, Ingvaldsen, & Benders, 2017:6) which discusses how “local managers had to decide which lean principles and tools were useful to their units and how they should be used”. In their editorial for a more recent article in the same journal, (Bateman, Radnor, & Glennon, 2018) state lean relates to the people issue, along with process and sustainability and that the reduction in spending levels continues apace across the globe.

This shift towards lean in public services therefore comes in the light of the economic constraints within UK services and specifically for public transport in London, and at a time when there has been a significant drop in government funding (Transport for London, 2019: How we are funded). For Transport for London (TfL) this means that there is a need to adopt, a simpler business structure, leaner processing, sustainable approaches to product lifecycle, and to deploy technology as efficiently as possible in performing the service delivery. Working with suppliers offers a chance to exploit lean in terms of cooperation where the supplier becomes an extension of the production line [service process] (Paton *et al.*, 2011) and to capture value from supply networks and operational processing where possible. Previous studies on Industry 4.0 have articulated the reasoning about the benefits of Industry 4.0, with its paradigm shift to cyber-physical systems and revised business models. Hence, the transformation of organisations in the era of Industry 4.0 has led to a re-framing of business models and practices. One such framing is that of stakeholder value contribution as associated to supply chain relationships cooperating within a highly dynamic network system. These ecosystems tend to be fluid in nature which makes it difficult to understand the contribution of value arising from the range of the interdependent components (Geisberger and Broy, 2012, cited in Lasi *et al.*, 2014) *co-operating* within the network system of the supply chain.

2. THEORETICAL POSITIONING TOWARDS THE RESEARCH APPROACH

Organisations are generally characterised as having three levels of strategy (Barnes, 2018). At the strategic, top level it's about the business that you are in, the relationships between different elements, the resources, and the design of overall control. Where organizations have business units, these come under the level of overall control and focus on the contribution, competitiveness and objectives of the business. At the subsequent, day-to-day operational level, the considerations are for the functional performance and delivery of the offering (product/service) that include decisions for technology and workforce. Put simply, “operations management (OM) is the science and art of ensuring that goods and services are created and delivered successfully to customers” (Collier & Evans, 2017). When considering operational level strategy, what actually happens within organizations is ‘decision making based’ which Paton, *et al.*, (2011:52) define as the major set of decisions about core competencies, capabilities and processes, technologies, resources and key tactical activities necessary in the function or chain of functions that create and deliver product and service combinations.

Significantly, the relationship between the top level strategic intention and operational level capability is a critical factor in the successful performance of an organization, and one that over the

lifecycle of the organizational development should see the operations performance capability becoming the influencer of the revised strategic intention. Interestingly Barnes (2018:75) explores this day-to-day perspective, viewed as the 'functional level strategy', wherein operations is one functional element; and he states that "an effective operations strategy is also one that makes a contribution to the competitive advantage of the organization". In which case, with the shift towards cost cutting, value for money and revenue generation, the extent to which the organization has enhanced its operations performance, provides the chance to exploit the value that this capability has in terms of both the internal and external operating environment. Hayes and Wheelwright (1988), considered this as the competitive edge perspective, defining it as an organization moving through enhancement stages from correcting worst problems; to adopting best practice; to linking strategy with operations; ending up being such a high performer that it acts to support external providers of similar or related market offerings.

Subsequently, their more recent research at Harvard, with additional academics, (Hayes, et al., 2004), appears to address the paradigm shift into the 4th Industrial Revolution, Industry 4.0; wherein the outcome defines that there are business to business, functional hubs, focussed across a common process or requirement. (Chen & Miller, 2015) see that there is a shift away from competitive behaviour, towards collaboration and determine that rivalry between organisations is about economic and market competition; and that the Awareness-Motivation-Capability (AMC) model, (when seen through the lens of relational competition), offers a number of performance consequences in comparison to the original competitive dynamics model; wherein engagement between firms is core to competition. Pertinently, they state that more attention is now paid to all stakeholders, as the need to garner support in any given situation becomes more of an imperative; and that the changing nature of competition drives awareness of the social and business need for closer relationships.

Technological advances have always impacted manufacturing. Initially it was steam which enabled mechanisation. This was then followed by the intensive use of electrical energy enabling mass production, and more recently by widespread digitalisation which allowed for the automation of production processes. (Lasi et al., 2014) define the term Industry 4.0 as having two development directions; one, as the application pull (related to the change in the operating framework) and the other, as the technology push, wherein industrial practice and use of mechanisation and automation will further increase. They describe how these are characterised by cyber-physical production systems and networks. The enabler of such a transformation will be the integrated use and coordination of multiple advanced information technologies (e.g. Internet of Things, cloud computing, data analytics, smart objects, etc.) which promises to change the landscape of manufacturing. For example, it is now possible to equip production plants (its machines, components, etc.) with sensory abilities and connection to an Internet-enabled platform enabling an increased level of monitoring and control. A further consequence, is the accumulation of enormous amounts of data (Big Data), which can, if organised and processed effectively and efficiently, provide benefits for the enterprise, its business partners (e.g., supply chain or business ecosystem) and its customers (e.g., mass-customisation). Moreover, Berman (2012), in the context of digital transformation defines the essential business capabilities, which require a consideration of transforming the operating model and to be able to design new business models. In terms of the supply chain perspective, Berman talks of going beyond traditional partnerships with developers and suppliers and to consider that in the new business model, organisations should explore how to collaborate with their competitors.

The increased level of data sharing and cyber-physical integration among network partners can lead to a shift in the way organisations compete/collaborate (Chen and Miller, 2015) and in the way that value is created and captured in a business ecosystem (Urmetzer, et al., 2016). Industry is traditionally recognised for the manufacturing of physical goods. However, in order to more adequately satisfy customer expectations and compete effectively on the market, industrial firms have increasingly offered services that either complement or integrate the manufactured product. Therefore, relationships between network partners are increasingly becoming service-based relationships and the networks in which they operate are enabling competitive performance as a result of cooperation and collaboration (Prajogo, et al., 2016). It can be expected that the increased flexibility, adaptation and

customisation that Industry 4.0 brings to the operating models and production will further reinforce this phenomenon, which is known as Servitization (Baines & Lightfoot, 2013; Bigdeli, et al., 2017).

In considering businesses being organised into networks and the difficulty in handling and interpreting value creation and capture Letaifa (2014) provides an outline of the theoretical developments of business ecosystems which refers to the work of Moore (1993) who in his seminal article "Predators and Prey: The New Ecology of Competition", puts forward the concept of business ecosystem for the first time. Letaifa (2014) talks of a system that includes resources of all sorts, drawing in capital, partners, suppliers, and customers to create cooperative networks determining the transition from supply chains to ecosystems. It provides a good scope of applied cases including radio stations and universities and it shows how the ecosystem unfolds over time and in concluding it mentions that the ecosystem requires a balance between value-co-creation and value-capture objectives to be able to innovate and survive. Urmetzer et al., (2016) then develop this further to focus on building a framework to help solve the problem of a lack of ability to understand the complete value exchange between partners in business ecosystems (focusing on the direct and indirect value capture and creation between key stakeholders). And in drawing on literature at the intersection of servitization, digital business models and supply chain, Vendrell-Herrero et al. (2017) empirically explore how digital disruption has affected business-to-business (B2B) interdependencies. They mention how dematerialisation of physical products is transforming the way firms are positioned in the supply chain. Specifically, they propose that these new market conditions can empower downstream firms, but that upstream firms can still capture additional value through digital services if their servitized offer includes difficult to imitate elements.

With the transformation to digital operations in a servitization era we should explore how organizations are integrating and collaborating their operations within the supply network. It is also pertinent to seek to understand how the holistic perspective of the service-dominant ecosystem (Luftenegger, Comuzzi, & Grefen, 2013) enables collaboration and value, and what this 'servitized' business model looks like in a range of product-service system contexts. There is evidence though that there is dissonance towards servitization and that there is currently a need for a clear understanding of the organizational intention in adopting it (Crowley, Burton, & Zolkiewski, 2018); in which case a first step is to assist organizations in the understanding of where it might be present and unrecognized as such; and that in doing so they are able to determine the value that it brings to the organization.

3. OBJECTIVES AND METHODOLOGIES

Set in the Industry 4.0 era, and framed by the contribution of operations capability aligned to strategy (Hayes & Wheelwright, 1988; Hayes, et al., 2004) the research includes understanding how adopting 'collaborative' supply network strategies acts to support the effective and efficient delivery of London Underground services. It seeks to explore how the strategy and technology and networks business units might capture and exploit the value and capability that the wider supply network members offer. We aim to do this by exploring how the organisation articulates and frames strategic intention and digital operational capability and how it adopts a 'collaborative' supply network as part of digital transformation. The intention is to understand the current collaborative perspectives and intentions of the business unit to business unit supply network relationships and dynamics. This offers an opportunity to understand and conceptualize the characteristics and design of the network and be able to frame a model of collaborative practice as associated to the BSI 11,000 model and in later research the ISO 44,000 framework. Adapting and applying the BSI 11,000 model (BSI, 2010b), which defines the stages and indicators of collaboration between businesses working together, we identify the occurrence and strength of these characteristics for a small number of the elements of the product/service offering. In order to consider the future of research in this field, we wanted to first establish a conceptual understanding of an Industry 4.0 collaborative supply network and servitization, through undertaking a initial and then deeper study of a case in which this is taking place.

Strategic intentions of organisations, and the characteristics of competitive and relational business approaches, as applied when [co]operating and collaborating within a supply network system and more

recently within interdependent, supply chain ecosystems, originated from the perspective of business ecosystems (Moore, 1993). In which case, the intention of this research is to be able to further define and understand collaborative business and ecosystem perspectives as evident within supply network relationships. The context for the research is determined by the factors and characteristics of Industry 4.0 era as related to service supply systems and networks in a mature public transport service and to the transition towards digital transformation. It seeks to provide conceptual considerations of collaborative, interdependent supply chain network ecosystems that can be understood and thereby become practical realities for other transport systems applying digital transformation. In addition, through the exploration of the strategic intention of the organization and operational implementation of it seeks to identify the occurrence of servitization practice, whether recognized and identified or not.

Designing the research questions took some time as it needed to carefully consider the perspective of the BSI 11,000 Standards that outline the strategic framework, indicating the characteristics of collaborative relationship management (BSI, 2010b); and the eight stage approach that it prescribes for how to achieve this. Firstly, adaptations were made to the naming of the stages of the prescribed lifecycle of collaborative relationship management, to provide an academic articulation of the terms. So, for example the stage 1, awareness perspective, was renamed 'strategic awareness' and stage 2, knowledge, was renamed 'strategic direction'. This did not change the overall way in which the case could be explored through questioning though, as it just acted to set it within what the researchers judged to be a more categoric and substantive academic position. Pertinently, this then linked the industrial perspective with the theoretical framing within the field of operations strategy and operational capability as specifically related to Industry 4.0 and servitization. Refinement established a scope of research that seeks to explore: 1) Strategic Direction; 2) Own Digital Operational Capability; 3) Use and Impact of 4.0 Technology; 4) Partner Selection; 5) Working Together; 6) Value Contribution; 7) Collaborative Capability Management; and 8) Relinquish Collaboration. Question sets had then been designed around the eight stages to gather the data with regard to what we wanted to find out about the extent of collaboration within the supply network of Transport for London, in line with these BSI standards and from the perspective of Industry 4.0 and Service 4.0.

4. CONTEXT AND CONCEPTUAL REFINEMENT

Transport for London is the umbrella organisation, within which there are a number of business units (TfL, 2018) which are 1) Customers, Communication & Technology; 2) General Counsel; 3) Finance; 4) London Underground Ltd; 5) Commercial Development; 6) Crossrail 2; 7) Human Resources; 8) Transformation; 9) Major Projects; 10) City Planning; 11) Surface Transport; 12) Walking and Cycling; and 13) Delivery Unit (note that it is not clear what the scope for 12 and 13 are as there are no listings for sub-ordinate roles beneath the director level). During this initial stage interview, with The Senior Strategy Manager, (for London Underground for Technology and Networks), and The Senior Business Architect, (Surface Operations); the efforts were targeted towards generating a deeper understanding of the conceptual perspective of collaborative supply relationships and how these appear to manifest themselves within internal and external supply networks. We expected there to be a more complex consideration compared to the more tangible elements of manufacturing due to the dynamic, non-linear, and intangible elements and nature of service provision; which there was. The design of the interview was driven by a precise set of questions which was intended to capture categoric detail from the two participants.

At this early stage of conceptualisation and initial exploration, we were surprised to find that the carefully designed set of questions (based on the refined articulation) were not able to be fully deployed; or as categorically as they had been intended. What actually transpired from the initial research engagement, is exactly what Peters et al., (2013) conclude, in that the business network is largely a reflection of what we know and understand about them [already]. They explore how academics undertake research into business networks and in their considerations they talk about how researchers, of business network practice, should not undertake a deliberation about how to do the research. Deliberating about whether to undertake qualitative research with a social constructivist lens

(seeking to unpick and rebuild what has been socially constructed by its actors following it having been substantiated by academics); or to do so with a critical realist one, (seeking to come to terms with the nature of reality which is graspable by research and can therefore be easily theoretically framed to build new concepts), is not allowing for determination of the 'real-life' practice.

The attempt to conceptualise in such a way, demonstrates that these assumptions will restrict the opportunities that the research process and data collection provide to be able to interpret the phenomenon of collaborative supply networks and the actual implementation of it in specific cases (Walsham, 2006). Actually, drawing from what Walsham (2006) and Peters et al., (2013) advocate, it is a better to approach the research by working closely with the business network participants to understand their perspective and the business supply network dynamic, as played out in practice. In which case, the data collection should include letting the participants be very open with the responses to the broader topical areas; and as the interpretative researcher, to be able to see what themes are evident with the data and what questions it appears to address. In this case this has come along with the promise of access to other business network members from which the data and therefore knowledge will grow and the applied understanding will develop. Fortunately, the current participants have offered to continue with the research in its later stages and will be able to accommodate introductions to additional business unit executive and senior level management; which will be further supplemented by the access to day-to-day operational staff to extend the research further, enabling a view at all levels of strategy (Barnes, 2018).

During the qualitative research process it is necessary to conduct precise, consistent and exhaustive activities that result in credible academic outcomes; which includes rigorous and relevant thematic analysis (Nowell, et al., 2017). At this stage, the researchers have undertaken a broad scope review of the themes within the interview transcript data and we are able to determine the following questions and themes within them:

Q1. What is the strategic intention and digital operations capability between business units as internal elements of the supply chain?

Themes include: technology as a solution; the recurring mention of the four priorities of the umbrella organisation (affordability, customer service, safety and reliability, and people; inhouse sourcing complimenting outsourcing; consultancy as an exploitation of the external value of the operational capability; competency [in the era of Industry 4.0]; value for money; constraints of legacy technology; and collaboration as an intention.

Q2. What are the characteristics of the relationship between the business units as network members? Themes include: the occurring mention of collaboration as practice (overlapping from the strategic intention); delivery partners working together; oversight and due diligence; partnership relationships; competency capturing and sharing; outsourcing as realized from technology push of external suppliers; forums; sharing knowledge; and delivery partners working together.

These themes are interesting, in that there is little mention of digital transformation, which is perhaps demonstrating the digital is inherent in all that they do. What is significant though, is the dominance of the themes of collaboration and value [capture] and that these match with the theoretical positioning that Urmetzer, Matinez, & Neely, (2016) conceptualize; most pertinently, this was the original trigger for the authors to undertake research in this field back in 2017.

5. CONCLUSION

London Underground and Surface Operations seems to merge together as internal supply network members, which is evident within the interview process, where there appears to be a seamless connection between the two business units and their senior managers; this is specifically evident when the articulation of the strategic intention and the digital operational capability comes across as mutually understood and appreciated. This very close working relationship (demonstrating collaborative internal supply networks), came as a result of an intended strategy; which aimed to bring these two business units closer together, and which hoped to avoid differences in strategic planning; and therefore to be able to address the four priorities more broadly and constructively; particularly as the reduction in funding began to impact very heavily on the overall organisation. Here the point that came across most

obviously was the need to ensure value, and *“so we define what we want, make sure we’ve got the money, make sure of the outcomes, try and define the business case that we are trying to achieve, look to T&D [Technology & Data Business Unit, Surface Operations] and look at the technical options of how we can deliver that”* (Senior Strategy Manager on what his role is). What arose from the interview proceedings, was a much more fluid and natural data set, which appeared very much driven by the collaborative and dynamic behaviour of the two senior level business unit participants, whose natural approach and mutual appreciation of the broader internal and external supply network appeared to show a deep level of understanding of the application of collaborative relationships. This deserves further research looking at it from the perspective of organisation development and dynamics of individual actor’s behaviour (but not for this project to undertake).

There are a number of very good examples given in the data that indicate how Transport for London work with external supply network members and here we can draw upon a single applied example of servitization in a superficial manner only, as so far, there has not been the chance to explore the applied realities of these specific aspects of the data. So for this example, we wanted to be able to explore and consider what the participants from the business units understood about the concept of servitization in public transport and how servitization of products is operationalized in London Underground. Understandably, they would not necessarily be fully aware of the concept of servitization of products. So, as we planned to be able to naturally capture examples of servitization, without being too explicit; we drew from the points they made about escalator services and the need to ensure customer satisfaction and the operational reliability of this element of the overall transport service. Fortunately this example had evolved during the interview session; and would have done so, based on the progressive design of the interview questions, and the flow towards the consideration for the use of Industry 4.0, and Service 4.0, technology (see Ennis et al., 2018) and servitization; although the business unit participants did not recognize their service process technology as applied in this manner. The interview culminated in them having discussed how using sensory devices to track escalator usage enabled them to understand the precise point in time when maintenance of the product was required; and then, as we identified for them, that they were operationalising servitization; thus enabling lean outcomes and value capture based on Industry 4.0 concepts and digital transformation. In which case, whilst it could be determined that the research design was prescriptive in nature, the openness of the business unit participants has enabled them to learn about the theoretical framing of this concept of collaborative supplier relationships (BSI, 2010a); and simultaneously (and collaboratively), enabled the researchers to generate an early stage understanding of the operationalization of the concept. This demonstrates that the value of collaboration extends beyond the explicit and obvious; and that it is notoriously difficult to understand the dynamics of the ecosystem in which you [co]operate; and, most importantly, that there is still a lot to learn about the realities of collaboration and relationships in applied practice in the era of Industry 4.0.

Certainly, as we progress further with research, and understand more deeply the benefits of digital transformation, and the related contribution of value to the ecosystem of suppliers, within the era of Industry 4.0; we will be able to understand more about the operational perspectives of the measures of that value contribution, and capture. Ultimately, where value contribution and capture is measurable and quantifiable (Urmeter, Matinez, & Neely, 2016), there will be an appropriate level of appreciation towards that contribution that sustains the overall collaborative relationship and brings value in a range of ways, such as cost and time savings, increased productivity and knowledge capture. This could be wherein the range of network members are seen to be cooperating, interdependently within a pool, where the contributing members are characterised as bubbles, which can expand, deflate or float away. The future is one of technological revolution and uncertainty, which as researchers bring us many opportunities, one of which is to be able to explore how this pool avoids too many of the members feeling deflated, exploited and undervalued; and one where there is a fair appreciation of the value which the members contribute to the overall pool and the ecosystem of collaborative suppliers.

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