Challenges in a Connected World: Issues in Digitalisation

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Digitalisation and the connected economy has brought about a sea change in both the measurement of economic activities as well as the ease of living for the general population. The ubiquitous availability of the internet and the omnipresence of mobile networks has meant that while on the one hand all our day-to-day activities from ordering essentials to the allocation of investments can happen online, it presents challenges to the conventional approach of keeping track of transactions. The emergence of newer paradigms like blockchain technology may offer robust options for ensuring the genuineness of transactions, but they also serve to illustrate how progressively evolving systems give rise to overheads of continually learning and relearning the rules of the game unlike the more traditional frameworks. Additional compounding factors include the expansion of the global supply chain, the proliferation of digital payment systems and a discerning end user who is no longer satisfied with what is available within national boundaries. Earlier limitations meant that interactions took place within particular legal and financial contexts, which resulted in simplified considerations; that comfort factor is no longer available as both firms and consumers choose to look beyond national boundaries in an effort towards deriving maximum value.

The present paper examines the changing kaleidoscope of online transactions and how they impact the efforts towards monitoring processes in a bid to ensure the economic safety of the participants while also offering a helping hand in terms of convenience. In this regard we utilise the viewpoint from a developing country like India. The nation has already been earmarked as one that is primed for substantial spurt of growth in the coming decades. This, coupled with the presumed demographic benefit of a predominantly young population and pro-active steps by the government that promote greater investment and expansion of manufacturing activities within the country, provide a test case that can be used for studying the impact of the shifting scenario.

Keywords: Digitalisation, Ecommerce, Information Technology, Digital Payments, Blockchain Technology, Demographic Dividend, Global Supply Chain.

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1. Introduction

Some of the buzzwords that have emerged in recent times include Internet of Things (IoT), cyber-physical systems and smart factories. They symbolise the paradigm shift that digitalisation has been bringing about in the field of industry and business (Geisberger and Broy, 2015). Work has been proceeding at an exponential rate on investigating the possibilities for ubiquitiously distributed smart and connected digital devices with regard to manufacturing, logistics, sales and allied activities (Heppelmann and Porter, 2014). During the last few years, these initiatives have produced an impressive output, which includes many different kinds of artefacts, such as prototypes and demonstrators, system architectures and models for value creation which have the potential to revolutionise many industrial sectors (Acatech, 2011; Bauernhansl, ten Hompel and Vogel-Heuser, 2014). All this has given us insight into the enormous possibilities of digitalisation. But how will these possibilities actually materialise in new businesses and industries? How will existing companies make use of the amazing technology which has been laid at their doorstep? And how will new entrants on the market position themselves with their offerings?

In contrast to previous waves of new technology, digitalisation currently seems to proceed from the bottom upwards instead of downwards from the top. Mobile, interactive technology has become ubiquitously available, in business contexts as well as private contexts. Enormous sets of data are generated and made available for usage. The strategies which put these devices and data in relation with systematic economic activity, however, remain widely unclear (Monostori 2014). While the technical instruments are well understood, their connections to the design of business operations and the definition of economic targets for a company are not. Considering this, it is not surprising that even decision makers in companies who are quite familiar with the potential of the latest generations of digital devices are known to be reluctant to take the necessary steps for realisation (Wang, Törngren and Onori 2015).

From a theoretical point of view, the potential of digitalisation can be related to the formation of new value streams across institutional and operational boundaries. Digitalisation makes it possible to associate previously unrelated domains and perspectives of business activities with each other by the means of information technology. This is addressed by the notion of cyber-physical systems, which provide direct access to material reality through sensors and actuators which comprehensively capture the status of physical objects in a given operational context (Lee 2008).

Cyber-physical systems, one could say, map different subsystems of economic activity on a common digital canvas which allows a radical redesign of business processes in many different ways. This enables companies to realise forms of value creation which were unthinkable before. In particular, it allows a better integration of different contributors to value creation. Using the term service as a reference to value co-creation, the resulting structures can be described as service systems (Maglio et al. 2006). Service systems engineering is currently becoming a new field of research in which the challenges and opportunities of these activities are addressed.

Business strategies for digitalisation accordingly can be considered as strategies for the formation of new, systemic forms of value creation. So far, there is still very little known about the awareness for these new forms of value creation in industry. Our research interest in this paper is therefore directed at the expectations that managers currently have regarding the impact of digitalisation on the business activities in their own companies in terms of the redesign of value streams. As an empirical field for our study, we chose cyber-physical systems in maintenance processes. Maintenance is an essential part of every industrial activity. It usually involves many different machines which have to maintained, machine users, internal and external experts and many other stakeholders, and a lot of physical and informational infrastructure. Maintenance is therefore an ideal field of application for cyber-physical systems (Herterich, Uebernickel and Brenner, 2015). The interplay of so many different entities provides endless options for the redesign of value streams through digitalisation. Our aim is to find out how managers currently approach these options and to understand the differences among these approaches.

Digitalisation can be seen as one of the enablers of the Circular Economy (CE) due to its building visibility and intelligence into products and assets such as knowledge of the location, condition and availability of assets. One of the key points in CE-based business models is that instead of selling products, durable products are leased, rented or shared wherever possible (Bocken *et. al.* 2015; EMF 2013). Thus, the shift towards product service systems (PSS) is suggested as being one of the key solutions in accelerating the transformation towards the CE and digitalisation is a major enabler in this process (EMF 2016). Combination of the cyber physical systems, Big Data, data mining, data analytics, Internet of Things (IoT) and new business models could provide major opportunities towards more sustainable industrial value creation, value capture and CE (EMF 2016; Raynor and Cotteleer, 2015). Increasing use of digital technologies such as utilisation of artificial intelligence or blockchain technology brings novel ways to improve traceability and transparency throughout product lifetime (Raynor and Cotteleer, 2015). Smart, connected products allow producers to monitor, control, analyse and optimise products' performance and collect usage data (Stankovic, Gupta and Figueroa, 2017; Porter and Heppelmann 2015). Knowledge of the product location in real time enables increased product accessibility and improves the possibilities for end-of-life collection, refurbishment, remanufacturing and recycling [7]. Knowledge of the product condition enables predictive and condition-based maintenance, advanced diagnostics and prognostics of the components and products. Predictive maintenance increases product reliability and availability and enables extending the lifetime of products and further remanufacturing with the historical knowledge of the product (EMF 2016). Knowledge of the availability of the product allows, for example, shared use cases through digital platforms and market places and improved recycling (EMF 2016; Stankovic, Gupta and Figueroa, 2017).

2. Research Questions

The aim of the study is to create understanding of the main opportunities and challenges of digitalisation implementing the circular economy transformation. Thus, we pose three research questions:

1. What are the main opportunities of digitalisation in implementing CE-based business models?

2. What are the main challenges of digitalisation in implementing CE-based business models?

3. How can the challenges related to the digitalisation in implementing CE-based business models be solved?

In this paper, digitalisation refers to new digital technologies that are currently transforming the industry. The major transforming digital technology is the IoT. According to Gubbi et al. (2013) IoT can be defined as interconnection of sensing and actuating devices that provide the ability to share information across platforms through a unified framework and with the help of innovative applications can present a common operating picture. This is possible with seamless large-scale sensing, data analytics and information representation using cutting edge ubiquitous sensing and cloud computing.

3. Instances from Literature

3.1 *CE Business Models*

Adapting circular business models enables companies not only to act sustainably, but also to create competitive advantage. Business models can be defined in the following way: (1) the business model is a unit of analysis that is distinct from the product, company or network. It is centred on a focal company, but its boundaries are wider than those of the company; (2) business models emphasise a system-level approach to explain how companies run their businesses; (3) business models explain both value creation and value capture. In addition to the extensive business model literature, there is a growing new literature stream on sustainable business models and sustainable business model innovation suggesting that instead of concentrating purely on creating economic value for companies, the value created for stakeholders, including environmental and social value, need to be taken into account. In this way, business models and business model innovation contribute to the sustainable development of the company and society. Furthermore, a circular business model can be defined as 'the rationale of how an organisation creates, delivers, and captures value with and within closed material loops'. Circular business models are networked by nature and thus, require different actors of value network to work together towards common objectives. There is a need to consider the changes in value creation for a broad range of actors, as there are often game-changing changes in business models. Circular business models can be divided into three groups: slowing, closing, and narrowing the loop. Slowing the loop is based on the idea for extending the product life cycle by design and maintenance. Closing the loop concentrates on efficient recycling of materials and can be implemented, for example, by industrial symbiosis. Narrowing the loop aims at using fewer resources per product and can be significantly boosted by intelligent technologies. Since these are closely supporting to each other, often circular business models include multiple groups or even all of them.

3.2 *CE and PSS*

The PSS can be defined as is 'a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs'. The idea of PSS systems is that, in this business model, companies have an interest in creating products that have a long service life, which are used and re-used

efficiently and are also cost and material-effective. Naturally, by definition, a PSS is not a circular business model, but it encourages companies to reach the similar targets that are central in gaining circular business models. In PSS systems, digitalisation enables collection of data that can be used in product innovation as well as for increasing the customer satisfaction. In addition, novel business models can be found based on the efficient data utilisation for example by selling the data for the third parties. Yet, there is still a major gap for understanding what the novel business opportunities are for integrating PSS, digitalisation and circular economy.

3.3 *Effect of Digitalisation on the Transition towards the CE*

Digitalisation's role as an important enabler of the CE is widely accepted. Introduction of digital technologies and connected objects have the potential to reduce resource use and facilitate circular systems. However, there is still limited amount of research on how digitalisation will enable the transition towards CE. Digitalisation of industry makes it possible to use fewer resources more efficiently. Smart solutions enable reduction of energy consumption, logistics routes and capacity can be utilised more efficiently. Digitalisation enables transparent access to data concerning products' resource consumption and makes it possible to optimise product life cycles and thus promote the move towards the CE. Technologies such as RFID help to collect information about how the product has been used, which plays a central role in PSS-related business models, for example. This data can be used to estimate the quality of returned products and facilitate the return flows into product lifecycle management. Bressanelli et al. have studied how IoT, Big Data and analytics facilitate CE transition. They identify eight functionalities that are enabled by these technologies: improving product design, attracting target customers, monitoring and tracking products, providing technical support, providing maintenance, optimising the product usage, upgrading the product, enhancing renovation and end-of-life activities. Circular economy systems with interrelated cycles consist of large amounts of data. Digitalisation provides new means to access this data. Decisions need to be made regarding the products' lifecycle stages, how waste materials should be reused, what type of logistical arrangements are needed and who are the actors involved in the value network. Digitalisation provides opportunities for the virtualisation of distribution channels. Value can be delivered to the customers through digital channels, e.g. online shops and digital products. This can lead to reduced environmental impact and circular business models. In the CE, the coordination of material and information flows is crucial. Information about quantity and quality of products and their raw material contents need to be collected and retained. Digital technologies enable keeping the data together with materials in the cycle and make it possible to use waste as a resource. Integration of digital intelligence provides opportunities to distribute knowledge, structure, ownership and different levels of customisation. This allows more connected and durable relationships with the customers and end users. In addition, digital solutions enable circular business models through automated monitoring, control and optimisation of resources and material flows.

3.4. *Challenges related to Digitalisation*

Earlier literature concerning the barriers for moving towards the CE have identified several barriers hindering the gained benefits of digitalisation. These can be divided into financial barriers (measuring financial benefits, financial profitability); structural barriers (missing exchange of information, unclear responsibility distribution); operational barriers (infrastructure, supply chain management), and attitudinal barriers (perception of sustainability, risk aversion). Finally, there also exists technological barriers related to the product design and integration of digital technologies into production processes. Although, digitalisation has significantly increased the amount, accuracy and cost of information, there is still much to be done. Currently, problems related to information can be seen as one of the major barriers to the implementation of the CE. These include, e.g., underdeveloped availability of information, increased transaction and search costs, and lack of knowledge. Issues related to data integration are often ignored when studying the role of digital solutions in the CE. This, however, is a central issue, as it is not necessarily known how to use data to support the transition from less linear and more circular business models. Data integration is an essential part of business applications. It combines individual information sources with the business goals of the involved stakeholders and their application in daily business.

4. The Road Ahead

The primary challenges related to the CE and digitalisation were regarding business models, data ownership, data sharing, data integration, collaboration and competence requirements. Business model challenges were related to finding financing for the new business ideas, developing ideas into successful business models, reframing and redefining business models and changing the mindset from product-oriented business towards service models. Challenges related to data were considered important. Ensuring access to data and questions related to data ownership are crucial. Participants mentioned data sharing in several ways. Sharing data between competitors, ensuring privacy and property rights, and lacking trust were mentioned as challenges. Integration of big data owned by multiple actors and management of information flows were considered as challenges as well. One of the key challenges identified was collaboration. The groups mentioned organising collaboration between different partners, defining shared processes, finding suitable collaborators, combining different areas of expertise and diverse perspectives being communicated from companies to consumers. One of the identified challenges was related to combining ICT and sustainability-related competences. Participants considered that there is a lack of understanding of the importance of digitalisation and lack of knowledge of basic CE concepts.

Co-creation, networking, increasing transparency and providing information were the most often mentioned solutions. Co-creation by sharing expertise between

organisations and combining competences from different types of actors was considered promising. The actors should be from different sectors and consist of small and large organisations. In education, collaboration between schools and business could be increased. Various types of competitions and hackathons could be used for co-creation. Networking with international partners (e.g., companies, NGOs) would bring opportunities to create solutions to the identified challenges. In addition, networking with domestic partners could be increased. Research projects that bring together companies would also increase opportunities for networking.

5. Conclusions

Some novel or at least not so well-known opportunities of digitalisation related to the CE transformation have been found. This included new opportunities based on virtualisation. In adopting a circular business model based on slowing, closing and/or narrowing the loop, virtualisation can be a major enabler helping to reduce costs, saving resources and providing an accurate and trustable data. Virtualisation can also be a great help in designing a modular, repairable co-creation with stakeholders and customers was mentioned as an opportunity enabled by digitalisation. In networking and cocreation, digital collaboration platforms with virtual technologies have a significant role. Furthermore, we know that consumers play a central role in the transition towards the CE as adopters of new products and services. This requires renewing the marketing from one-way to two-way communication. Challenges related to data sharing need to be resolved to enable efficient collaboration. In data sharing, gaining trust and security are grand challenges that can be tackled with innovative technological solutions, such as utilising blockchain technology. Thus, further studies on the real company cases including both qualitative and quantitative data are needed.

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