




It joins all – Synchronicity: How technology is reshaping our understanding of collaboration



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Background: Management literature pays insufficient attention to the strategic potential of collaboration. While normally encountered in supply chain management literature as discourse on supply chain effectiveness, this study shows that in a Fourth Industrial Revolution (4IR) world, the role of collaboration needs to be re-examined.

Objectives: To understand how technology has enabled collaboration between companies to the extent that a collaboration should be viewed as an external business environmental factor.

Method: A qualitative, grounded theory approach was followed. Semi-structured interviews were conducted with 14 senior managers of a global technology-driven company manufacturing electrical heat tracing systems. Data were analysed using a three-stage coding process to develop an essential narrative.

Results: Technology has presented new possibilities for collaboration across supply chains and industries. This results in co-creation of product offerings between companies opening new markets. Collaboration is no longer only an internal tool that can facilitate efficiency and effectiveness between collaborating partners but spills over as an influence on strategy from the external environment.

Conclusion: If a collaborative climate is not nurtured and supported by all parties involved, a business will not be able to reach its full potential especially in a 4IR world. Advances in technology have enabled new possibilities for companies to collaborate, both internally and with each other.

Contribution: Literature rarely extends the value of collaboration beyond the realm of the supply chain. This paper suggests that by viewing it as a macro-environmental factor, collaboration can be viewed as a strategic opportunity.

Keywords: collaboration; technology; co-creation; PESTEL; macro-environment.

Introduction

Collaboration, whether between or within companies, has historically been tacitly accepted as a synchronicity¹ of meaningful coincidences almost been taken for companies to survive and thrive. With the proliferation of technology in the rise of Fourth Industrial Revolution (4IR), collaboration (especially e-collaboration) can now be deliberately focussed for improving supply chain performance (Hove-Sibanda & Pooe 2018; Kang & Moon 2016).

Technology is altering the way companies, customers and society interact and how they use and transfer knowledge (Bala, Massey & Montoya 2017; Nambisan 2003). By utilising technology, customers and the knowledge they possess are incorporated into the design process of product offerings, thereby enabling collaboration. By using real-time information from across the supply chain, and employing smart devices through the IoT, companies are realising that collaborative possibilities emerge through co-creation and fusion of technologies. In this research, the process of collaboration and co-creation is explored at Company X, a technology-driven company specialising in bespoke, intelligent and inimitable electrical heat tracing (EHT) systems. These EHT systems are industrial temperature control systems used in transportation, storage and production processes across a variety of industries. Company X continually develops EHT technology as distinctive solutions that its customers eagerly embrace. The study highlights how Company X has implemented information technologies facilitated by deliberate collaboration and knowledge sharing between employees, customers, suppliers and intermediaries across the supply chain. Technological connectivity is a prerequisite for collaboration (Pooe & Munyanyi

1. Lyric excerpt from 'Synchronicity II' (1983) by The Police.

2019), strengthening company expertise through combining knowledge, reducing the impact of resource constraints, nurturing creativity and encouraging the search for new business ideas. Collaboration is evolving as an environmental force that is shaping the nature and playing field of future business.

Rationale for the study

It is apparent that the possibilities brought about by new technologies have necessitated a rethink of the concept of collaboration. Instead of something that can offer a company a distinctive competency, collaboration seems to be increasingly elevated to the realm of an external environmental force, something that can, if approached strategically, provide immense opportunity, not only to individual companies but also to industries or markets. Given this 'reframing' of the concept of collaboration, it is necessary to explore what exactly collaboration refers to in a business environment dominated by technology and the 4IR. This study poses the following research question: *How has technology enabled collaborative arrangements across the supply chain that creates value for all involved?*

Following from this research question, the following research objective is posed: To understand how technology has enabled the potential to collaborate across the supply chain to such an extent that collaboration can be viewed as a key variable in the macro business environment.

Literature review

The rapid development in digital technology and expansion in the usage of Information and Communication Technology (ICTs) has affected companies' collaboration activities in many industries (Lozano, Barreiro-Gen & Zafar 2021). The increase in digitisation and the IoT has seen the growth of e-business, which has led to changes in how companies operate in various markets (Yang et al. 2017). Supplier collaboration has been specifically affected (Yang et al. 2017). Amazon, Dell and Lenovo are examples of e-businesses that have experienced both economic and non-economic benefits through borderless collaborative arrangements (Zhu, Zhao & Bush 2020). E-business has enabled information sharing throughout the supply chain, making wider integration possible among various suppliers. Collaboration is seen to share knowledge and improve efficiencies and decrease costs, which is an essential facilitator of performance (Bals, Laine & Mugurusi 2018).

Business collaboration

Collaboration in business occurs when two or more entities (one of which being a commercial enterprise) cooperatively work together and share resources to achieve something that would not be possible if they worked independently (Huang, Han & Macbeth 2020). This can lead to competitive advantage because of this collective access to, and usage of, resources and knowledge (Prior 2012), as well as collaborative advantage, where the value of collaboration

outweighs working single handedly (Huxham & Vangen 2013). While much literature exists around company-university collaboration (Belderbos et al. 2018), inter-organisational learning (Lin et al. 2017), public sector collaboration (Torfing 2019) and supply-chain collaboration (Huang et al. 2020), there seems to be a paucity of literature concerning the impact of collaboration on the greater business environment.

The need for companies to remain competitive in a changing business environment has focussed managerial attention on supply chain collaboration (Cui et al. 2020). Managers are developing their competitive strategies and competitive advantage based on optimising the supply chain, and subsequently, a shift seems to have occurred in where competitive advantage is sought. No longer is competitive advantage viewed as company-based but rather supply chain-based (Suryanto, Haseeb & Hartani 2018). Changes in the nature of the business environment itself have resulted in companies considering new ways to manage supply chains effectively and efficiently while still generating value and maintaining a competitive position (De Sousa Jabbour et al. 2017; Olatunji et al. 2019). Collaboration within supply chains is important in the competitive business environment (Baah, Acquah & Ofori 2021) as it ensures competitiveness within supply chains (Baah & Jin 2019; Routroy et al. 2018). Supply chain collaboration implies two or more autonomous companies working together on supply chain operations which offers substantial benefits and potential for competitive advantage to the partners (Panahifar et al. 2018).

These collaborative arrangements spread risk, increase access to scarce resources and boost the financial performance of partnering companies. For this type of collaboration to be successful, knowledge and information that is trustworthy, useful and relevant need to be shared between supply chain partners (Panahifar et al. 2018). Literature suggests that supply chain networks that are enhanced with information tend to outperform those where information is not enhanced in the network (Baah et al. 2021; Zhang & Cao 2018). Collaboration through these types of networks allows for flexibility, enhancing the company's ability to adapt as the market changes. Furthermore, collaboration across the supply chain gives supply chain intermediaries insights into customer requirements, potentially improving delivery to the customer (Baah et al. 2021).

Collaboration and co-creation

Co-creation implies the establishment of key business processes based on knowledge gained through collaboration between companies with customers and stakeholders such as suppliers and business partners. (Wang, Oshri & Zhao 2021). This co-creation eventually culminates in the development of new products and services (Schleimer & Faems 2016). Successful co-creation seems to be achieved through value-creating activities associated with sharing resources, transferring knowledge and building relationships and translates to co-production of product offerings and defining value in use for customers (Ranjan & Read 2016). Co-creation

can therefore be seen as the pinnacle of collaborative arrangements, as the entire supply chain, as well as other stakeholders (such as the customers) work together in unison to create new products and services to the benefit of the market.

The perspectives of different stakeholders, especially those of customers, in the collaborative co-creation process are of critical importance, as these perspectives bolster the innovativeness of the collaboration (Wang et al. 2021). The contribution of the customer in co-creative arrangements is an effective way to ascertain whether newly developed products and services are likely to succeed in the market (Alam 2018). B2B is vital for product idea generation, as they provide information on customer requirements and new product possibilities and capabilities (Wang et al. 2021). Customers do not only add value in generating ideas for new products and in co-creating them but also, in testing prototypes, and providing end-user support. Furthermore, stakeholders such as business partners play an important role in the development of products, services and business processes. Projects no longer start from within a single company; instead, they evolve from the joint action of a network of companies such as manufacturers, partners, customers and independent design houses.

Collaborative business models

The rapid increase in digitisation has impacted business models, creating new models to meet new needs and demands (Golzarjannat et al. 2021). More traditional descriptions of business models centre around value creation from the company perspective and value gain from the market perspective while contemporary definitions place greater importance on the business ecosystem and stakeholder interaction (Massa, Tucci & Afuah 2017). Companies seem to be currently partial to the burgeoning notion of platformisation (Ahokangas et al. 2019), which implies that companies are seemingly interacting around technology-related platforms which provide opportunities for various stakeholders, including customers and suppliers, to collaborate. Technology facilitates the exchange of data, services and knowledge. In so doing, opportunities, as well as value, are provided to stakeholders that can be acted upon through the application of appropriate business models (Teece 2018). These platform-based business models are also necessitating companies to explore new ways of designing business processes (Gomes et al. 2019), as they create value through social and economic interaction, and providing infrastructure for stakeholders' communication as well as activities inside of the business ecosystem (Golzarjannat et al. 2021).

Demand-driven collaboration

Recent events, such as the coronavirus disease 2019 (COVID-19) pandemic and other 'black swans' have triggered an escalation in collaborative projects across industries (Kazantsev et al. 2022). For instance, collaboration between Airbus, McLaren, Ford and Siemens with medical companies,

Penlon and Smiths enabled the UK to dramatically increase manufacturing of emergency medical equipment over a 12-week period at the height of the COVID-19 pandemic (Microsoft 2020). Demand-driven collaboration typically occurs when a business opportunity emerges that is characterised by a short time frame, a lot of regulatory or legal 'red tape' and few companies in the market that can take advantage of the opportunity presented (Schirrmann & Drat 2018). Through the establishment of demand-driven collaborative arrangements, partners can access other industries they are active in and apply their excess capacities for specific business objectives at specific points in time (Kazantsev et al. 2022). Entire supply chains and companies alike can use digital platforms to share pooled resources and pursue demand-driven collaborative opportunities (Faustino, Gohr & Santos 2019). Digital platforms facilitate demand-driven collaborative arrangements, driving innovation and ultimately the development of product offerings (Payne & Frow 2016).

Research methods and design

Ethical clearance (code 2019BM84) for the study was granted by the University of Johannesburg, and all interviewees were assured that the gathered data would be treated with the necessary sensitivity. The company upon which the study was based wishes to remain anonymous referred to as 'Company X'. In line with the interpretivist paradigm ascribed to in this study, qualitative research methods were employed (Creswell 2014). A qualitative case study design was used, as case studies allow for an exhaustive examination of everyday phenomena in their natural locations (Yin 2014). Here, the impact of technology on collaborative arrangements across the entire supply chain is observed from the perspective of a technology-driven company such as Company X.

Semi-structured interviews were conducted with 14 Company X managers on executive management level from seven countries Company X operates in Canada, China, Germany, Italy, Singapore, South Africa and Spain. Interviewees were briefed on the purpose and the interview guide was made available to them for reference purposes. Interviews were audio-recorded, with notes taken to complement the voice recordings. Interviews lasted 2 to 3 h. Interviews were analysed using Strauss and Corbin's (1990) three-stage grounded theory coding process. This is also called the constant comparative method (Williams & Moser 2019). Categories thus emerge from the data, rather than a preconceived idea being imposed upon the data of what these categories should be (Glaser & Strauss 2014; Neuman 2014).

Strauss and Corbin's coding is dependent on three stages:

- **Open Coding:** Involves breaking data down to units of meaning and assigning labels (which eventually become categories) to these units of meaning as they occur in the data (Given 2016; Strauss & Corbin 1990). The point of departure is deciding on the unit of coding, which could

be words, sentences, paragraphs or entire texts (Strauss & Corbin 1990). These labels are fluid, as new labels are constantly added and changed. In this study, open coding resulted in 608 labels being identified.

- **Axial Coding:** Data are innovatively reconnected by making connections between categories. Data are also scrutinised inside each of the categories for the dimensions and properties it possesses (Scott & Medaugh 2017; Strauss & Corbin 1990). Not only is the nature of each category scrutinised but also how categories link up with others (Scott & Medaugh 2017). During axial coding, it was evident that 'association' was closely linked to 'collaboration', as the two terms were often used interchangeably by interviewees. This construct became so prominent in the study that the authors considered it prudent to focus on this construct as a separate area of investigation. To this end, all open code labels derived from data containing the words 'association' and 'collaboration' were earmarked for the purposes of this paper. In this study, the process of axial coding led to 17 categories, all of which related to collaboration.
- **Selective Coding:** Implies the selection of ubiquitous core categories that mark the origin of theory as an 'essential narrative' developed from the findings (Saldaña 2013; Strauss & Corbin 1990). The essential narrative for this study was based on three core themes.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg, Department of Business Management Research Ethics Committee (no. 2019BM84).

Results

Three core themes materialised during analysis of the open code labels derived from data containing the words 'association' and 'collaboration'. These themes form the basis of the ensuing discussion: (1) macro forces necessitating collaboration, (2) the process nature of collaboration and (3) business impacts on collaboration. Limited evidence from interviews is presented in the interest of conciseness, but more evidence is available upon request from the authors.

Theme 1 – Macro forces necessitating collaboration

For interviewees, technology has accelerated globalisation, resulting in companies of any size now competing in the global market (Table 1). They opined that companies and economies are being integrated globally through use of mobile phones, social media and the IoT. All interviewees mentioned that employees of Company X continually seek global experience applying this knowledge to solve problems, co-create and innovate to remain competitive. The benefits of globalisation are seen as forming networks where value is created using digital tools and knowledge from around the world. Globalisation removes barriers to the movement of goods, services, capital and technologies, which creates opportunities for innovation, research and development and global collaboration (Ocloo et al. 2014).

Business and consumers are experiencing radical change with technology, and the impact thereof is generally considered positive (Mykhailychenko 2019). Interviewees see 4IR as innovative technologies associated with using big data, the Internet of Things (IoT) and Artificial Intelligence (AI) offering the potential to expand their competitiveness. Product and service innovations not only improve the competencies of companies but also influence how companies and customers relate to one another. Interviewees felt that the impact of 4IR is ubiquitous as technological development is evolutionary and will continue developing. Interviewees were cognisant that 4IR would imply new ways of conducting business, as new technology will improve business processes bringing changes in production, sales, marketing, business systems and delivery of goods and services.

Interviewees opined that the world is entering a new 'Information Society', where information and data are forms of capital that create value and economic sustainability. They see this as indicative of a new consciousness and thinking, where information is no longer an aid to existence, but central to existence, and where people and technology are connected (Bakker et al. 2019). Interviewees also feel that society has lost the creative ability to create demand and is reliant upon technology to innovate and develop new products and services. Technology will thus drive demand, which in turn will challenge technology and creativity.

TABLE 1: Excerpts from interviews relevant to theme 1.

Participant number	Participant excerpts
Participant 6	'... globalisation, increasing co-operation between different sectors of the economy, making it important to have technology, and knowledge transfer. Co-creation is a result of globalisation, where companies in different parts of the world collaborate.'
Participant 1	'The 4IR is going to be the fusion of various technologies, developing new technologies continuously [that] society has no concept of. Adapting with technology will be a life model and a business model. Technology performing analysis and inspection by using sensors will improve life and benefit huge numbers of people. Although we fear new technology when dealing with personal matters, there will be developments that will improve life: computers can assist doctors, attorneys and radiography for example. Companies are implementing 4IR systems, no people – the processes are performed with robots that are self-optimising and learning better processes. Everything will be associated to the internet and have immediate updates on information and data.'
Participant 7	'The 4IR is an evolutionary process, when technologies like AI and IoT and automation are integrated impacting technologies that will continue to be developed as a result. This is possibly the way to save the planet, developing new ways of storage and production of energy, developing and using different materials, improving recycling. The use of autonomous electric vehicles will in itself drive development and impact sustainability.'
Participant 2	'Technology will continue to evolve, and it will change lives and business causing redundancy in certain sectors but, at the same time, establish opportunities for business and society. Generations X, Y or Z need to be studied. Certain people will need to upgrade their skills, which will become a challenge for governments in the world.' '... but technology is giving customers more choices, where customers have the internet which includes transparency and sharing of information and the customer becomes a source of information.'
Participant 10	'... interactive software systems that will build a product or system from the input of the customer.'

The opinion of interviewees is also that business intelligence and analytics are drivers in developing new business models, as business innovations would be tested by customers before launching, reducing the risk of failure. Requirements of customers have changed to expectations, where customers enjoy constant support. Customer expectations, therefore, have influenced company processes at various levels, as customers are part of innovating products and services. Customers influence every aspect and process of the business; with online business and constant evaluation by customers, companies improve their processes continuously using customers to improve products and services and business value (Suo et al. 2015). Digitisation is influencing the business model and creating technological opportunities, challenging companies' strategic objectives in a complex environment where innovation creates demand and customers influence innovation (Bouwman, De Reuver & Shahrokh 2017).

In the view of some interviewees, the digital age has seen business becoming the embodiment of technology, with companies such as Google and Amazon being built around technology platforms. Interviewees agree that 4IR and the technologies associated with it have changed the way companies operate, impacting the lives of consumers, influencing different generations and shaping how they view and integrate technology into everyday life. There was an understanding that modern society has developed a culture that purchases technology not because it is needed, but because it has become part of daily life. This affects how companies need to adapt when managing their human capital, as the new generation entering the workplace, Generation Z, has grown up with digital technology, and it shapes their identity (Gaidhani, Arora & Sharma 2019). Employees have different approaches to work and different worldviews from previous generations, and it is essential that companies develop cross-generational workplace cultures to tap into the strengths of each generation in a multigenerational workplace (Knoll 2014).

Theme 2 – The process nature of collaboration

Development across the business was an important condition for the growth of international operations for interviewees, through the improvement of processes, systems and the creation of new products and services (Table 2). There is an expectation among interviewees that technology drives collaboration with both internal and external customers creating new systems within business models for future competitive advantage. Development is revolutionising

what companies are capable of, how they interact in the market, interact with customers and are managed internally. Companies are now dependent on technology-linked systems and processes to create collaborative opportunities.

Interviewees observed fundamental changes in business processes because of technological advances, with smart devices, robotics and AI transforming these processes. To enhance core processes such as customer experience and business opportunity creation, companies have to transform their systems using digital technologies (Demirkan, Spohrer & Welser 2016). The interviews revealed that business process changes occur out of necessity to remain relevant. Furthermore, interviewees were vocal in their opinions that business processes not only change but are becoming highly collaborative in structure. They elaborated that the essence of creating new product offerings was innovation through knowledge of customer requirements from collaboration with customers, suppliers and even competitors. Collaborative arrangements must embody knowledge sharing and innovation using concepts and processes external and internal to companies to create value. Companies now form part of a complex business ecosystem that becomes more global as technology develops so assisting with collaborative processes. This process is a joint creation of value creating competitive advantage over those who do not wish to become part of this ecosystem (Autry, 2013).

It is apparent from the interviews that technological innovation has led to new product offerings, which have created demand. Investment in digital technologies and development is seen as a driver of business performance improving the operations of companies while integrating companies deeply with their market. In so doing, costs are reduced, response times are improved, collaboration across the supply chain is encouraged and the boundaries of companies are expanded to improve the customer experience (Slusarczyk 2018). This digital integration leads to the emergence of sustainable business ecosystems (Curry 2016), which improve business intelligence and value creation opportunities for companies (Knabke & Olbrich 2017).

Interviewees acknowledge that these advances in technology are all associated with business strategic change of some sort seeing change as now constant in business. They note, however, that change can impede collaboration as changes to systems or processes sometimes negatively impact

TABLE 2: Excerpts from interviews relevant to theme 2.

Participant number	Participant excerpts
Participant 3	'Technology will require the development of associations. It can be used to revolutionise the organisation, and, if not, it could be the demise. The speed of change will become faster.'
Participant 12	'Innovation and development will create demand, and with this mentality the company will continue to develop and survive in the fast-changing business world. The company has to develop and create new systems or products or features.'
Participant 1	'Business processes will never be the same; it is and will continue to fundamentally change. It will become association based. No pricelist and standardised pricing. It will be solving problems and bespoke designs. Online design, engineering help desk, customer designs his system with our product and our engineering. Ease of use, clients will not be looking for multiple quotes. Knowledge services and tools will change in the next few years dramatically. Using monitoring systems to assist the customer and create demand.'
Participant 8	'... collaboration and co-creation, using the internet and a device with software that allows companies to work together.'
Participant 11	'... customer cannot always create and configure what they want with your company and your products.'

associations established with suppliers and customers, especially if information is not shared with partners in the co-creation relationship. Furthermore, there was a sentiment that change must not take place for the sake of change. It is the responsibility of management to identify what needs to be changed to improve company performance, but management needs to be sensitive to employees' proclivity for change as changes that are seemingly unwarranted lead to resistance to change.

Theme 3 – Business impacts on collaboration

All interviewees see technology as fundamental to the continuation of business and to maintain competitive advantage (Table 3). They see technology as an enabler for developing products and services and mention that technology also impacts business processes, making them more association driven. It is evident that business demand is associated with technology, as technology has changed the way demand is created. Interviewees cited examples of companies that were developed as a result of technology, such as Amazon, Google and Apple, and the demand for their product offerings has followed, leading interviewees to conclude that technology acted as a driver for the product offerings put to market.

Therefore, ideas constitute an important aspect of demand, as ideas drive technology and demand, and these ideas lead to innovative applications of technology and, eventually, new product offerings. As the global economy changes in the face of global competition and technological change, companies need to be innovative and investigate new ways of staying competitive and relevant (Soto-Acosta, Popa & Martinez-Conesa 2018). Innovation affects competition (Kim & Mauborgne 2014), and as 4IR and digital technologies accelerate, innovate and fuse technologies, these changes will create new markets and business demand.

Interviewees see competitiveness as consisting of a host of seemingly diverse concepts, such as unique systems, technology, knowledge, associations and unique product offerings. They see companies' strategic direction moving away from a product and service orientation towards an information orientation, with big data being applied to create

new business models, enabling new levels of decision making. Being competitive implies that management has defined their priorities, according to the interviewees, and that they understand the greater business environment, the drivers of business and what needs to be done to ensure survival in a changing economy. Competitiveness is thus an indicator of the company's position in the market. Technology pervades Company X in an effort to innovate products, improve systems and associations and improve processes. Using technology that improves quality and output, collaboration and outsourcing is a process created by technology and access to big data, where Company X can collaborate and outsource to improve its position.

Interviewees felt that companies could achieve greater profitability and long-term sustainability by developing and implementing more sustainable systems. By using technology and being innovative, systems can be improved to ensure the development of innovative product offerings. Such sustainable systems would support companies to achieve their goals, even if technologies are causing disruptions in the market. These types of systems are also seen as key in engaging with customers and role players across the supply chain in developing new products and services and exploring new markets. Some interviewees touched on the emergence of Smart Intelligent Systems (SISs), which are systems comprised of smart devices that communicate with remote controllers to give system designers the advantage of ensuring system reliability (Stojkoska & Trivodaliev 2017). Such systems are seen as being at the core of digital solutions, aiding the creation of new systems, products, processes and solutions, which, in turn, creates demand. For some interviewees, SISs allow companies to develop innovative strategies and business models that create distinctive competencies.

Interviews revealed that innovation is crucial for establishing competitive advantage. Technological innovation is viewed as a catalyst to develop product offerings for customers, which open new markets for companies. Interviewees also noted a significant association between innovation and growth in income, and they felt that innovation impacts the entire company, from the business model, to the structure, processes, systems and product offerings that enhance

TABLE 3: Excerpts from interviews relevant to theme 3.

Participant number	Participant excerpts
Participant 3	'Systems that will co-create – no brochures, catalogues or data sheets – just a device with a screen and the customer can create and configure what they want with your company and your products.' 'Technology can and will increase the demand for a product or service. If our product with certain technologies can offer a new service like remote monitoring, this will create global demand across a wide variety of industries. The industries do not want to do the R&D themselves; they just want a product that helps them do better. Technology can improve speed to market of new innovations that provide new business opportunities for customers and the business's close association with the client, sharing and supporting this new technology opportunity, which will increase demand.'
Participant 1	'Generate demand, not create. Create is when you have the Steve Jobs approach – revolutionise technology. Ideas drive innovation, which drives demand. There will be collective development. Technology enables innovation, and innovation creates demand.' 'Technology will create a new dimension of what society is, where certain products and systems will not be needed in society or in business any longer.'
Participant 7	'Increasing efficiencies, reducing waste and improv[ing] workflows, implementing enterprise resource planning (ERP), AI that will control inventory and the replenishing of parts and components. Technology impacts certain businesses differently and change is slower, but if there is no change, the company would eventually close.'
Participant 4	'Technologies are in every aspect of business and used to optimise the business, innovate products, differentiate, improve systems, improve communications and establish associations.'
Participant 2	'Companies are streamlining their business processes. Technology enables companies to outsource, for example, cloud-based operating systems. Countries are now competing, with making sure the infrastructure is in place to enable this.'

distinctive competencies. Innovation is seen as an opportunity to introduce new product offerings, but it is also essential in the development of new systems and business models to accommodate the introduction of new product offerings (Pucihar et al. 2019).

Discussion

The analytical process vividly revealed the ubiquitous impact of technological advancement. No longer can business leaders question the necessity to keep abreast of technological advances; it is now a given that lagging in the implementation of new technologies is guaranteed to be a company's demise. The findings indicate that technology can be used in companies as a mechanism to foster collaborative potential across the supply chain, and to encourage the co-creation of product offerings, which in turn can create demand.

Technology allows companies, key role-players in industry and customers to interact and collaborate, thereby enabling companies to assess their market relevance and value proposition. In so doing, companies can constantly search for new ways to serve the market and create demand. With digital technologies, companies globally can collaborate with customers, the industry, suppliers and even competitors to create value for the company. Including customers and the industry in the process of developing demand allows companies to gain insights and knowledge from customers and the industry to ensure relevance. Collaboration also allows for co-creation of product offerings using input from the industry and customers.

Companies are therefore able to develop relevant product offerings with the input of all stakeholders. Technology allows collaboration to take place with customers being part of the process, as customer knowledge is vital to the process. Collaboration and co-creation are focused on new, innovative developments that improve current systems or create new solutions by using new technologies or fusing technologies. One can therefore argue that a strong link exists between collaboration and innovation, as the more collaborative arrangements there are that reside within companies, the more innovative those companies are likely to be at creating value. Innovation and invention are also aligned to both industry and customer. Technologies such as smart products, big data and the IoT, allow multiple users to contribute to designs, thereby driving innovation and creating demand. As collaboration strengthens and innovation increases, companies build their value proposition within the industry and the market. This value proposition is the unique collaborative offering that the company develops and offers the industry. The value proposition increases as collaboration strengthens and as innovation escalates.

Such collaboration implies that, companies are increasingly operating in a networked environment (Constantinides, Henfridsson & Parker 2018). Technology has made it possible

for companies to interact with the entire supply chain and gain knowledge on a continuous basis. It also enables companies to co-create by sharing knowledge and collaborating with specialists and customers, providing clarity and improved understanding between companies, customers and suppliers. Co-creation through collaboration allows for value creation with multiple inputs at every stage of design and production, which creates a sense of ownership among collaborative partners.

Through ICTs, the emphasis has shifted from company-designed product offerings to the co-creation of products and services through the involvement of customers and supply chain stakeholders. Certain technologies, such as smart devices, the IoT and AI, facilitate co-creation and interaction between the supply chain, customers and manufacturers. Technology-driven co-creation expands the scope of manufacturers through the ability to innovate and develop innovative product offerings. The process starts by using these technologies to establish possible areas of demand and to collaborate with co-creators to develop ideas, which are engaged with to be converted into a final product or service. Co-creation thus depends on technology, continuous engagement and collaboration.

New technologies driven by 4IR are enabling new levels of collaboration, using digital platforms that enable companies to access knowledge, skills and capabilities. The use of the IoT and big data allows companies to be innovative inside company parameters, as well as outside of them, breaking down barriers between companies and industries and allowing companies to collaborate for the development of partnerships with stakeholders across the value chain. This changes the association with customers and allows demand to be developed through collaboration, which is a rapid departure from the 'traditional' view on demand, where societal needs are identified and converted into products and services by companies to satisfy these needs. In today's business environment, technology is the catalyst for collaboration that kick-starts innovation and co-creation to develop product offerings that the market does not know it wants or needs yet.

Collaborative arrangements can be internal or external to companies. Internal collaboration refers to implementing technologies to collect and share data across organisational divisions for effective decision making, internal skills development or capacity building required to deal with the changing environment. Digital teaching and instruction platforms are used for such purposes, as are data-collecting techniques and systems that collect data throughout the company to collaborate with systems engineers, planning systems and the production function, reducing waste and improving output processes. Technology allows continuous connectivity, using real-time portals that can convey real-time data that will improve efficiencies, processes and customer service.

External collaboration implies the implementation of technologies and connective ability of companies that will allow collaboration using external skills and knowledge for development and growth (Pooe & Munyanyi 2019). In a connected world, companies can collaborate with specialists and other companies to improve efficiencies and tap into specialist knowledge and resources. This collaboration leads to a situation where the supply chain, including customers, have a vested interest in product offerings under development, which is a distinctive competency. External collaboration is therefore an extension of well-developed internal collaboration, where companies can share resources, knowledge, skills and specialised abilities across the supply chain. This adds value for all concerned, deepens understanding of the business environment, improves internal and external efficiencies, lowers risk and improves company performance.

In the final analysis, rapid advances in technology in a 4IR world are not only allowing companies to collaborate more efficiently and effectively internally but also – and more significantly – externally across the supply chain. This collaboration is enabling supply chain partnerships to emerge as companies explore ways in which opportunities posed by advances in technology are innovatively explored for potential value benefit to all parties concerned. Such partnerships, with collaborative input from customers and even competitors, give rise to opportunities for the co-creation of product offerings that can be put to market. Commercial success of such relationships ensures their sustainability, which does not go unnoticed in the industry. This, in turn, leads to the establishment of more collaborative arrangements. Over time, a climate is established across the entire supply chain that is conducive to external collaboration. Once such a climate exists, external collaboration is no longer a ‘nice to have’, serving as the basis of distinctive competencies; it becomes a ‘must’, an essential requirement to ensure survival in the industry. From this lens, this type of collaboration impacts the company as an external variable.

More specifically, collaboration can be viewed as a macro-environmental variable. It is closely linked to, and dependent on, technology, but it is not the same as technology. It is more than technology. It is the outcome of how technology has transformed the way people, companies and society operate (Bala et al. 2017). Companies worldwide are implementing technologies to facilitate open interaction, information and knowledge sharing, internally and externally with strategic partners (Plumpton 2019). Collaboration is not only a market force; it is more influential than that when it becomes a collaborative climate. When such a climate exists, it is engrained in the ethos of society and all the role players in society. Hence, it is a macro-environmental force.

In the light of suggesting that collaboration, or collaborative climate, constitutes a macro-environmental variable, we suggest that this variable be incorporated in what is commonly referred to as the ‘PESTEL’ analysis. PESTEL is an

acronym for ‘Political, Economic, Social, Technological, Environmental and Legal’ and represents factors that are ubiquitous to the environment any given company operates within. As an analytical tool, PESTEL is used to analyse and monitor how these macro-environmental factors could impact companies’ performance (Yüksel 2012). Political, Economic, Social, Technological, Environmental and Legal is particularly useful when starting new ventures or exploring new markets (Yusop 2018), but has its drawback that it does not analyse the collective impact of forces, but rather the individual impact of each variable without evaluation of how they impact one another (Yüksel 2012). Political, Economic, Social, Technological, Environmental and Legal, like most business environmental assessment tools, is ideal to be used complementary to other tools (Tsangas et al. 2019), is considered a powerful tool for macro-environmental analysis and is an input mechanism to the Strengths, Weaknesses, Opportunity, and Threats analysis (SWOT-analysis) for strategic decision making (Christodoulou & Cullinane 2019).

By adding the variable ‘collaboration’ to this framework, we propose the acronym PESTCEL, placing Collaboration in spatial proximity to Technology, indicative of the linkage between these variables. It is believed that the addition of the variable ‘collaboration’ will propel this tool into the 21st century, as it was originally developed in 1967 by Francis Aguilar as the Economic, Technological, Political, Social (ETPS) factors. By the late 1990s ‘Environmental’ and ‘Legal’ had been added, making it the PESTEL (or PESTLE) framework. However, since the turn of the century, this framework has remained essentially unchanged, which places it on the periphery of becoming outdated, especially if seen against the backdrop of the rapidly evolving world in which we find ourselves. By adding ‘collaboration’ to the framework and extending the acronym to PESTCEL, we are of the opinion that the framework will regain relevance in a 4IR world.

Managerial implications

To remain competitive in the contemporary business environment, companies need to continually review and rearrange their portfolio of operations, with ongoing reflection about what they undertake in-house, and what they collaborate on with stakeholders and supply chain partners. Advances in technology, coupled with the advent of 4IR, and widespread adoption of ICTs have made it possible for companies to collaborate beyond component or systems production and to collaborate in the realm of design. Indeed, in many instances, such collaboration is the result of competitive necessity. As a result, companies are narrowing their focus on fewer business processes, thereby maximising value across the supply chain. Yet, despite technology being in place and the potential existing for such collaborative opportunities, it is crucial that the management structures of companies exhibit an appetite for collaboration. If a conducive climate does not exist across supply chains that supports and nurtures collaboration, it will be very difficult to take

advantage of the opportunities presented by collaboration through technology.

It is apparent that collaboration can no longer be taken for granted as something that is assumed to 'be there'. Neither is collaboration merely an activity or tool that must be managed to ensure either supply chain effectiveness or organisational efficiency. This study shows that collaboration is far more than that. Internal collaboration can be utilised as a powerful mechanism in leveraging organisational capabilities and competencies that can aid in identifying a distinct competitive advantage for companies. On an external level, collaboration needs to be viewed as an environmental variable. Managers need to understand that if a climate exists that is conducive for collaborative arrangements to be established, the whole supply chain will benefit at the end of the day. Technology might enable the potential for increased collaboration across the supply chain, but the climate conducive for successful collaboration is a function of the effort of the managerial intention of individual role players that make up the supply chain. Without the will from management to make collaboration across the supply chain a reality, any investment in technology for collaboration will come to nothing. Thus, technology might provide the potential for collaborative opportunities to exist, but managerial will to create a conducive climate for collaboration remains the life-force behind collaboration.

The aspect of establishing an internal and external communication strategy with a stated implementation structure and goals becomes critical in keeping all stakeholders up to date as information on new opportunities and threats will flow into the collaborative system continuously. An important aspect of this strategy involves setting distinct goals with key performance indicators to use the information and fuse inflowing ideas together within this communication strategy. This could also act as a potential source of both future collaborative advantage and competitive advantage. A system of multiple stakeholders from both within and outside the company collaborating also brings with it risks that can manifest in terms of opportunities for cybercrime. This places an onus on managers to ensure that software and hardware updates across the stakeholder relationships are understood by all as to their impacts on shared information. As a risk management tool to protect against unwanted incidents that may affect the quality of collaboration, this in turn draws attention to the necessity for setting up business continuity planning and recovery that is shared and applied by all involved stakeholders.

Conclusion

The impact of technology is undeniable. As a single case study, this study is exploratory and more studies will need to be conducted with technology-driven companies pursuing collaborative arrangements across their supply chains to serve their markets to build a broader understanding of the topic. Furthermore, as the 4IR takes effect, the nature of collaborative arrangements spurred on by technology in

industries that are traditionally not seen as 'high-tech' or 'technology driven' would make for an interesting juxtaposition against 'high-tech' industries. For management academics and business practitioners alike, the role of technology has changed dramatically in recent times. It is imperative that managers explore what is possible through available technology in terms of collaboration. A major hurdle to a conducive climate where collaboration can be fully explored is the human element of management.

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Data availability

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