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ORIGINAL CONTRIBUTION

Role of Industry 4.0 in Pandemic Covid-19 and Shifting Business Models

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Abstract— We have conducted a brief literature review to learn more about the impact of Covid-19 on supply chains and how Industry 4.0 has helped to innovate business models as a result. Industry 4.0 (I4.0) was gaining popularity in every field before the pandemic. It brought a change in almost every area of life. It was becoming mandatory for organizations to change according to industry 4.0 parameters to remain competitive. Covid-19 has hit the world badly, leaving business operations to halt worldwide. It has accelerated the transformation process. It has forced practitioners to think about innovative Business models. Business models are the backbone of any progressive business that links its core technological functions and other activities to fulfil customers' needs. This paper sums up the transformation process under the umbrella of I4.0. It also summarises the effect of Covid-19 disruptions that hit the SC. It explores the stages which can be followed to recondition the business models. We summed up literature for practitioners to see possibilities to transform and survive existing disruptions. We have discussed emerging business models with the latest technologies. In this literature, we incorporate a four-step business model innovation process. Artificial intelligence, smart machinery, the Internet of Things, and Robotics are the main components of I4.0 that can revolutionize the value enhancement phenomena of any BM. Covid-19's effects on supply chain resilience and agility and the coping mechanisms provided by I4.0 were not thoroughly examined in previous studies.

Index Terms— Covid-19, Business models, Industry 4.0, Innovation, Supply chain management

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Introduction

In recent years, supply chains and traditional BMs have faced several challenges, and this study aims to consolidate these issues (Sigala, 2020). Countries have implemented social distancing to lessen the risk of Coronavirus transmission from person to person. Lockdowns, consumption reductions, community closures, and the abolition of businesses are all steps toward achieving this goal (Bretas and Alon, 2020). Economists believe this was a "black swan" event, meaning that they could not foresee its consequences. It is so severe that it changes political and economic environments and business failures (Amankwah-Amoah et al., 2021; Kuckertz et al., 2020; Winston, 2020).

High-speed innovation and globalization have left nothing to be stable. During this time of economic downturn, companies are facing difficulty in surviving. Intense global competition requires firms to adapt quickly and respond to market changes. The ability to manage change is now no longer a choice; it is necessary. Augmenting talents, altering the traditional organizational structure, and change management is dire levers under the I4.0 digitalization, and it has gifted enriched speed, improved visibility, and budget economics beyond our imagination. For industries, business processes, and manufacturing firms, I4.0 is a vast goldmine. It has endless possibilities and ways out to complex problems (Sommer, 2015).

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I4.0 can gravitate to greater sustainability in supply chain processes (Stock and Seliger, 2016). There is, therefore, a requirement for business decision-making to embrace radical changes in an environment of competitiveness (Roblek et al., 2016).

As envisioned by I4.0, the firm digitization progress integrates firm functions with all supply chain members. It helps them become a fully transparent and unified ecosystem (Schrauf and Berttram, 2016). Intelligent systems are necessary to achieve transformation. The interface between humans in cyber-physical spaces makes "smart environments." Consequently, performance will be enhanced in cost, simplicity, efficiency, and effectiveness (Laput et al., 2017). With I4.0, performance and efficiency can be improved by 25-30% (Rüßmann et al., 2015).

Technology experts describe the current global upheaval as an opportunity or challenge, depending on one's perspective. BMs can be changed, and new technologies can be implemented if the company chooses.

Researchers have looked at the impact of Covid-19 on businesses separately from the effects of Industry 4.0. However, both phenomena and their role are not examined in a single study.

So, we aim to investigate the following in this paper.

- Concerning the fourth industrial revolution, how are businesses adapting?
- Covid-19's impact on I4.0 technologies is being examined.
- How the SC faced disruptions in pandemic and
- How I4.0 technologies have helped to sustain?

Researchers and practitioners alike will benefit from this study, examining how Covid-19 affected supply chains worldwide. A business model that incorporates cutting-edge technology while preventing disruptions is what we are aiming for.

Literature Review

According to a rough estimate, the GDP of many countries dropped by three to five percent in 2020. There has been an intense shift in customer demand, such as panic buying toilet tissue seen in Europe. Such disruptions decrease supply chain performance levels (Fernandes, 2020; Ivanov, 2020). Many huge corporations have a substantial impact on the economy and the well-being of their customers. Customers' loyalty and desire to shop for a company that provides exceptional customer service are paramount to all businesses (Fadel et al., 2020).

COVID-19, a SARS-CoV-2 virus that is causing Coronavirus illness. Countries have faced extreme situations after World War 2. Coronavirus was first reported in Wuhan, the city of China. Gradually and then rapidly, it spread out worldwide. Countries strictly closed the border and imposed countrywide lockdowns to control its transmission. Countries negatively impacted consumer spending, reserves, and disturbances in global SC (Kumar and Managi, 2020; Ivanov and Dolgui, 2020).

According to Ivanov, this pandemic disrupted the supply chains in recent history and has weakened many organizations' SC globally.

Traditional SCM practices are not producing results in the information technology age, and SCM complexity makes it mandatory for companies to adopt IT systems. Accordingly, IT is considered an efficient and effective tool for incompetence because it paves a way towards effective SCM.

The latest technology means the latest revolution started in 2011 in Germany. Since then fourth industrial revolution (I 4.0) was gaining much attention from practitioners and researchers in almost every field. The idea of I4.0 is originated to address the changing conditions of customers, globalization, market volatility, competition, and complexity (H. Lasi et al., 2014). Research studies mainly focused on industrial aspects of I 4.0.

Intelligent network-linked systems are used in I4.0.0 to connect people, machines, and products. Germany proposed the idea of I4.0. I4.0 connects physical and virtual worlds and converts businesses into smart factories (Thoben et al., 2017). Skills enhancement change in traditional organizational systems is the critical lever of I 4.0.

When Covid-19 hit the world, the need to transform BMs and reshape SC becomes the most important to carry out operations. Due to severe governmental restrictions worldwide, economic conditions began to degrade. Companies are forced to make difficult decisions to stay afloat during a moment like this.

Scholars believe that I4.0 is a goldmine in the business world because of its endless opportunities and solutions to complex problems (Sommer, 2015). So, researchers started to find the best possible solutions to do business amid covid-19.

I4.0 is based on three main pillars, including the automation system, information system, and the cyber-physical system, as shown in Figure 1. I4.0 implements digital technologies to help companies connect their suppliers, production sites, products, and purchasers to gather and disseminate operational information and real-time news about the market (Kiel et al., 2016).

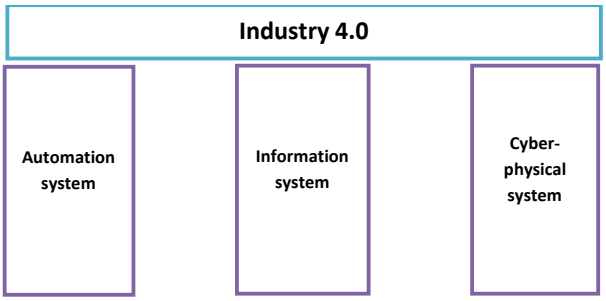

Fig. 1. Major Pillars of I4.0

Rapid digitalization forces academicians and practitioners to reset their BMs (Ibarra et al., 2018). The pandemic has forced everyone to get solutions from the latest technology like cyber-physical systems and the internet of things robotics. These technologies can make social distancing virtual presence possible, resulting in uninterrupted operations.

Before the pandemic, it was observed that businesses that were not giving due attention to BMs were struggling to profit with new technologies. Still, now chances of survival for those firms are minimized. Product and process innovation, along with BM innovation, is necessary now. The BM links business strategy, technology, and processes. BMs depict the organizational structure and all activities to process and control systems that create significance for the organization. Researchers believe that BM innovators perform better than product or process innovators (Weking et al., 2019).

A BM is a narrative of any organization's complex functions to achieve its purpose. (Massa et al., 2017). According to (Wirtz et al., 2016), a company's customers and partners and how those can be turned into revenue are what constitutes a company's "BM" (Brown et al., 2014). The BM has gained popularity in the 1990s.

There are three main categories in which BMs are defined,

1. Insight of organizational units.
2. Model of the organization system.
3. Business elements to achieve some goals.

It is a basic and accumulated interpretation of the relevant actions of a business. It enlightens how the value-added module creates marketable facts, products, and services. Besides the planning of worth creation, customer and market components are reflected. Creating or rather maintaining a competitive advantage is the ultimate goal. Current BMs should be constantly scrutinized from a dynamic perspective, with the awareness that internal or external changes over time may necessitate the evolution or innovation of existing BMs.

BMs and SC are the backbones of any progressive business which links its core technological functions and other activities to the contentment of consumers' needs. BMs are conceptual tools that describe the whole mechanism of how the company is created, delivered, and captured customer value. So BMs span the major firm's boundaries and all related value-creating activities in the firm's business environment. According to Ritter, there are four elements of BMs; resources, customers, value proposition, and value demonstration. All parts should be aligned; digitalization is one element that significantly impacts others (Coreynen et al., 2017).

A clear understanding of I4.0 implementation in industries to remain competitive and achieve sustainability can be gained by using the BM concept. This topic is gaining interest due to changes in the dynamics of doing business. So, we are interested in looking into these changes taking place in real.

Research Methodology

Using I4.0 and the Covid-19 era as a lens, we will look at the literature on BM amendment in this era. I4.0's impact on BMs will be examined in detail in this paper, including a review of relevant articles.

Contemporary research is a structured literature review based on Tranfield et al., (2003) principles.

Figure 2 shows the procedure we followed in selecting and extracting the articles for review. In the first step of selecting articles, we extracted articles from Google Scholar (GS) by a manual search of key terms. We also monitored the citation of quality journals for related articles to incorporate all relevant references in our work (Massaro et al., 2016).

The publication dates of articles that we have used to review are between 2015 to 2021. We used 2015 as a starting point because the term I4.0 gained acknowledgement after its introduction in 2011. After that, we focused on 2020 and 2021 because we aimed to explore the relationship of Covid-19 with the application of I4.0 technologies.

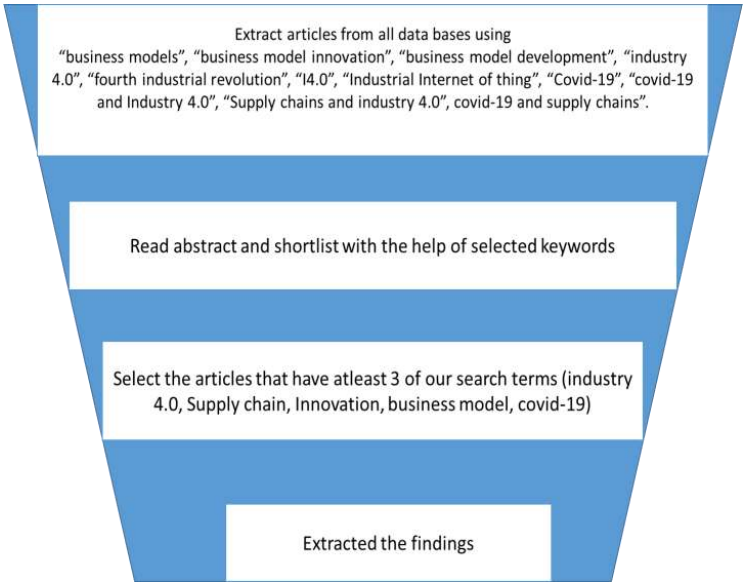

Fig. 2. The Selection Process of Research Articles and Summary of Research Methodology

For this, we have selected articles having keyword terms "I4.0", "BMs", "business model development", "fourth industrial revolution", "I4.0", "Industrial Internet of thing", "Covid-19", "business model innovation", "covid-19 and Industry 4.0", "Supply chains and industry 4.0", supply chains and Covid-19".

We shortlisted 53 articles that have the terms mentioned above in their abstracts, keywords, or titles from the list of articles. From those selected articles, we aimed to collect data about the changes observed in BMs, SC, and the role of covid-19 in accelerating those changes.

Findings from Literature

The current pandemic procured social isolation, lockdown, and the emergence of a new normal. There is only one way to keep the economy from collapsing in our current state of digital transformation. Employees must improve their skills, knowledge, and digital competencies to meet arising opportunities. In times of transition, new rules of competition emerge, but when the crisis subsides, the true value of a company once again serves as the final arbiter of business success. Figure 3 is the extracted keywords from all relevant articles, encompassing our main keywords, i.e., industry 4.0, supply chain management, innovation, Covid-19, business models.

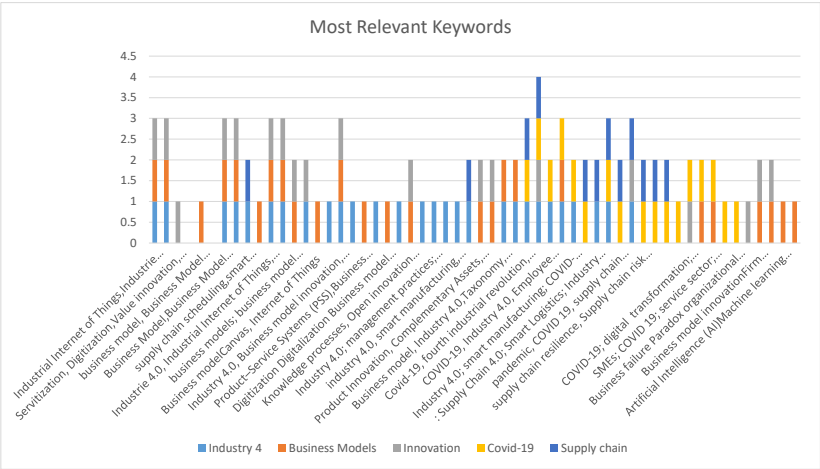

Fig. 3. Extracted Keywords from the Literature

Below is the table of shortlisted articles that we used to extract answers to our questions.

Table I
Data Classification

Year	Journal	Keywords	Country
2015	"International Journal of Computer Integrated Manufacturing"	"Cloud computing, (IoT), distributed resources, Cloud manufacturing"	USA
	"Journal of Cleaner Production"	"Business model, Tactics, Literature review, Servitization, Sustainability"	Sweden
	"European Management Journal (EMJ)"	"Knowledge processes, Business models, Organizational design, Open innovation strategies"	Norway
	"Production Engineering"	"Cyber-Physical Systems, Cloud gateway."	Germany
	"Journal of Industrial Engineering and Management"	"I4.0, SME, Digitalization, Automation, IoT"	Germany
2016	"International Journal of Innovation Management"	"IIoT, I4.0, BM, business model innovation, German industry sectors"	Germany
	"Journal of Business Models"	"Ecosystem, Industrial Internet, Internet of Things"	Finland
	"International Journal Of Production Research (IJPR)"	"SC, smart factory, flexible flow shop, alternative machines"	Germany
	"Procedia Computer Science"	"Business Model, IoT"	South Korea
	"IAMOT conference"	"I4.0, Industrial Internet of Things, BM Innovation, Industrial Manufacturing, Systematic Literature Review"	Germany
	"Procedia-Social and Behavioral Sciences"	"I4.0, service provision, service engineering, evaluation model"	Romania
	"Journal of Product Innovation Management"	"Product Innovation, Business Models, Servitization, Business Models, Value Creation"	Barcelona
	"Long-Range IFAC-Papers Online"	"Human-centered design, CPS, Mobile systems, I4.0"	Germany
2017	"BHM Berg-und Hüttenmännische Monatshefte"	"I4.0, IIoT, BM, Business Model Innovation, Systematic Review"	Germany
	"Industrial Marketing Management"	"Digitization, Value innovation, Manufacturing companies, SME"	Belgium
	"Procedia Engineering"	"BM, Business Model, (IIoT)"	Poland
	"Technovation"	"Industrial Internet of Thing, Industrie 4.0 BM, BM innovation."	Germany
	"IEEE Internet Academy of Management Annals"	"BM innovation; strategy; value creation and capture."	.
	"Computers and Industrial Engineering"	"Human-Machine Aid, Levels of automation, intelligent manufacturing systems, I4.0"	France
	"Energies"	"I4.0, Management practices, innovative capability, knowledge management"	UK
	"International journal of automation technology"	"I4.0, smart manufacturing, CPS, industrial internet, smart factory"	Germany
	"Procedia Manufacturing"	"SCM, I4.0, Internet of Things, IoT impact"	UK
2018	"Procedia Manufacturing"	"BM, Business Model Innovation, digitalization, I4.0"	.
	"Technological Forecasting and Social Change"	"Internet of Things"	Italy
	"International journal of production research"	"I4.0, smart manufacturing, operational improvement"	France
	"Technological Forecasting and Social Change"	"I4.0, Business model innovation, SME, Multiple case studies"	Germany
		"Product-Service Systems, BM Innovation, Innovation Strategies"	Germany
	"Foundations of Management"	"Digital transformation, BM, digitalization, business model canvas, change management."	Poland
2019	"Journal of Business and Industrial Marketing (JBIM)"	"Value innovation, IoT, I4.0, innovative strategy."	Belgium
	"Industrial Marketing Management"	"Digitization, Digitalization, BM, Business-to-business marketing"	Denmark
	"International Journal of Production Economics"	"BM, I4.0, Internet of things (IoT)"	Germany
2020	"Sustainability"	"Environmental awareness, environmental space, space economy"	Italy
	"The International Journal of Business Management and Technology"	"I4.0, IoT, Supply Chain, SMEs, COVID-19"	Mexico
	"Social Science Review"	"Pandemic, COVID 19, supply chain management, risk, disruption"	Bangladesh
	"International Journal of Production Research"	"SC Resilience, SC risk management, SC dynamics, intertwined supply network, survival, COVID-19"	Germany

Table 1 Continue ....

Year	Journal	Keywords	Country
	"Journal of Business Research (JBR)"	"COVID-19, Retail strategy Pandemic"	UK/Italy
	"Information Systems Management"	"COVID-19, digital transformation, digital economy, innovation"	Spain
	"International Journal of Information Management"	"Business models, Agility, Digitization."	India
	"Journal of Business Research (JBR)"	"COVID-19, Impacts, Recovery, Resilience"	Australia
	"European Management Journal"	"Business failure, COVID-19, Novel global crisis"	UK
	Journal of Business Research	Digitalization (IoT), AI, Product-service systems (PSS), New service development (NSD)	Norway
	"Journal of Business Research"	"AI, Machine learning, Sustainable BM, Knowledge Management System (KMS)"	Italy
2021	"International Journal of Productivity and Performance Management"	"Covid-19, fourth industrial revolution, I4.0, Pandemic, SC, Sustainability"	Brazil
	"Computers in Industry"	"I4.0, SC innovation, COVID-19, Big data analytics, Blockchain, IoT, AI, Virtual reality"	Australia
	"International Journal of Production Economics"	"COVID-19, I4.0, Employee performance, Services"	UK/Australia
	"International Journal of Production Economics"	" I4.0, smart manufacturing, COVID-19, business dynamics, business continuity, challenges, DEMATEL"	UK/Pakistan
	"International Journal of Research in Engineering, Science and Management"	"Big data analytics, Digital SC, E-commerce, Digitalization"	India
	"International Journal of Innovation and Applied Studies"	"SC 4.0, Smart Logistics, I4.0"	Morocco
	"International Journal of Innovative Science and Research Technology"	"Blockchain Application, Global SCM, IoT, Innovation, I4.0"	China
	"Technological Forecasting and Social Change"	"Covid-19, SC resilience, SC risk."	.
	"Sustainability"	"COVID 19, transformation drivers, digital technologies, BM"	Croatia
	"Journal of Business Research"	"BM innovation, Firm performance, Absorptive capacity, Agility"	.
	"Journal of Business Research"	"Digital Transformation, Knowledge Management, BM, Sustainable Performance"	Italy

Supply Chain Resilience in Covid-19

The chain resilience of many organizations has experimented in the Covid-19 pandemic that claims to be strong. There are concerns about the robustness and adaptability of SC and the recovery capability (Amankwah-Amoah et al., 2021; Ivanov et al., 2018). In the COVID-19 pandemic, we learned more about the possibility and intensity of disruption observed within global SCs, one aspect of network resilience had been illuminated (Dolgui et al., 2018).

According to Ivanov, an interruption to the supply chain's normal operation is called the "Ripple effect." It can lead to a shift in the system's structure and parameters, affecting overall performance. The COVID-19 pandemic has had a wide range of repercussions. Companies were operating globally, getting part or raw material from one part of the world and assembling in another part of the world. Manufacturing, retail, and transportation all ceased in the months leading up to May 2020 due to the massive ripple effects. Every industry and service in the world was adversely affected (Bae et al., 2020; Ivanov and Dolgui, 2020).

Supply Chain Agility in Covid-19

During the covid-19 breakout, companies faced severe ups and downs as physical retail stores were closed due to lockdown, and demand for certain products rose. People did panic buying and did stockpile to deal with an uncertain future. This behaviour has put companies under severe pressure to maintain their operations. E-commerce for food was at a low level before the crisis. However, businesses seek professionals who can help with unexpected increased demand in industries like groceries. Due to border closures, many businesses have gone virtual, and some have switched to local SC (Pantano et al., 2020). A new agile approach will amend delivery time between irregular consumers' demand and retailers' responses. Businesses must comprehend how consumers think and collaborate with them (Gordon et al., 2020; Sjödin et al., 2020). it would help considerably reduce reaction times and the process's simplification. Increased engagement with all participants is consequently necessary (e.g., by asking for feedback throughout operations) to let them be a part of the system and development, rather than merely suppliers or end-users. The new agile approach must be deployed rapidly to prepare the shops to

recover speedily in the consumption at the end of the pandemic whilst also taking measures in consumption stabilization once the bounce fades.

Glocalization

Companies are forced to rethink their global system of production with complex SC. The coronavirus pandemic has shown the potential dangers of Just-in-time and lean delivery methods. Due to lockdown and reduced global operations, companies have tried to adopt smart logistics systems by using the Internet of Things (IoT). Local sourcing is becoming simpler by knowing where parts and components are located. It is expected that SC will be more localized in the future. "Glocalization" trends are becoming a big topic of discussion.

Reliance on Technology

I4.0.0 technologies like automation, robotics, and cloud computing are best practices in social distancing. It also helps in reduction to energy usage and transportation costs. In this scenario, humans will be replaced with robots that will be able to operate remotely. Various work activities can incorporate robotics, such as restocking shelves and helping in care management (Corkery and Gelles, 2020). When implementing new technology in the industry, I4.0 and smart business is the best option. It helps reduce many of our fears about physical contact in pandemic situations. Blockchain (IoT) and RFID sensor technologies can improve supply chain traceability and transparency. Satellites and artificial intelligence can be used in conjunction with IoT monitoring systems. When it is vital to identify the locality and situation of critical commodities, they are located in intricate supply chains to save time, resources, and energy.

Business Models Digitization

Innovation is not a new concept, as the first artificial intelligence conference was held in 1956 (Ritter and Pedersen, 2019). The research stream of BM innovation spans the transformation of existing BMs to new competitive BMs (Weking et al., 2019). The key challenge to technological disruption or change is effective interaction between technological development and BMs. The technological shift is toxic to competitive businesses. The concept of the latest technology transformation is not just related to a single firm, but it encompasses the whole ecosystem. New technologies are increasing the complexities in the business environment, so studies are required to increase understanding across business boundaries (Matthyssens, 2019). The rules of industry competition are changing as a result of digitalization. Digital platforms and ecosystems they support are at the centre of a new BM emerging recently. This type of BM is related to technologies such as the internet, smartphones, and social media platforms.

Major drivers of the digitalization of BMs are customers. The increased competition is also causing BMs to change everything from customer relationships to internal processes and value propositions. Moreover, the Digitization capability of an organization can lead to digital BMs (Ritter and Pedersen, 2019).

The changes due to I4.0 are the addition of smart, intelligent methods into the industrial setting, new expertise (Lalanda et al., 2017), emerging new roles and growth of human competencies (Wittenberg, 2016), varied styles of controls on production (Lalanda et al., 2017; Moeuf et al., 2018; Pacaux-Lemoine et al., 2017) and logistic processes, have an impact on the manufacturing industry. These changes respond to the challenges of shortened product life cycles, constant improvements and innovations, globalization, intense competition globally, and increasing complexity of products, processes, and channels (Arnold et al., 2017). Innovative BMs have been examined in-depth. In this examination of innovation in BMs, (Bhatti et al., 2021) found three influences: organizational agility, knowledge absorbent ability, and the attentiveness of top management. New and developed BMs can serve as a mediator among the factors that have impacted an organization's performance and the value created through emerging technologies if they merged in the innovation process with care. Using emerging technologies to share information about new ways of doing business is an important part of strengthening corporate governance within organizations (Di Vaio et al., 2021). Building a knowledge management system and incorporating Artificial intelligence AI in business can modify organizational culture and improve business performance. This way, companies implementing AI technology today will benefit from its advantages for developing new products and services to enhance their competitive position. Through this type of information processing approach, organizations can access more productive data than they were able to before due to having comprehensive insight into what is happening within each part of their operation (Di Vaio et al., 2020; Scuotto et al., 2017).

Literature discloses that BM development and BM innovation are two different concepts, so distinction should be made between them. BM development does not change business core values and value proposition structure entirely. BM innovation brings about new BM with extensive changes. As drastic changes can be a reason for the failure of firms, the managing staff is more interested in slight adjustments of BMs (Arnold et al., 2016).

According to the authors, advancement In the existing BM or developing its improved version requires a strategic move. It usually occurs when technological advances, social approval for former models, economies of scale due to snowball effects, or revolutionary innovations. (Kotarba, 2018). A "disruptive innovation" is not a passive thing. For example, they halt a system or process from operating

as usual or according to plan. The COVID-19 pandemic illustrated a good example because organizations had no control over its emergence and spread; as a result, they had to react to the situation and, if necessary, rethink their business models (Kilkki et al., 2018). Social media and mobile technology are the most popular way of transforming communication channels or delivery services.

According to the definition, BMs tell us how an organization creates, delivers, and captures value. Keeping this in view, we can show the transformation in BMs from traditional to I4.0 (Figure 4). According to the literature, there are four ways to bring about BM development or innovation (Ibarra et al., 2018), as shown in Figure 4.

Internal and external process optimization refers to alterations in traditional BMs introducing the latest technologies to optimize the process (Ibarra et al., 2018). It is the first step towards I4.0 of any organization.

Secondly, customer interface improvement deals with improved value proposition with the help of new technologies. That creates new avenues of communication with the customers (Ibarra et al., 2018).

Thirdly, a new ecosystem and value network focuses on skills enhancements, a partnership to share the uncertainty. In this phase, the emphasis is converted radically from value chains to ecosystems causing a sweeping change in BM elements (Ibarra et al., 2018).

Lastly, new BMs are based on the exclusive features of I4.0. Big data, smart goods, innovative services, cloud computing, and embedded systems birth a new BM. It brings about change in all parts of BMs (Ibarra et al., 2018).

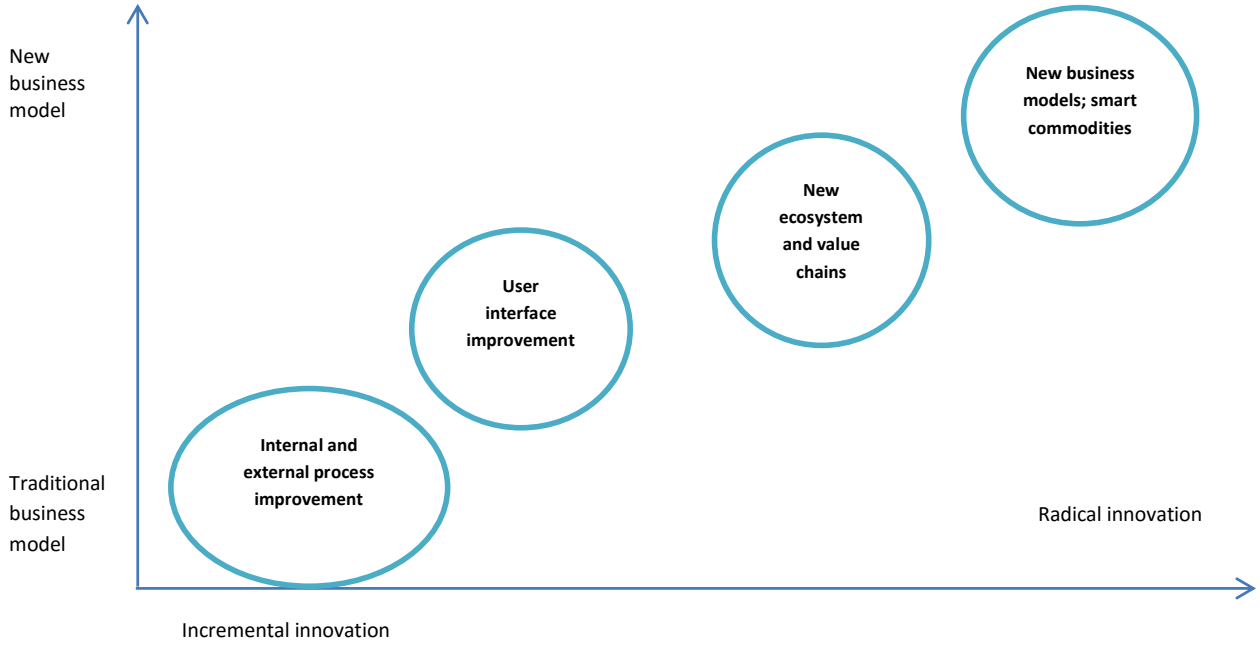

Fig. 4. BM Innovation Process

We focus on the BM explanation presented by (Osterwalder & Pigneur, 2010). In terms of BMs, they talked about creating value, the proposition of value, and capturing that value. So, we draw some data concerning changes in BMs due to I4.0.

Value creation

With the introduction of I4.0, organizations can cover information transmission loopholes effectively. The latest communication technologies can help optimize demand, decrease failures, increase efficiency in production and supply, and lead to ultimate value creation. The organizations that want to bring I4.0 into practice are needed to invest in highly efficient computing capacities; it will help look after all essentials in the product life cycle. Investment in CPS "cyber-physical system" can be costly, but organizations can minimize it by sharing the risk with other organizations or governments (Müller et al., 2018).

Apart from technologies, highly developed skills and managerial assistance are also required. Intensive employees training is needed for new skills development and in case of machine failure (Müller et al., 2018). Due to flexible production, workers' responsibilities are diversified. CPS and other I4.0 technologies can replace inexperienced workers, but they cannot be an alternative to experts, especially IT and manufacturing. Technology can help less-experienced workers in their work as processes can be explained easily through visuals (Müller et al., 2018). Though several organizations lack proficiency in I4.0, there is an opportunity to create value by partnering with

different companies. Investment in Information communication technology is risky, but it can sort out by sharing information and joining networks to implement I4.0 (Shin et al., 2014).

To bring innovation in the BMs, Companies should share all data related to products and processes with customers and suppliers in real-time, beneficial to all supply chain members. Real-time data sharing with all chain members also brings issues related to cyber criminality, which should be properly addressed ethically, legally, and technically (Müller et al., 2018) because sharing information is not an easy task; it includes all data related to inventories, hurdles, and issues.

Value proposition

The literature repeatedly shows that if manufacturing companies want to redesign their models, they should adopt servitization "product only offer to service-oriented offer". This value offering minimizes customers' cost of information search and other related services, increasing positive goodwill (Visnjic et al., 2016). It can be real-time product co-development, data sharing, optimizations, and digitization of processes (Müller et al., 2018).

Value Capture

Connectivity in I4.0 is crucial. Information and communication technologies "ICT" and CPS can help create fast real-time connections with suppliers and customers. This connectivity allows capture more value (Müller et al., 2018). Ease in order placements and payments and communication with all partners can help reach wider customer segments. Data sharing can positively optimize processes by demand balancing and effective predictive analysis (Müller et al., 2018). Servitization in manufacturing companies can help them capture more profits (Visnjic et al., 2016). New I4.0 solutions are payment-per-feature, payment-per-use, and payment-per-output (Müller et al., 2018; Visnjic et al., 2016). Due to these versatile offers, payment documentation time is reduced, and customers are more willing to pay (He and Xu, 2015). I4.0 solutions provide transparency in money circulation to establish long-term partnerships.

Emerging Business Models

Open innovation/integration oriented BM

I4.0 technologies like IoT, smart factories, and CPS enable BMs to convert from closed BMs to open and innovative ones (Weking et al., 2019). Compared to closed BMs, open innovation is inclined towards being proactive in business practices. It involves exploiting innovative activities by licensing technologies, crowdsourcing, or forming coalitions. Open innovation can also be achieved by horizontal and vertical integration to expand traditional business boundaries (Ibarra et al., 2018). Traditional businesses are to adopt new BMs to beat the competition.

Crowdsourcing BMs

Crowdsourcing BMs are a subtype of innovative BMs. Crowdsourcing is obtaining information or ideas from a large group of individuals that fosters innovation, mostly on the internet, and work can be completed by some people (Weking et al., 2019). Thus crowdsourcing can open up new avenues to deal with competitions.

Mass customization BM

Due to rapid technological changes and the introduction of autonomous production systems, two different, opposite concepts of mass production and customization are combined as mass customization. Advancements in IT have led to this new production paradigm (Weking et al.2019). Advanced smart systems allow their customers to mend features according to their own needs before buying. Mass customization necessitates tighter control over the supply chain and real-time information exchange between vendors and customers. Information technology is required for this entirely new BM (Weking et al. 2019). In this new BM, firms allow more customer involvement with decreased transaction costs and lead times.

Service-oriented BM

Product service system BMs are based on I4.0 principles (Weking et al., 2018). A BM mainly includes tangible products and intangible services. This product-service system is a competitive combination in the modern business world, aiming at closer customer connection, effective use of resources, and stability in revenue streams.

Internet of things BMs

A central module of the internet of things BMs is the value proposition. The main facilitator of the I4.0 paradigm is the IoT (Ju et al., 2016; Metallo et al., 2018). IoT in BMs involves customers in production and design procedure (Arnold et al., 2017; Gierej, 2017; Kiel et al., 2017). Key resources in these BMs are software, internet devices, and technology specialists (Arnold et al., 2017; Gierej, 2017; Ju et al., 2016; Kiel et al., 2017). Key partners in this BM are internet and communication control devices (Arnold et al., 2017; Gierej, 2017; Kiel et al., 2017).

Cloud BMs

Cloud-based BMs offer massive computing power, data storage, and automation of the operating system. The first is an Infrastructure-as-a-service "IaaS" approach that makes cloud-based hardware and software readily available over the internet (Arnold et al., 2017). Secondly, they provide a Platform-as-a-service “PaaS” model that facilitates organizations' development and integration of applications. Thirdly, the cloud feature provides Software-as-a-Service “SaaS” model that provides online customized applications.

Process-oriented BMs

Process-oriented BMS is based on process optimizations feature which reduces lead times and downtimes (Arnold et al., 2017) like 3D printers, which enable the customers to design, customize and print, leading to reduced process time and delivery times.

Conclusion

This research went through the predominant literature on BM changes due to I4.0 technologies. It also explored the role played by the pandemic in structural changes of BMS.

I4.0 is more about changing or inserting new technologies. It is about changing skills, processes, management, production, responsibilities, and logistics (Lalanda et al., 2017; Moeuf et al., 2018; Pacaux-Lemoine et al., 2017). Major drivers of the digitalization of BMs are customers (Ritter, 2014). Strategic decision-making must be a major change in BMs (Kotarba, 2018). Process optimization, customer interface enhancement, and a whole new shared ecosystem are the steps towards I4.0 BMs (Ibarra et al., 2018).

It is the companies' capabilities, and intentions that help bring about the change. Change can be in the form of BM development or radical innovation. Small and medium-sized enterprises (SMEs) re-evaluate their core capabilities, identify new opportunities, redefine and rethink sustainable BMs more speedily with the recent pandemic of COVID-19. We have seen the stages which can be followed to remodel the BMs. Major alterations are not required in traditional BMs, and just process optimization can be helpful.

In the case of traditional BMs where major changes are not required, only process optimization can be helpful. The leading stage can be effective real-time communication with customers with the help of new technologies; it will pave the road toward unique ecosystems and value networks. The radical BM will be where change will occur by incorporating all industry 4.0 enabling technologies.

Due to border closures in the pandemic, manufacturing firms were forced to use local sourcing to deal with the disruptions in SC (Pantano et al., 2020). In this era, a new term Glocalization is developed, which is the localization of global chains.

Cyber-physical systems and digital automation proved the perfect solution for social distancing. I4.0 technologies facilitate all businesses to go virtual and try to keep things working (Corkery and Gelles, 2020). Sensor technologies robotics has helped manufacturing firms to track things being processed being virtually present.

This paper shows that there are many possibilities to transform existing BMs. CPS, IoT, and ICT are the main components of I4.0 that can revolutionize and change the value creation, value proposition, and value capturing phenomena of any BM. High connectivity, information and data sharing, active involvement of all partners in the production process can create long-term relationships among whole supply chain members. Change is not a choice now, and it has become a necessity. I4.0 revolution and Covid-19 both have hit businesses worldwide.

Limitations and Future Research Directions

The goals set out at the beginning of the paper have been met due to the literature review. We have understood how Covid-19 affected supply chains worldwide and discovered cutting-edge technology business models that help avoid interruptions.

We have looked at how Covid-19 affects the entire supply chain. Disruptions can be better understood by studying each chain member individually.

Because of the constantly changing environment, it has been determined that further research on the topic is necessary to provide a deeper understanding of the process of Business Model Innovation. Future studies should include a wider range of methods, techniques, and tools that can help companies deal with the opportunities and threats of Industry 4.0.

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