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The Impact of Sustainability Model on Sustainable Production during the Covid-19 Pandemic

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Abstract

Purpose: This research aims to give managers and organizations with the best means and practices for maintaining sustainable production with the use of SSCM practices during challenging periods, such as global crises, pandemics, or any other circumstance that impacts the business.

Design/Methodology: The research sample comprised of managers and department heads employed by enterprises in the Industrial area of Jeddah who were situated in various industries. This research used a non-probability sampling approach with roughly 260 responses from diverse industries.

Findings: Each of the variables of the sustainability model have a positive impact on sustainability production during the pandemic with organizational culture, as an exception. Based on the findings, it was found that organizational culture did not affect the sustainability production.

Research Implications: In terms of profitability, sustainable enterprises with a networked structure and strong virtuality outperform hierarchical organizations. In difficult situations, shared leadership should be utilized to quickly gather information from all functional areas. People-driven companies are better positioned to endure COVID-19 and future viral outbreaks. Before and after crises, successful organizations utilize ICT to build trust and relationships with employees, stakeholders, and customers. Finally, balancing resource hoarding with resilience is crucial. Continuous functioning of companies requires equipment, cognitive, and human capital. After a pandemic, an organization's capacity to analyze financial sustainability and find other funding sources is critical to survival. Companies with financial contingency plans allowed operations to flourish.

Originality/value: This study focuses on the impact of network structure, resilience, organizational culture, distributed leadership, ICT and financial contingency on production sustainability during the pandemic. This study provided a channel for further research on distributive leadership and organizational culture to understand the different aspects of crisis

management, especially with respect to Saudi Arabia and the effect of the pandemic on sustainable production

Keywords: Sustainability, Production, Resilience, Network, ICT, pandemic, COVID-19, crisis management,

Paper type: Research paper

1. Introduction

The COVID-19 outbreak had a worldwide impact. During the crisis, many firms' operational sustainability and capacity to resist hardship were questioned. A long-term and difficult-to-quantify impact of the epidemic on society is unknown (Alajmi et al., 2021). Thus, additions to the literature and research are essential. This study examines the impact of the global pandemic on the sustainable development model, highlighting the interdependencies between the goals in light of the new circumstances. This study uses literature that considers the pandemic crisis' wide surroundings to examine the interdependencies of model factors on sustainable manufacturing.

Saudi Arabia was no different when the COVID-19 pandemic was declared on the 8th of March, 2020 with the unexpected shutdown of several businesses. The government of the Kingdom of Saudi Arabia made praiseworthy efforts to restrict the development of COVID-19 by implementing a variety of timely and well-developed measures to reduce the disease's consequences. For the purpose of mitigating the effect of COVID-19 on the economy, labor market, and people, the government spent more than 7% of GDP in the year 2000. Although the government has made significant efforts to contain and contain COVID-19, the scale of the pandemic is causing socio-economic disruptions throughout the country and beyond, affecting every sector of the economy and every aspect of life (Saudi Arabia, 2020).

Historically, global supply networks were constructed to maximize profits by minimizing labor costs and expenses. Nonetheless, the COVID-19 pandemic revealed the vulnerability of global supply lines. Over the last two years, supply chain disruptions have affected more than 80 percent of all industries worldwide. This caused almost three-quarters of them to relocate manufacturing closer to home, closer to customers, or to shift products and components to key partners. Saudi Arabia desires relocation of global supply chains to the Kingdom. Given the country's major tourist initiatives, inexpensive energy, youthful talent, and increasingly predictable operating climate, this may be well worth the effort. Reshoring industrial plants may have a variety of far-reaching implications and can contribute to a nation's long-term economy (Rahman & Qattan, 2021).

As a destination for rerouted supply chains, Saudi Arabia aims to profit from higher capital investment, greater productivity, and the development of secondary and tertiary industries. Any aspect that is beneficial for an economy is also beneficial for the financial services that serve the market. Known as Vision 2030, it is a long-term vision for the future of Saudi Arabia that places sustainability at the core of everything the country does, from policy formulation and investment to planning and infrastructure development. Therefore, based on this vision, the Kingdom aims to recuperate and flourish through the post-pandemic era (AlArjani et al., 2021).

The Sustainability Model, posited in this study, focuses on the growing production, especially during the pandemic times. Obrenovic et al. (2020) proposed the dimensions in this study that are based on the Crisis Management Team Theory, the Stakeholder Theory, and the Distributed

Cognition Theory in order to investigate the influence on production sustainability during the COVID era. With the current study, the role of Sustainability Model on production during the pandemic will shed insight on the sustainable supply chain management (SSCM) theories that have acquired significant traction in today's competitive corporate environment, regardless of industry (Islam et al., 2020).

Sustainable production is a crucial aspect of study currently for many businesses. The current COVID-19 epidemic impacts global and national manufacturing and commerce networks. Food, groceries, and pharmaceutical supplies are among the numerous vital things whose supply and demand are dramatically not syncing (Kumar et al., 2020). Meanwhile, the coronavirus epidemic is helping the environment by closing several factories and cutting down on logistics and distribution. However, the supply chain network was not resilient to the pandemic, with roughly quarter of manufacturers reporting supply chain network disruption (Yu et al., 2021).

The COVID-19 pandemic resulted in economic difficulties in several regions of the globe, affecting the organization, the business sector, and the manufacturing sector. To assure the survival of the world's economies in the case of a crisis, it was necessary to explore the most significant components and models that ensure and favorably affect the continuity of organizational and commercial productivity in times of crisis. It is difficult for company owners in this industry to apply sustainable supply chain management approaches because of a number of hurdles (Tundys, 2020; Islam et al., 2020; Obrenovic et al., 2020).

The following research questions will be addressed in this project, which will use a modified model from Obrenovic et al. (2020):

RQ1: What impact did the Supply Chain Sustainability Model have on the long-term viability of the production during the COVID era?

RQ2: Identifying the most effective techniques found in the Supply chain sustainability model that may aid in increasing production sustainability outcomes during times of crisis is important.

The main objective of this study is to provide the managers and organizations with the best means and practices to maintain the sustainable production with the help of the SSCM practices during the difficult times- such as global crises, pandemic or any other situation that affects the organization.

The study is based on SSCM model practices and these are as follows:

- ✓ Network Structure
- ✓ Supply Chain Resilience
- ✓ Organizational Culture
- ✓ Distributed Leadership
- ✓ Digitalization and ICT
- ✓ Financial contingency planning (Obrenovic et al., 2020)

Obrenovic et al., (2020) proposed that network structures are less structured, decentralized organizational structures wherein managers in a network system coordinate on an internal and external basis. Supply chain resilience is the ability resist and recover through the times of crisis thereby avoiding the supply chain disruption. Organizational culture relates to the principles, expectations, and practices that govern the team activities. Distributed leadership promotes the understanding and analysis of how leadership works in a complicated organization. Digitalization implements ICT and digital tech for the business in order to generate new avenues of income. Financial contingency provision focuses on the offer that is reliant on securing mortgage financing, usually covered by a timeline (Obrenovic et al., 2020).

2. Literature Review

2.1 Theoretical Background

The COVID-19 pandemic has disrupted the supply chains, which has harmed global industry as a result. As a result, governments and companies throughout the world have been obliged to consider the long-term health of their supply chains. Fortunately, the re-evaluation has roughly coincided with the recent ramping up of ambitious and wide-ranging national development plans in Saudi Arabia. The Saudi Arabian government adopted a sustainable and resilient supply chain strategy almost from the beginning of their development projects, rather than needing to make significant modifications once the projects are already well underway. Manufacturers have made significant investments in increasingly globalized, specialized, and lean supply chains in recent decades in order to decrease costs and capture efficiencies, among other things (Islam et al., 2020). Certain nations have supplied the vast bulk of the components, suppliers, raw materials, and finished products for numerous global industrial activities throughout the years. Therefore, the SSM model based its premise on the three core theories that aid in the understanding of the impact of COVID-19 pandemic on the supply chain management practices (Tundys, 2020).

2.1.1 Crisis Management Theory

A crisis is an organizational phenomenon that occurs when an organization is under stress. The organization, which exists in human society, is in one way or another directly related to society in its origination (Bundy et al., 2016). Smits & Alley (2003) propose that the company is required to confront and resolve the problem via the use of crisis management techniques. A crisis is a situation that is unwelcome, unexpected, unprecedented, and practically impossible to handle (Stern and Sundelius, 2002).

According to the findings, such extraordinary incidents threaten the lifeline of an organization. From the perspective of its features and consequences, Clark (1988) recognized three aspects of a crisis: a danger to objectives, a diminished capacity to control the environment, and a perceived time constraint. Throughout this examination, themes from a range of academic disciplines, including communication, sociology, anthropology, political science, and psychology, will be discussed. As a result, this report captures the diversity of the field of risk communication, as well as an analysis of the key strengths and weaknesses of dominant theories and models, allowing risk communicators and managers to quickly identify the information and research that is most relevant to their interests (Clark, 1988). The past decade, academics have worked to enhance risk communication practice by creating, testing, and refining communication theories and models that attempt to explain the anticipated and unexpected consequences of risk communication. These

theories and models have been tested and refined throughout time. A great deal of scientific progress has resulted from these efforts, but there is no one theory or model that encompasses the whole spectrum of factors that influence risk communication initiatives in a comprehensive manner (University of Maryland, 2012). Therefore, the following stages are highlighted through the following:

Preparedness: The risk communication before the event takes place describing practical preparedness actions, including education on the expected risk features of various threats (e.g., variables distinguishing a terrorist attack with an improvised nuclear weapon from an earthquake etc);

Response (Imminent Warnings): crisis communication and advice for protective steps to take just before, during, or immediately after an incident;

Recovery: messages addressing needs and guidance throughout the weeks, months, and years after an occurrence (University of Maryland, 2012).

2.1.2 Stakeholder Theory

A model of capitalism that emphasizes on the links between a business and its customers, suppliers, employees, investors, communities, and other stakeholders that have a stake in the firm is stakeholder theory, which was defined by Laplume et al. (2008). Several years after publishing the first comprehensive account of the Stakeholder Theory of organizational management and corporate ethics in 1984, R. Edward Freeman issued a second comprehensive definition in 1989, which deals with morality and values in the context of managing a firm (Key, 1999).

According to the experts, the theory emerged as an important element in the study of business ethics, and there has been a significant increase in the popularity of the theory since the 1980s, with experts throughout the world continuing to question whether focusing on shareholders' profit as the most basic purpose of business is sustainable—particularly during the pandemic (Mahmud et al., 2021). Stakeholder theory was proposed as a holistic approach to corporate management that acknowledged stakeholder duties and the firm's fiduciary duty to them. Despite its strong roots in organizational management, stakeholder scholars criticize the theory's lack of attention in strategic management research (Freeman et al., 2010). The importance of stakeholders in the decision-making process of organizations are being more recognized. Directors believe that in order to produce value in a sustainable and ethical manner, it is vital to strike a balance between the interests of different stakeholders. A good example of this tendency may be seen in the management literature, where significant progress has been achieved in the field known as stakeholder theory. There was a tight link and exchange of ideas between stakeholder theorists and operational researchers throughout the early years of stakeholder theory's development (Gooyert, 2017).

2.1.3 Distributed Cognition Theory (DCT)

Edwin Hutchins, a cognitive psychologist and anthropologist, studied on how navigation is coordinated onboard US military ships in the San Diego area (Perry, 2003), and he is credited with being the original originator of the navigation coordination hypothesis. The notion of distributed cognition was introduced by Nardi (1996), who argues that a person's personal and physical circumstances have a vital part in determining their degree of knowledge.

According to the findings of a research done by Schwartz (2008), knowledge is disseminated from mind to mind, from mind to tool, and from tool to mind. Using a comparable theoretical framework and ontological premise for characterizing human action, distributed cognition expands the classic idea of cognition. Using the same computational base to analyze human behavior as cognitive psychology, the most developed framework of distributed cognition utilizes the same ideas of information representations and representational transformations that are used in cognitive psychology (Kirsh, 2006).

The use of distributed cognition in the analysis of systems allows for the incorporation of all of the relevant characteristics of the environment that contribute to the performance of tasks. In order to complete a task, researchers must analyze all of the aspects that are pertinent to the task, bringing together the people, the issue, and the instruments that were employed into a unified unit of analysis. As a result, it is an excellent tool for uncovering the artifactual, social, and cultural components of work that are present (Hoolan et al., 2000).

2.2 Network Structure

Network structures are organizational structures that are less hierarchical, more decentralized, and more adaptive than other forms of organizations. They are often referred to as "flat organizations" (Nagurney et al., 2002). According to Nagurney et al. (2002), supply chain networks are made up of producers and retailers, and the needs connected with retail outlets are unpredictably distributed across the network. Researchers in this work developed a model of the optimal behavior of a diverse set of decision makers and used it to determine the equilibrium conditions, as well as to develop a finite-dimensional variational inequality formulation. Further to this, supply chain network is comprised of the activities of procurement, manufacturing, distribution, and retailing, all of which contribute to the creation of value for customers in the form of products and services (Li et al., 2009). In this study, despite the fact that the dynamics of various surroundings are different, a supply network collaborates the same stable structure in all environments. Supply network structure stability and fitness are improved when the businesses in the SN pursue long-term cooperation strategies rather than short-term collaboration strategies, as opposed to when they pursue short-term collaboration strategies.

Wei et al. (2013) and Ouyang & Daganzo (2006) argue that these uncertainties, which arise as a consequence of order and inventory fluctuations, may result in unexpected dynamic behaviors such as instability, the bullwhip effect, and even pandemonia. The studies further elaborated that these findings held true regardless of the level of client demand. A stream of orders placed at any point of the chain where the customer demand process is well-known and an accurate formula for the variance of orders issued is provided. The authors also demonstrate that by including pledges for future orders into the ordering rules, the bullwhip effect may be minimized to some extent (Wei et al., 2013; Ouyang & Daganzo, 2006; Wang et al., 2009). Therefore, Lemke et al. (2020) proposed that it is important to build strong relationships throughout the supply chain network in order to better serve the end customer, regardless of whether one is a manufacturer, distributor, or retailer. This has a flow-on effect to the end consumer, which was one of the primary strategies for businesses to survive during the pandemic.

2.3 Supply Chain Resilience

Supply chain resilience is referred to as the ability of a supply chain to withstand and recover from disruptions in the supply chain. This includes the ability to mitigate, if not completely eliminate, the ramifications of a supply chain interruption — as well as the ability to recover rapidly in the event of such a disruption occurring (Tukamuhabwa et al., 2015).

Due to the pandemic, the effectiveness of more than two decades of research, debate, and preparedness on supply chain resilience was put to the ultimate test. Spieske & Birkel (2021) and Ivanov & Das (2020) state that small and medium-sized enterprises' business continuity plans, which were once considered to be foolproof, have shown to be catastrophically insufficient. Recognizing that a global pandemic is an extreme example of an HILP event (high impact low probability event), which is obviously beyond the reach of many organizations' risk radars and resilience planning procedures, is a crucial defense (Spieske & Birkel, 2021; Ivanov & Das, 2020). Spieske & Birkel (2021) discovered a technique used to analyze the automotive industry's resilience prospects in the event of a large supply chain interruption. The research concluded that big data analytics might help improve supply chain resilience. Using pre-disruption resilience approaches for more effective proactive risk management was also reported by the authors.. According to Siagian et al. (2021), the recent COVID-19 disruptions, resulted in an eight-fold increase in average container shipping charges, worldwide transit times that have increased by 25 percent or more, and severe product shortages at every level of the value chain, were predicted by a few researchers but were not fully realized. Collective capabilities were developed, according to a study conducted by Malindretos and Binioris (2000), by utilizing an operational research and development framework for boosting cooperation. In this study, the authors developed an integrated methodological framework for mixed participative interactive activity in a collaborative environment. The result of this study contributed to a better perspective of resilience in order to deal with the rising trend of susceptibility and minimize risks associated with globalization of markets, which is a cornerstone of a company's long-term viability and sustainability.

2.4 Organizational Culture

The elements of organizational culture establish the standard of behaviour for employees. Consequently, leaders build common viewpoints and values, which are subsequently conveyed and reinforced in many ways, influencing employee perceptions, actions, and comprehension (Shahzad et al., 2012). To comprehend the culture of an organization, one must comprehend its signs and symbols, prevalent practices, and implicit assumptions. For instance, an economic crisis might prompt an organization to revise its culture so that it better reflects the changing environmental conditions. However, it is conceivable for macro-level cultural transformations to cause an organization's culture to diverge from that of society as a whole (Spicer, 2020). Muriithi (2021) revealed that reputed firms put a high value on cultures as a source of competitive advantage and the foundation for employees' attitudes toward innovation, leadership, and management as well as overall performance. Culture offers companies a feeling of identity and personality, and it is considered as a significant commodity that rivals cannot duplicate. Culture is the core framework that governs an organization's activities, procedures, and management practices. Following the COVID-19 epidemic, organizations emphasized some cultural features while eliminating others. In reaction to the epidemic, organizations deemphasized customer focus, individuality, detail orientation, results orientation, and cooperation, researchers determined. It was found that all

business cultures in the pandemic age placed empathy, understanding, and mutual support over high performance which constituted a larger segment from organizational culture (Pinzaru et al., 2020; He & Harris, 2020).

2.5 Distributed Leadership

Distributed Leadership, as Bush (2013) refers to is the practice of using the leadership knowledge present at all levels of a school in order to expand the number of possibilities for change and to develop the institution's ability to make enhancements. The focus is placed not on the individual and autonomous activities connected with persons who have official leadership duties or responsibilities, but rather on the interdependent interactions and practices that take place. In many respects, the notion of dispersed leadership and the concept of shared management are interchangeable phrases. As a result of this approach, decision-making shifts from a single person to a group of people working together on a single project (Spillane, 2005).

Research on how dispersed leadership affected performance during the pandemic is still ongoing. However, several studies have shown that the COVID 19 outbreak had an influence on both administration and education in the educational sector. During the epidemic, it was discovered that close coordination between administrators and teachers is crucial to the growth of students. Charernnit et al. (2021) conducted a study in which the descriptive correlational design was adopted in this investigation in which a survey of selected schools in Southeast Asian countries was conducted online. According to the findings of the study, exceptionally beneficial effects are observed at the levels of principal shared leadership practices, teacher soft skills upgrading, and student competitiveness. The sharing of leadership abilities in communication, coordination, direction, and influence e the elements that the school leaders were capable of. Principals' shared leadership was shown to be associated with elements impacting teachers' soft skills and students' competitiveness, demonstrating the importance of dispersed leadership in the classroom (Charernnit et al., 2021). Primarily, examples of distributed leadership have been researched in the field of education so far. Due to the scarcity of research in the business sector, this section offers a gap that needs to be investigated further.

2.6 Digitalization & ICT

"Digitalization" is the process of integrating digital technologies into manufacturing operations. Digitalization is the increased use of information and communications technology (ICT) in both business and society (Wen et al., 2021). Using a large sample of Chinese manufacturing organizations, the authors discovered that their research added to the existing body of work on the relationship between industrial digitalization and company environmental performance. The data show that industrial digital transformation has considerably improved manufacturing enterprises' environmental performance. It is also a major contribution to the positive environmental effects of the spread of information and communications technology (ICT). Industrial digitalization reduces the production scale of polluters and improves product innovation and green total factor productivity, but its influence on total factor productivity is insignificant.

Business and economic strategies that are fresh, according to Harianto and Sari (2021), are required. Most respondents perceived technology as a strategic tool rather than a cost-cutting tool, resulting in more sustainable businesses. The authors of this research underlined the potential of UMKM to withstand the COVID-19 pandemic by formulating and implementing a strategy for

corporate digitalization. The gathered survey data from the Katadata Insight Center (KIC) in the Jabotabek area in June 2020. This study found that conventional UMKM business operations (Offline System) resulted in a 30% decrease in sales turnover. As a result of this, just 3.8 percent of UMKM (Online System) firms, such as smart phones (PCs or laptops) linked to the internet, saw a rise in sales. This is in contrast to Offline System) business operations that are analogized. Lastly, it was found that by lowering waste generation and relying on renewable energy sources, digitalization and information and communications technology (ICT) contributed in the manufacture of clean materials for environmentally friendly manufacturing (Fatimah et al., 2020; Bila, 2021).

New business and economic strategies and procedures are necessary to adapt to the changing business and economic environment. The majority of respondents believe that technology is a critical component of their organization, rather than just a source of cost savings (Harianto & Sari, 2021). A range of technical abilities are mentioned by companies that have effectively reacted to crises, including resolving personnel shortages, using new technology, and acting quickly in testing and designing solutions (Lee et al., 2021; Khai et al., 2020).

2.7 Financial Contingency & Planning

The Covid-19 epidemic caused a financial disruption in supply chains, which destabilized the economy, particularly new companies, and had a severe impact on the world economy. Covid-19 epidemic caused a financial disruption within supply chains, which destabilized the economy, particularly small and medium-sized enterprises (SMEs) (Obrenovic et al., 2020). This study found a response to the 2008 financial crisis, supply chain finance (SCF) has the potential to aid in the management of the new problem; however, new paradigms are required for SCF to be an effective mitigation approach- a similar action was taken to deal with the COVID-19 pandemic crisis as well as the financial contingency planning for the new problem- (Moretto & Caniato, 2021). The COVID-19 crisis verified the performance measurements and emphasized the essence of SCF as a tool for promoting sustainability.. Empirical studies proved the value of SCF solutions in maximizing economic and financial performance, not only for firms but also supply chains, particularly for SMEs (SMEs). This was about a company's financial performance. COVID-19 triggered an economic and financial crisis, highlighting the necessity to safeguard supply chain competences and protect supplier jobs, which may be local or worldwide. For example, Gucci, PUMA, and OTB all used SCF solutions in the preceding decade.

To manage contingency events such as the COVID-19 pandemic while also focusing on performance of the organization, such as technology (IT) and other linked competencies, supply chain partners and integration of supply chain systems that contribute to cooperation are crucial (Oh et al., 2020). Because of the uncertainties surrounding the crises, businesses were confused whether to establish emergency response, business continuity, or crisis management plans. In the event of a pandemic, previous solutions were either non-actionable or non-consumable, unable to account for the emotional and human consequences of the outbreak (Ajmal et al., 2021).

2.8 Sustainable Production

Sustainability in production and consumption is the development and use of products and services in a manner that is socially beneficial, commercially viable and environmentally benign over the duration of the product's life cycle, according to one definition (Alayon et al., 2017). In this study,

Alayon et al. (2017) found that the majority of sustainable manufacturing practices continue to place a significant emphasis on the environmental aspect of sustainability, with the greatest number of practices stemming from principles relating to the conservation of energy and materials as well as waste management. It was determined that Swedish environmental and social rules were the driving force behind sustainable manufacturing practices. According to the authors, quality and environmental management systems were recognized as significant instruments for putting sustainable production concepts into effect.

Researchers found that the outbreak of the coronavirus had a significant impact on the global industrial and supply networks (COVID-19). The majority of industrial managers and politicians sought efficient solutions to improve production patterns while still meeting client demand for their products. The vast majority of raw materials are imported from China and other Asian growing markets, including India. Several supply chain and distribution linkages between suppliers, manufacturing facilities, and customers have been affected as a result of the COVID-19 outbreak (Kumar et al., 2020; Bai et al., 2020). It is thus necessary to evaluate sustainable production and consumption habits in the aftermath of COVID-19. As almost all major economies across the world have been placed under lockdown, the focus has shifted to the increased need for essential commodities and services. As a consequence, demand for a variety of non-essential products and services has decreased. In this paper, the difficulties of pandemic production and operations management are reviewed, and policy strategies for system resilience and long-term viability are suggested (Sarkis et al., 2020).

3. Research Framework and Hypotheses Development

Network Structure & Production Sustainability

Global manufacturing firms have been compelled to postpone production systems, according to Gupta et al. (2020), as they hunt for long-term solutions to guarantee smooth delivery and cooperation from both the company and consumer viewpoints. The referendum addresses issues such as supply and demand, as well as worries about COVID-19 production and consumption. With the rapid rise of information technology, supply chain networks are being transformed, creating interdependence between firms. The traditional method of assessing production capacity is based on centralized processes that involve little data sharing. Furthermore, traditional techniques depend on subjective manual labor with insufficient data (Sarkhosh-sara et al., 2020).

In this study, The IoT, machine learning, and blockchain technologies were all incorporated in the supply chain network evaluation system developed by the researchers. It assisted in the collection of real-time data and the automation of the evaluation of company production capabilities. Aside from that, blockchain technology is being utilized to enable for transparent data storage and transaction between parties. The proposed system is evaluated using a simulation exercise. It demonstrated how to choose upstream companies using the strategy that was posited. As a result, production efficiency was improved, risks reduced, and a more sustainable production management system was implemented in supply chain networks (Li et al., 2020). Regardless of whether one is a manufacturer, distributor, or retailer, Lemke et al. (2020) argued that it is vital to create strong connections across the supply chain network in order to provide a higher level of service to the end consumer. This has a knock-on impact for the customer in the end, which was one of the principal techniques that companies used to maintain their viability during the epidemic.

Therefore,

H1: Network structure affected the production sustainability positively during the pandemic

Supply Chain Resilience & Sustainable production

This resilience is achieved by the inclusion of some redundancy and maybe variety in these regional value chains (RVCs) in order to withstand shocks. The focus of sustainable resilience is on increasing the resilience of (global) value chains in the most environmentally friendly way possible (Grumillar et al., 2020; Kumar et al., 2020). In order to achieve sustainable manufacturing, it is necessary to strengthen supply chain resilience, redundancy, and stockpiling while also driving better levels of resource and energy efficiency across the supply chain (Tarigan et al., 2022). In a study by Spieske and Birkel (2021), the authors discovered a methodology that was developed and used for the automobile sector, which was impacted by COVID-19, in order to assess the industry's resilience prospects in the event of a significant supply chain disruption. This methodology was used for the purpose of the automobile sector, affected by the pandemic. According to the conclusions of the research as a whole, big data analytics assisted in strengthening the resilience of supply chains. In addition, the authors discovered that visibility and velocity are the two antecedents of resilience that had the most significant influence on resilience. In addition to this, another study posited that productivity improvements helped to strengthen supply chain resilience, which has in turn reduced risk (Hayat et al., 2021). Hence, the following hypotheses can be validated,

H2: Supply chain resilience affected the production sustainability positively during the pandemic

Organizational Culture & Sustainable production

The Covid-19 pandemic has had a significant impact on workplace culture. The global curfew and travel restrictions have altered people's perspectives of their jobs and professional relationships. People have discovered that they may work from home and avoid the rigors of the office environment. They are not required to commute. Others have decreased the amount of time they spend traveling for work (Isensee et al., 2020).

In a practical study conducted by Andini & Wicaksono (2021), the authors explained that the management of small and medium-sized enterprises in Semarang is dependent upon organizational culture. The organizational culture of SMEs consists of an ethical organization. In this study, the authors address the topic of the influence of organizational culture in the management of small and medium-sized enterprises (SMEs) in Semarang during the pandemic wherein they employed qualitative methods by conducting in-depth interviews with the owners of small and medium-sized enterprises (SMEs) in Semarang. SMEs implemented a new organizational culture in their company management by converting from offline to online sales, implementing a healthy procedure for offline sales, and employing delivery services or money transfers to avoid meeting directly with clients during the epidemic. This way, the organizational culture supported the sustainable production of the company thereby surviving through the pandemic times. In another study, authors argued that while preparing for a pandemic and planning for recovery in terms of sustainable production, organizational leaders must select which cultural changes to preserve and which to reverse as they adjust to the situation (Hadi & Baskaran, 2021).

Individuals that work within an organization's culture are defined by the collective standards of behaviour that they adhere to. Slowly but steadily, the workplace culture shifts. It adjusts gradually over time, amassing little encouragements and the occasional flash of understanding (He & Harris, 2020). As such, the third hypothesis is validated by,

H3: Organizational Culture had a positive impact on the production sustainability during the pandemic

Distributed Leadership & Sustainable Production

Distributed leadership is best defined as participatory leadership when it comes to distributed leadership. Those who have the skills and abilities to move the institution ahead embrace and share the responsibility and accountability that comes with being a leader. This is accomplished by a group of accountable leaders, rather than by a single positional leader. As a result, the influence of dispersed leadership on the work process on sustainable production is clear, as it provides for a more fluid flow of information (Wingrove et al., 2015). In research conducted by Algan & Ummanel (2019), in the education sector, the study looked at dispersed leadership and long-term school development strategies. The findings of the research revealed relationships between dispersed leadership and the school environment, teacher professional development, instructional program management, and good teaching and learning outcomes for students (Algan & Ummanel, 2019). Dambrauskien et al. (2019) discovered that distributed leadership has a positive influence on schools by increasing the efficiency, purpose, and success of their work. Another similar study was conducted by Keshky et al. (2020) with three schools that maintained sustainability during the pandemic in which the “psychological” sustainability was greatly affected and the solution proposed was to enforce distributed leadership by the HR organization to ensure that the organizations survive through the pandemic. Based on the literature search, there are relatively fewer studies that have been conducted so far on distributed leadership and its impact on sustainable production. This offers a gap for researchers to involve with further research.

H4: Distributed Leadership had a positive impact on the production sustainability during the pandemic

Digitalization-ICT & Sustainable Production

"Digitalization" refers to the process of incorporating digital technology into a wide range of industrial processes and procedures. Digitalization refers to the rising use of information and communications technology (ICT) in business and society (Wen et al., 2021). By using a large sample of Chinese production organizations, the authors discovered that their research added to the existing body of work on the relationship between industrial digitalization and company environmental performance. The data showed that industrial digital transformation has considerably improved manufacturing enterprises' environmental performance. It is also a major contribution to the positive environmental effects of the spread of information and communications technology (ICT). Industrial digitalization reduces the production scale of polluters and improveed product innovation and green total factor productivity, but its influence on total factor productivity is insignificant.

New business and economic strategies are essential, as per Harianto and Sari (2021). Most respondents perceived technology as a strategic tool rather than a cost-cutting tool, resulting in

more sustainable businesses. The authors of this research underlined the potential of UMKM to withstand the COVID-19 pandemic by formulating and implementing a strategy for corporate digitalization. The UMKM gathered survey data from the Katadata Insight Center (KIC) in the Jabotabek area in June 2020. This study found that conventional UMKM business operations (Offline System) resulted in a 30% decrease in sales turnover. As a result of this, just 3.8 percent of UMKM (Online System) firms, such as smart phones (PCs or laptops) linked to the internet, saw a rise in sales. This is in contrast to UMKM (Offline System) business operations that are analogized. Finally, digitization and ICT helped to the production of clean materials for environmentally friendly manufacturing by reducing waste output and using renewable energy sources (Fatimah et al., 2020; Bila, 2021). Therefore, this validates the fifth hypothesis,

H5: Digitalization-ICT & sustainable production have a positive impact on the production sustainability during the pandemic

Financial contingency & sustainable production

According to Obrenovic et al., 2020, the Covid-19 epidemic caused a financial disruption within supply chains, undermining the economy, particularly small and medium-sized firms (SMEs), and having a substantial effect on the global economy (Obrenovic et al., 2020). Supply chain finance (SCF), a response to the 2008 financial crisis, has the potential to aid in the management of the new problem; however, new paradigms are required for SCF to be an effective mitigation approach - a similar action was taken to deal with the COVID-19 pandemic crisis and the financial contingency planning for the new problem- (Moretto & Caniato, 2021). In this research, the COVID-19 crisis confirmed the performance indicators and emphasized the importance of SCF as a strategy for promoting sustainability via the viewpoint of the Triple Bottom Line. Empirical data shown that SCF solutions may optimize economic and financial performance not only at the company level, but also at the supply chain level, particularly for small and medium-sized businesses (SMEs). This was a reference to a company's economic performance.

According to Imbrogiano (2021), in terms of sustainability, COVID-19 precipitated an economic and financial crisis that drew attention to the necessity to protect skills throughout the supply chain and safeguard employment in the supplier community, which may refer to either local or global employment. Sustainability service is being established to address the needs of unsustainable businesses due to the crisis of the pandemic. Leading companies' financial planning and risk management enabled them to remain stable and battle the pandemic's aftermath, resulting in sustainable operations (Imbrogiano, 2021). Hence, this proves the following hypothesis:

H6: Financial contingency & sustainable production had a positive impact on the production sustainability during the pandemic

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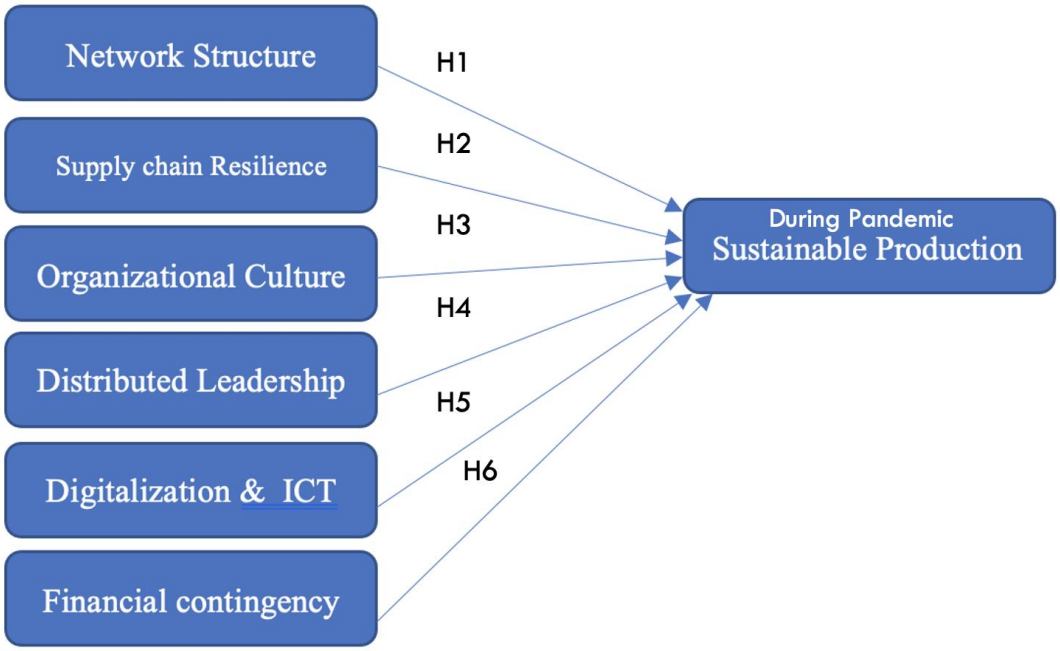

Figure 1: Conceptual Model for the proposed hypotheses

6. Methodology

The philosophy of positivism was used for this study as it focused on current real-world issues (Shields & Whetsell, 2013). In this philosophy, the issues on-hand are dealt with and in most cases, deductive approach is used for the purpose of the study. This study employed deductive approach to evaluate the changes in the physical attributes of the variables (Azungah, 2018). The research strategy was based on a deductive approach, with questionnaires employed to get a better understanding of the effect of variables on sustainable production during the pandemic (Alharbi et al., 2021).

In terms of method, mono-method was implemented as the study primarily focused on quantitative data collection. For the purpose of this research, the data was primarily collected to compile reliable and accurate information from the sources provided by the participants. Primary research data is the first-hand information that the researchers use for their study (Paradis et al., 2016). This research used the analytical approach, with the goals of studying the impact of variables on production sustainability during the pandemic.

The following items are included as sources for the investigation:

• Primary sources include survey questions for the managers, department heads of the pharmaceutical companies based in the Industrial area of Jeddah, Saudi Arabia

• Secondary sources, which might include books and articles from scholarly publications in order to broaden the scope of the study.

Google form was used to make the questionnaire and the link was forwarded to the head of the departments, managers and upper-level management for participation. Google Form was used in the development of the questionnaire. The questionnaire was kept anonymous with no personal details of the participant. The link could only be opened and filled once. In case, the participant missed that opportunity, a new link would be sent to them to ensure that they have the access to the questionnaire. The questions were first drafted in English

The data collection was implemented by using the questionnaire which was delivered through a web link so that responders could easily share their replies. It consisted of 23 questions related to all the variables such as network structure, supply chain resilience, organizational culture, distributive leadership, digitalization-ICT, financial contingency and sustainable production. The Google survey was used once per person. Five-point Likert Scale was used for this survey (Appendix: Table 1: Survey).

With respect to sample characteristics and design, the research sample was composed of managers, supervisors, department heads and upper-level management team of the companies based in the Industrial Area of Jeddah, Saudi Arabia. This sample was chosen for the study as these leaders played a vital role in the key management issues during the COVID-19 pandemic. They were also the decision-makers who played a vital role in the supply chain management during the period of crisis. The sample was selected from the Industrial Area of Jeddah due to the ease in accessibility.

Expert Non-probability sampling technique was used in this study with approximately 260 responses recorded.

The data was examined using the structural and measurement models. The AMOS 26 software was used to assess the model's fit indices and construct validity (testing hypotheses) that also assessed the model's dependability, contrasting value, and construct validity. Using the SPSS application, the mean, standard deviation and factor loading.The study utilized SPSS IBM Statistics v (22) and AMOS 20 to conduct an analysis of the data and provide a response to the hypothesis. After that, exploratory factor analysis was carried out in order to determine the size of each component, and then confirmatory factor analysis was carried out in order to determine whether or not the data matched the model. In the final step of this investigation, the researcher examines how the independent variables of Network Structure NC, Supply Chain Resilience SCR, Organizational Culture OC, Distributed Leadership DL, Digitalization and ICT DT, and Financial Contingency FC interact with the dependent variable of Sustainable Production PR.

7. Results

The purpose of this study was to provide managers and organizations with the best ways to keep the product sustainable using SSCM practices during difficult times such as COVID 19 period.

In this part of the study, the researcher uses SPSS IBM Statistics v (22) and AMOS 20 to analyze the data and answer the hypothesis. First, descriptive statistics of the demographic profile. Exploratory factor analysis was then performed to establish the size of each factor, followed by confirmatory factor analysis to see if the data fit the model. Finally, the researcher tests the effect Network Structure NC, Supply Chain Resilience SCR, Organizational Culture OC, Distributed Leadership DL, Digitalization and ICT DT, Financial Contingency FC as independent variables on Sustainable Production PR as dependent variable.

7.1 Descriptive statistics

Demographic profile

260 sample respondents were used in this study, most of whom were male 52.3%, additionally the main age category 37-48 years 30%, most respondents hold a master's degree 36.5%, 35% have an experience of 2-4 years. Table 1 shows the results.

Table 1: Descriptive statistics of demographic profile

	Number	Percentage
Gender		
Male	136	52.3%
Female	124	47.7%
Total	260	100%
Age		
18-24 years	57	21.9%
25-36 years	64	24.6%
37-48 years	78	30.0%
49+ years	61	23.5%
Total	260	100%
Educational Level		
High school Diploma	3	1.2%
Bachelor's degree	17	6.5%
Master's degree	94	36.2%
Vocational qualification	145	55.8%
PhD	1	0.4
Total	260	100%
Experience		
0-2 years	16	6.2%
2-4 years	91	35.0%
5-10 years	76	29.2%
More than 10 years	77	29.6%
Total	260	100%

7.2 Exploratory Factor Analysis EFA

The supply chain sustainability model and the sustainability of production in the time of COVID were analyzed by EFA. To condense the initial number of articles into a smaller collection of new variables, an exploratory factor analysis (EFA) was performed. The minimum value for a successful factor load study is 0.3 (Tabachnick and Fidell, 1996). However, for a sample size between 150 and 200, a load factor of less than 0.45 is suppressed. With the varimax rotation method for factor analysis, the principal component extraction method was used and all eigenvalues greater than one were considered in this case. Barlett's measure tests the null hypothesis that an identity matrix is the initial correlation matrix. Kaiser Meyer Olkin Sampling Test (KMO) Fit calculation ranges from 0 to 1 and values closer to 1 are better. The factorizable

existence of the data is recognized when it is between 0.7and 1 (Igalens and Roussel, 1998; Evrard et al., 2003).

The KMO result of this data 0.883 is above the cutoff point 0.7, implying that we have an sufficient sample size. Barlett's p-value 0.000 and < 0.05 specifies that the correlation matrix is not an identity matrix.

Additionally, the percentage of variance extracted (Table 2) for each construct with a cumulative explained variance of 89.915% was reported.

7.3 Confirmatory Factor Analysis CFA

Confirmatory factor analysis (CFA) tries to decide whether, on the basis of a pre-established theory, the number of factors and the loading of the calculated variables (indicator) on them conform to what is expected. Based on the above theory, indicator variables are selected, and factor analysis is used to see if they load on the expected number of factors as expected. Convergent and discriminant were assessed using CFA via AMOS (20). In the dataset, the latent variables NC Network Structure, Supply Chain Resilience SCR, Organizational Culture OC, Distributed Leadership DL, Digitalization and ICT DT, Financial Contingency FC, and Sustainable Production PR. According to Hult, Ringle and Sarstedt (2014), the thresholds are 0.7, all CRs were between 0.928 and 0.865, which are greater than 0.7. Each mean variance extracted (AVE) dimension is between 0.681 and 0.866 greater than 0.5 and all CR > AVE (Hair et al., 2013). Therefore, the different aspects of this study have convergent validity. Table 3 shows all AVEs, and the square root of each construct's AVE is greater than the construct's highest correlation with any other construct in this study. Estimates suggest that these constructs are valid and reliable (Hair Jr. et al., 2014).

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Table 2: Exploratory Factor Analysis

Construct		Items	Factor Loading
α			0.906
Network structure	NC1	I can acquire information conveniently from other peers in my department.	0.930
	NC2	I am in a dominant position of my department.	0.872
	NC3	There are many benefits for my relationship with my peers and we communicate frequently.	0.904
	NC4	My social network has many members and I keep in touch.	0.604
α			0.961
Supply chain Resilience	SCR1	Our company has the ability to adapt to the supply chain disruption easily through information sharing.	0.910
	SCR2	Our company has the ability to deploy adaptive capability and alternative plans.	0.898
	SCR3	Our company has an adaptive supply chain structure to cope with the changes brought by the supply chain disruption.	0.878
α			0.955
Organizational Culture	OC1	Members of management work together effectively as a team.	0.936
	OC2	A major focus of this organization is to work on team development.	0.932
	OC3	The management encourages employees to be innovative and creative.	0.924
α			0.920
Distributed Leadership	DL1	My manager always pushes the members for increased production.	0.873
	DL2	My manager tells me what to do if I want to be rewarded for my work.	0.873
α			0.933
Digitalization & ICT	DT1	We incorporate digital services into product	0.880
	DT2	We use digital automation with sensors for products and operating conditions identification as well as flexible line.	0.842
	DT3	We use remote monitoring and control of production through systems such as Manufacturing Execution and System and Supervisory control and Data acquisition.	0.864
α			0.886
Financial contingency	FC1	My self-esteem is influenced by how much money I make.	0.900
	FC2	I feel bad about myself when I feel like I don't make enough money.	0.890

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α			0.970
Sustainable Production	PR1	Investments in environmental innovation are recycled in time.	0.830
	PR2	The market share is increased by studies on environmental innovation.	0.813
	PR3	Sales have been increased by studies on environmental innovation.	0.820
	PR4	Use of materials converted from used products as input for production processes.	0.824
	PR5	Production of the products that can be used for other purposes with the same production technology.	0.837
	PR6	Preparation of various environmental scales/indicators in order to improve and follow environmental sensitivity of product and production processes.	0.827
KMO			0.883

Table 3: Convergent and Discriminant validity

Construct	CR	AVE	NC	SCR	OC	DL	DT	FC	PR
Network structure	0.902	0.702	**0.838**						
Supply chain Resilience	0.924	0.802	0.476	**0.895**					
Organizational Culture	0.951	0.866	0.303	0.263	**0.931**				
Distributed Leadership	0.865	0.762	0.310	0.333	0.326	**0.873**			
Digitalization & ICT	0.897	0.743	0.222	0.437	0.368	0.302	**0.862**		
Financial contingency	0.890	0.801	0.296	0.288	0.178	0.317	0.302	**0.895**	
Sustainable Production	0.928	0.681	0.527	0.530	0.398	0.559	0.532	0.434	**0.825**

To estimate the fit of the models, goodness-of-fit indices were used. The χ 2 -statistic (Chi-square statistic) and goodness-of-fit indices such as the Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Parsimony Goodness-of-Fit Index (PGFI), Normed Fit Index (NFI), Tucker and Lewis Index (TLI), Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA). Table 4 provides a description of the fit indices and their corresponding threshold values.

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The statistics fit the following: chi-squared = 198.863 at p-value = 0.206, degree of freedom = 162, normed chi-squared (CMIN/DF) = 1.228, goodness-of-fit index (GFI) = 0.938, adjusted goodness-of-fit index (AGFI) = 0.895, (NFI) = 0.973, comparative fit index (CFI) = 0.995 and Root Mean Square of Error of Approximate (RMSEA) = 0.030, Standard Root Mean Square Residual (SRMR) =0.0321. All of these indicate shows an adequate level of fit.

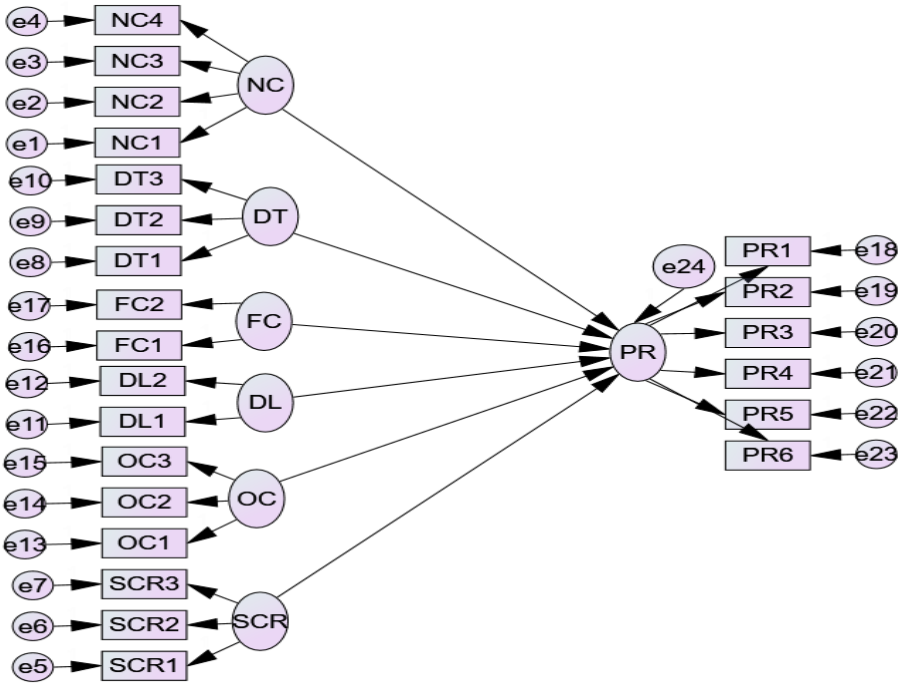

Figure 2

Table 4: Model Fit Indices

Fit indices	Estimates	Acceptable Level
Chi-square	198.863	
Degree of freedom (d.f)	162	
P	0.206	>0.05
Normed Chi-square (CMIN/DF)	1.228	<3.00
Goodness -of -Fit Index (GFI)	0.938	≥ 0.90
Adjusted Goodness of Fit Index (AGFI)	0.895	≥ 0.95
Norm Fit Index (NFI)	0.973	≥ 0.95
Comparative Fit Index (CFI)	0.995	≥ 0.95
Root Mean Square Error Approximate (RMSEA)	0.030	<0.08
Standardized Root Mean Square Residual (SRMR)	0.0321	<0.08

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7.4 Research Hypothesis

The researcher uses SPSS 22 and Amos (20) (Preacher *et al.*, 2007), bootstrapping 5000 to test the Supply Chain Sustainability Model affecting the production sustainability during the COVID times and the most effective practices identified in the Supply chain sustainability model that can assist with increased production sustainability outcomes during the times of crises. The results were displayed below:

H1: Network structure affected the production sustainability positively during the pandemic.

H2: Supply chain resilience affected the production sustainability positively during the pandemic.

H3: Organizational Culture affected the production sustainability positively during the pandemic.

H4: Distributed Leadership had a positive impact on the sustainable production during the pandemic.

H5: Digitalization and ICT had a positive impact on sustainable production during the pandemic.

H6: Financial contingency planning had a positive impact on sustainable production during the pandemic.

Table 5: Regression Weight Results

Regression weight results				Estimate	S.E.	C.R.	P
H1	PR	<---	NC	0.152	0.040	3.772	***
H2	PR	<---	SCR	0.177	0.041	4.350	***
H3	PR	<---	OC	0.055	0.044	1.238	.216
H4	PR	<---	DL	0.273	0.043	6.395	***
H5	PR	<---	DT	0.260	0.047	5.546	***
H6	PR	<---	FC	0.196	0.052	3.799	***

Table 5 displays the AMOS results for regression weight estimates, for first hypothesis the value of t-Value or C.R amounted to 3.772> 1.967, P value 0.000 <0.05 then H1is supported, so it can be assumed that Network Structure affects production sustainability. Results of second hypothesis test obtained t-Value or C.R 4.350 >1.967, P value 0.000> 0.05, then H2 is supported, so it can be assumed that Supply Chain Resilience affects production sustainability. The third hypothesis testing result obtained that t-Value or C.R 1.238> 1.967, P value 0.216 >0.05 then H3 is rejected, so it can be concluded that the Organizational Culture does not affect production sustainability. The fourth hypothesis in having t-Value or C.R 6.395> 1.967, P value 0.000 <0.05 then H4 supported, so it can be concluded that the Distributed Leadership effect on production sustainability. From Table 5 we get the result for the fifth hypothesis that is t-Value or C.R 5.546> 1.967 or P value 0.000<0.05 then H5 is supported, so it can be concluded that Digitalization and ICT affects production sustainability. Results of H6 test obtained t-Value or C.R 3.799 >1.967 or P value 0.000< 0.05 then H6 supported, so it can be concluded that Financial contingency planning affects production sustainability.

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8. Discussion

This research investigated the impact of the sustainability model on sustainable manufacturing during the COVID-19 pandemic. The purpose of the worldwide supply networks was to maximize revenues by minimizing labor costs and expenses. The COVID-19 epidemic, however, revealed the vulnerability of global supply systems. In the manufacturing sector, supply chain disruptions have had the greatest effect over the last two years, resulting in plant relocation.

Based on the study and data gathering, the initial hypothesis that network structure had a favorable effect on production sustainability during the pandemic was confirmed. This is also shown by the research investigations conducted by Gupta et al. (2020), which revealed a connection between manufacturing firms and sustainability. Another study posited that the second hypothesis, supply chain resilience has a favorable effect, was also confirmed to be true. According to a study by Malindretos & Binioris (n.d.), institutional efficiency is crucial in countering power concentration and utilizing interfirm and interdisciplinary Supply Chain Re-engineering to provide resilience and long-term sustainability (SCR). According to Isensee et al., (2020), the literature review in which the variables were examined and ten ties were discovered between organizational culture and sustainability, the third hypothesis demonstrated a favorable relationship between organizational culture and sustainable production. However, recent studies and statistics have shown that organizational culture has little effect on sustainability. Referring to recent research by Fietz and Gunther (2021), organizational culture has no effect on sustainability since both are "context-dependent" and the outcomes change according on the workers' or managers' attitudes.

The fourth hypothesis was confirmed when it was determined that distributed leadership has an effect on production sustainability, which validates the research done by Algan and Ummanel (2019) that focused mostly on the education sector. Despite the fact that the results revealed a link between distributed leadership and sustainability in the business sector, further study is required since very few publications were found throughout the research. During the pandemic, when new business and economic strategies are necessary, the fifth hypothesis was verified by the study results, which further confirmed by the investigations done by Harianto and Sari (2021). The majority of respondents in this survey saw technology as a strategic component of the organization, as opposed to just a cost-saving tool, resulting in more sustainable businesses. The last hypothesis concentrated on financial contingency, which also presents a new door for future study owing to the paucity of cogent studies resulting from the epidemic. Even though some supporting literature was discovered, there is a significant knowledge gap in the industrial industry that must be addressed (Obrenovic et al., 2020).

8.1 Theoretical and Practical Implications

The development of sustainable firms is a broad and comprehensive topic, not least because enterprises come in a variety of forms, not only in terms of size, sector, and physical dimensions, but also in terms of management, governance, legal status, and operational aims. All businesses are a part of society; they both influence and are influenced by the groups in which they operate. During the pandemic, businesses that were able to sustain served as exemplars for the new or struggling ones.

Nevertheless, it is not too late to acknowledge and adapt the practices of the sustainability model to mitigate the risks and drawbacks incurred by organizations thus far due to the pandemic. A

model sustainability management plan can be presented as a resource for corporate executives who are interested in ensuring the long-term business run. To be more precise, the study offers actionable instructions on how sustainability should be formed and cultivated.

Promoting sustainable businesses involves strengthening the institutions and governance systems that foster enterprises – strong and efficient markets require strong and effective institutions – and ensuring that human, financial, and natural resources are combined equitably and efficiently to foster innovation and increased productivity. This can be done through the sustainability model by adhering to the variables such as network, leadership, digitization, resilience and financial back-up. This, further, necessitates new kinds of collaboration between government, industry, and society to maximize the quality of current and future life (and jobs) while preserving the planet's sustainability. The sustainability model encourages innovation, critical thinking, corporate social responsibility and financial acumen (Fioravante, 2021).

8.2 Limitations and Further Research

As for limitations, this research was restricted to the higher-level managers, department heads, CEO and COO as they are the prime decision-makers for making the key decisions in an organization. The results of this study cannot be generalized for all the employees. Further to this, the geographical scale was also limited to the companies that were in the Industrial city of Jeddah and not Kingdom wide. Hence, the results of this study may not be fully applicable to all the industries or companies located outside the location as the workforce and services vary.

This study presents two new directions for future research: distributed leadership on production sustainability and the impact of sustainability model on operations management. These directions may provide new insights into crisis management in the field of supply chain management in relation to the pandemic and the manufacturing industry. Specifically, the study examines the influence of the sustainability model and distributed leadership on production sustainability.

9. Conclusion

The research investigated the effect of the Sustainability Supply chain Model on sustainable production during the pandemic. The results showed that sustainable enterprises with a networked structure and strong virtuality outperform hierarchical organizations in terms of profitability. They regularly stress test their organization to find any flaws to ensure that the organization is ready for any disruptions. Through this study, it can be seen that distributed leadership enables decentralized decision-making by allowing decisions to be made independently. There is a flow of communication between the major company units to enhance information flow and knowledge management. Businesses with decentralized leadership and personnel structures are more likely to survive COVID-19 and any following viral outbreaks. Successful firms utilize ICT to develop trust and connections with workers, stakeholders, and consumers. These groups may employ technology to collect, analyze, and distribute data, as well as coordinate relief activities. Businesses were able to withstand the epidemic due to advances in digitization and internet technologies. Finally, finding a balance between resource hoarding and resilience is critical. Businesses cannot function well without enough levels of equipment, cognitive capital, and human capital. Having a strategy in place to analyze an organization's potential to stay financially stable or find alternative sources of money is critical to surviving a pandemic and promptly returning to business.

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Appendix A: Measurement Scales

Rate on a scale of 1-5 (1 being the lowest and 5 being the highest)

Constructs	Questions/Measure items	Source of scales
Network Structure	a. I can acquire information conveniently from other peers in my department b. I am in a dominant position of my department c. There are many benefits for my relationship with my peers and we communicate frequently d. My social network has many members and I keep in touch	Li & Zheng (2015)
Supply Chain Resilience	a. Our company has the ability to adapt to the supply chain disruption easily through information sharing b. Our company has the ability to deploy adaptive capability and alternative plans c. Our company has an adaptive supply chain structure to cope with the changes brought by the supply chain disruption	Scholz (2021).
Digitalization	a. We incorporate digital services into products b. We use digital automation with sensors for products and operating conditions identification as well as flexible line c. We use remote monitoring and control of production through systems such as Manufacturing Execution and System and Supervisory control and Data acquisition	Scholz (2021)
Distributed Leadership	a. My manager always pushes the members for increased production b. My manager tells me what to do if I want to be rewarded for my work	Lee, (2011).
Organizational Culture	a. Members of management work together effectively as a team. b. A major focus of this organization is to work on team development c. The management encourages employees to be innovative and creative	Usman (2019).
Financial Contingency	a. My self-esteem is influenced by how much money I make. b. I feel bad about myself when I feel like I don't make enough money.	Park et al. (2017)
Sustainable Production	a. Investments in environmental innovation are recycled in time. b. The market share is increased by studies on environmental innovation c. Sales have been increased by studies on environmental innovation d. Use of materials converted from used products as input for production processes e. Production of the products that can be used for other purposes with the same production technology f. Preparation of various environmental scales/indicators in order to improve and follow environmental sensitivity of product and production processes.	Gedik & Cil (2018)