

Structuring Supply Chain Sustainability in the Selected Tertiary Institutions in Kenya amidst COVID 19 Disruptions

Everline Chebet¹ & Charles K. Chogo²

¹Technical University of Mombasa & Koitaleel Samoei University College, Kapsabet

²Technical University of Mombasa, Kenya

Abstract

The COVID-19 pandemic has brought unmeasured disruptions and challenges to the supply chain both in public and private Institutions not only in Kenya, but Globally. Public institutions are characterized by regulations which tend to be more procedural than sustainable. Supply chain sustainability in public institutions and tertiary ones in specific, are vital for a long-term growth of education in the country since the government has invested heavily in ensuring an equitable education in Kenya. This research paper theorized the structure of a sustainable supply chain in TVET Institutions in Kenya amidst the disruptions caused by COVID 19 pandemic. The structural illustrations for supply chain sustainability in this study were supply chain agility and supply chain virtualization while policy formulation was used as the moderating variable on supply chain sustainability in the selected tertiary institutions in Kenya. The study adopted the efficient supply chain analytical structures such as the Pareto Analysis and Total Interpretive Structural Model for theoretical underpinnings. The respondents of this study were procurement managers and data were collected virtually through google forms structured in the Five Likert Scale format. The study findings revealed that supply chain agility was lacking in the selected Tertiary institutions; Supply chain virtualization were uncommon, while there was no policy on supply chain agility and policy on supply chain sustainability among the selected tertiary institutions in Kenya. The study recommended a structural policy formulation for agile supply chain and virtualization of supply activities in the tertiary institutions in Kenya

Key words: *Supply chain sustainability, digitalization, policy formulation, TISM*

Introduction

The Global supply chain has been drastically disrupted by the current COVID19 epidemic (Ivanov & Dolgui, 2020). There is a Global permanent disruption of the supply chain and stakeholders have to come up with strategies on how to minimize the effect (Remko, 2020). A report by International Monetary Fund (IMF) estimates that the advanced economy would fall by nearly 6% at the end of 2021, while the emerging markets and developing economies would fall by 1% (IMF, 2021).

Economic consequences of this pandemic are followed by loss of jobs and/or a significant reduction of income and working hours for citizens worldwide (ILO, 2020). Characterized with Global travel restrictions and Governmental lock-downs, COVID 19 has disintegrated supply chain completely and will continue to be disrupted along all the sectors of operations whereby educational institutions are not spared. According to Dun and Bradstreet, (2020), nearly 0.5 million companies depend on China as their tier 1 suppliers and more than five million companies as tier-2 suppliers. On the estimates of Dun and Bradstreet, (2020) have indicated that nearly 16% and 94% of Fortune 1000 companies have tier-1 and tier-2 suppliers, respectively. Since China is known as a low-cost country (The World's Factory), the entire World supply chain has been upended.

The concept of procurement sustainability is enshrined in the roots of the broad aspect of Sustainable Development Goals (SDG) established as one of the current global agenda for the future (Bai, Kusi-Sarpong, Badri & Sarkis, 2019). The focus of sustainable procurement objective is to meet the varied requirements of all individuals in current and future societies, to promote private well-being, social cohesion and to create equal opportunities. It also enables organizations to satisfy their requirements for products, utilities, services and building works in a manner that achieves value for cash on a life-long basis in terms of creating advantages not only for the organization, but also for culture and economy, while at the same time maintaining environmental ability (Majumdar, Shaw & Sinha, 2020).

Supply Chain Disruptions

Supply chain disruptions arise from a combination of unintended and unexpected triggering event that occurs along in the upstream supply chain (the supply network), the inbound logistics network, or the purchasing (sourcing) environment, and a consequential situation, which presents a serious threat to the normal course of business operations of the focal firm (Bode & MacDonald, 2017). Disruptions, whether natural or human-caused, are an inherent part of the global context of all supply chains—regardless of the niche market in which those supply chains operate or the critical nature of the goods and services they provide. The studies in the supply chain disruptions have traditionally included localized events, such as the 2019 wildfires in Australia or the 9.0 magnitude earthquake which hit Japan in March 2011, causing the Fukushima Daiichi Nuclear Power Plant explosion. The earthquake not only caused damage in Japan, but the effects of the rolling blackouts traveled through global supply chains, necessitating the temporary closure of a General Motors truck plant in Louisiana, for example, due to a lack of Japanese-made parts. The COVID-19 pandemic is a disruption of an entirely unprecedented magnitude, which is testing the resilience of global supply chains.

The ability for a supply chain's operators to effectively plan, enabling a means for the supply chain to absorb, recover from, and adapt to disruptions of various lengths, impacts, and probabilities, is essential to ensuring the supply chain's function and become sustainable in the long run (Bode & MacDonald, 2017).

The TVET Institutions in Kenya

Historically, the missionaries like Johann Ludwig Krapf and Johannes Rebmann who travelled to Kenya introduced the organized education in as early as 1728 as in indicated in the Swahili manuscript *Utendi wa Tambuka* (Book of Heraclius) attesting to the fact. The missionaries interacted with locals in the coastal town of Mombasa and set up one of the earliest mission schools in the country at Rabai in 1846. With the expansion of the railway from Mombasa to Uganda, the missionaries expanded their work into Kenya's interior. An attempt to set up a school and mission at Yatta in 1894 was resisted by the Kamba tribe. The missionaries then penetrated into western Kenya and set up schools and missions. The first school in western Kenya was established at Kaimosi in 1902.

During the colonial era, the number of Kenyans with exposure to education steadily increased and a good number of them were privileged to proceed abroad for further education. The Kenyan 7-4-2-3 System or 8-4-4 Curriculum has seen ever been faced out. Since 1985, public education in Kenya has been based on an 8-4-4 system. To date, there has been steady growth in the advancement of education in the country, the country boasts of a great number of public and private universities as well as middle-level colleges.

In 2017, Kenya for the second time in history introduced a new system of education; the Competency Based Curriculum (CBC), to replace the traditional 8-4-4 system. The Competency based Curriculum was designed by the Kenya Institute of Curriculum Development (KICD) with the aim of churning reforming the education to match the current job requirements. The TVET institutions has been therefore established to ensure the achievement of the Competency Based Curriculum; which puts emphasis on seven core competences namely; communication and collaboration, critical thinking and problem-solving, creativity and imagination, citizenship, digital literacy, learning to learn and self-efficacy. The traditional curriculum has been teacher-centered while the CBC is learner-centered. In these Tertiary institutions, learners are constantly assessed on the seven competencies based on the following areas; Meeting Expectations (ME), Approaching Expectations (AE) and Below Expectations (BE). Currently, Kenya has 86 TVET colleges grouped as either under university, technical training institute, institutes of technology and polytechnics.

Problem Statement

The disruptions of supply chain by the Corona virus disease 2019, commonly known as COVID 19 has brought light to the fact that the function of supply chain is very vital on the economic growth. All the sectoral businesses have faced unprecedented challenges across the world as a result to the disruptions on the supply chain caused by COVID 19 (Knut, Azcue & Barribal., 2020). The hospitality sector is facing a downward growth due to slow down in trade; health facilities are faced with uncertain demand which may lead to bullwhip effect; manufacturing industries have failed to get enough raw material due to the "work from home" order; education sector has failed to keep students in school due the government order: the supply chain operations in almost all sectors have been disrupted. A number of scholars and industrial experts have highlighted the adverse impacts of COVID 19 on the supply chain design and structure across the sectors (Remko, 2020). Shortages of materials, delayed deliveries, vulnerable transportation systems, offline suppliers among other factors resulting from this disruption propagated the performance degradation of global supply chain in terms of revenue gains, service level excellence, productivity disruptions and delayed deliveries whereby educational centers are not exempted (Knut, Azcue & Barribal., 2020).

Since education centers are ever evolving, supply chain sustainability in this sector requires frequent mapping more so at this time of disruptions. The functions of supply chain however vital; are not considered strategic in the education sector (Remko, 2020). In addition, most study in this developing supply chain sustainability have not focused on virtualization aspects (Rajesh, 2017). Literature examining the aspects of supply chain sustainability contains blurred information on the education sector. The role of supply chain management is gaining due significance in the environmental leadership of an organization that extends beyond compliance, regulations and cost savings.

Bode and MacDonald (2017) indicated that organizations do not have a clear strategy for day-to-day activities and methodologies or processes to include in their activities the sustainability into procurement processes. A report by Ivanov and Dolgui (2020) emphasized that purchasing activities play a crucial role in incorporating the values of sustainable development across all the enterprises. While many organizations recognize the significance of supply chain sustainability, the challenge is on the implementation of sustainable aspects in the institutions.

Even though a research by Walton, (1998) showed doubt that sustainable procurement strategies can pay off economically, Karim, Smith, Halgamuge and Islam, (2016) demonstrated that the sustainable supply chain led to more financial burden on the institutions.

Research have showed that supply chain sustainability varies across Organizations, Industries, Places, and actions Based on the identified knowledge gap, this research study was therefore based on unearthing the structures that constitutes supply chain sustainability in the learning institutions in Kenya amidst the epidemic (Karim, Smith, Halgamuge & Islam, 2016).

Study Objectives

The main objective of this study was to determine the structures of supply chain sustainability in the selected Tertiary Institutions in Kenya amidst COVID 19 disruptions

Specific Objectives

- a). To assess the structural influence of supply chain agility on supply chain amidst COVID 19 disruptions in the selected Tertiary institutions in Kenya.
- b). To assess the structural influence of supply chain virtualization on supply chain sustainability amidst COVID 19 disruption in the selected Tertiary institutions in Kenya.
- c). To assess the structural influence of supply chain policy framework as a moderating variable on supply chain sustainability amidst COVID 19 disruption in the selected TVET institutions in Kenya.

Scope of the Study

Since the main objective of the study was based on the structures of supply chain sustainability amid the supply chain disruption by COVID 19, the study was conducted at the selected TVET institutions in Mombasa county. These institutions included Technical university of Mombasa, Coast National Polytechnic and Shanzu Teachers Training College. The study was bound to specific objectives such as agile supply chain structure, supply chain vitalization structure and supply chain policy framework. The study adopted Pareto Analysis and Total Interpretive Structural Model for theoretical relations. The respondents were supply chain managers, finance officers and IT officers from the selected Tertiary Institutions. The study was conducted in May 2021.

Literature Review

Theoretical Framework

The Pareto Principle. Developed by Juran in 1896, who stated that for many outcomes, roughly 80% of consequences come from 20% of the causes (the “vital few”).

The Pareto principle is also known as the Pareto analysis, the 80/20 rule, the law of vital few or the principle of factor sparsity. The Pareto principle is only tangentially related to Pareto efficiency. Mathematically, the 80/20 rule is roughly described by a power law distribution (also known as a Pareto distribution) for a particular set of parameters, and many natural phenomena have been shown to exhibit such a distribution. It is an adage of business management that "80% of an event cause of effect comes from 20% of the stakeholders (Shishodia, Verma & Dixit, 2019).

The Pareto analysis is a ranked comparison of factors related to solutions on the problems and is a statistical decision-making technique used for the selection of a limited number of tasks that produce a significant overall effect. It helps to identify and focus on the vital few factors that affects the organizational course of action. Pareto diagrams and tables are presentation techniques used to show the facts and separate the vital few from the useful many. As used to depict the supply chain sustainability problem in the TVET Institutions, the Pareto analysis depicts and ranks the sources from largest to smallest and shows the total cumulative impact for the two largest, three largest etc. in order of preference.

Pareto analysis has been performed to summarize experts' opinions and recognize the pertinent risk factors from the five-dimensions to supply chain sustainability that are essential for the TVET Institutions. Pareto chart is a widely used technique and is mainly used to highlight the major problems and help management and decision-makers in the decision-making process. The application of Pareto analysis in this study helped to understand the prioritization and grouping of the course effects in the selection on the agile supply chain for ensuring sustainability in the TVET Institutions.

The Total Imperative Model

Total Interpretive Structural Modelling (TISM) is an approach that is used for theory building as it helps the researchers to answer the fundamental research questions of what, how and why (Rajesh, 2017). TISM approach helps in identifying and defining the variables, the relationship between them and the reason for causality between variables. The supply chain virtualization has become very flexible in the recent past with its flexibility being playing an effective role in sustainable SCM. Sustainable flexibility is an attribute of a system technology for coping with the variety of its environmental needs and changes. Virtual supply chain flexibility reflects the ability of an Organization to change or react with little penalty in time, effort, cost or performance. For the analysis and intersections between virtual supply chain and sustainability factors has been utilized by TISM technique in this study. TISM is advancement of interpretive structural modeling technique, and is used to model and structure the factors for greater understanding of the interaction of these factors.

In literature TISM has been utilized by many researchers in formulating the sustainable framework requirements in an organization (Otto et al., 2017).

Wasuja, Sagar & Sushil (2012) used TISM to create a hierarchy amongst the various factors of cognitive bias in selling specialty drugs and interpret the relationships amongst them. TISM was used to model strategic performance factors for effective strategy execution (Jayalakshmi & Pramod (2015). proposed TISM based model to evaluate the causality and illustrate factors with interpretation of relationships via directed links in the form of interpretive matrix, and suggested that the factors at the bottom level were crucial for sustainability focused chain to build its capability on risks and risk issues. They identified 15 flexibility factors and analyzed their driving and dependence powers on the basis of fuzzy-MICMAC analysis. In this study, the TISM was adopted to explain the influence of virtual structure and policy framework of supply on sustainable chains in the selected TVET institutions in Kenya.

Empirical Review

Supply chain agility and sustainable supply chain. The supply chains (SC) activities are backbone of economies growth in the society, and largely interact with nature. The interactions in these SC ecosystems are very complex and triggered by mutual interrelations and feedbacks between SCs, nature, society, and the economy. Being initially developed in the veins of leanness and agility, and their combination as legality SC research has been extended by the perspectives of resilience and sustainability (Dubey et. al, 2021).

Being lean, responsive, and globalized in structural designs, SCs have also learned a great deal about how to act in line with nature and societal interests (i.e., become sustainable), how to strengthen their resilience during disruptions triggered by severe natural or man-made disasters, how to recover and manage the ripple effects (Dolgui, Ivanov & Rozhkovet, 2020), and how to utilize the advantages of digital technologies in SC management.

The agility and sustainability of SCs have been put to the test by the global pandemic. SCs worldwide have experienced an unprecedented series of shocks caused by the COVID-19 virus outbreak and global pandemic, a new instigator of SC disruptions quite unlikely seen in recent times (Dolgui, Ivanov, & Rozhkov, 2020; Chesbrough, 2020). The COVID- 19 outbreak and global pandemic have immensely affected all areas of the economy and society raising a series of completely novel decision-making settings for SC researchers and practitioners.

The agile structural design reacts to the disruptions and maintaining the resilience in case of any disruption such as natural disasters, strikes, fires, etc. along the supply chain. This kind of design, i.e., the resilient SC builds around proactive and reactive capabilities such as risk mitigation inventory, capacity flexibilities, and backup suppliers (Chesbrough, 2020). In the long-term, global disruptions such as COVID-19 pandemic, the agile supply chain entails the adoptive design characterized by production changeovers (e.g., production of ventilators or masks instead of cars), reducing the product variety, radical changes in supplier base and logistics, and production localization.

Supply Chain Virtualization and the Supply Chain Sustainability

Supply chains are increasingly becoming more complex, expensive, and fragile to the current emerging technologies. To deal successfully with the increasing challenges, SCs must become smarter with new interconnected business systems which extend from isolated, local, and single-company applications to the supply chain (Balzarova, & Castka 2018). The smart SC incorporates advanced technologies and systems, such as Internet of things (IoT), smart machines, intelligent infrastructure, intelligent decision-making, and efficient and responsive processes (Wu et al., 2016); to establish a large-scale intelligent infrastructure for merging data, information, physical objects, products, and business processes.

The smart SC, also known as SC4.0, offers a vertical and horizontal integrated supply network within which all the value functions such as smart suppliers, connected customers, smart factories, production machinery, smart products, and intelligent materials interact and communicate with each other in real-time and at the global scale (Rajesh, 2017). The application of all these advanced technologies such as IoT, big data analytics, or cloud data leads to the decentralization of production that enables machines, human resources, materials, and process controllers to intercommunicate in real-time as naturally as in a social network (Wang et al., 2016). Technological integration in the SC has also led to innovative systems such as, SMART containers, SMART warehousing, SMART ports, SMART shelves, and SMART manufacturing (Tu et al., 2018). All these innovations associated with the digitalization of the SC contribute to an increase in the amount of communication efficiency, transparency, surveillance, and control, and, consequently, to minimize downtime, waste, defects, and risk across production processes which can ensure sustainability of supply chain activities in the TVET Institutions.

Policy Framework and Supply Chain Sustainability

Muendo, (2015) analyzed the public procurement system in public secondary schools in Kenya as governed by the Public Procurement and Asset Disposal Authority, (PPADA,2015).

There is a Public Procurement and Regulatory Authority established under the Act mandated to ensure that procurement procedures are complied with, and to generally monitor and assist with the implementation and operation of the public procurement system. In general, the main steps are as follows: invitation to tender, preparation of tender documents in accordance with the PPADA, (2015), submission and receipt of tenders before set deadline, opening of tenders and the evaluation of tenders. The invitation to tender must be advertised at least twice in a newspaper of nationwide circulation. Muendo, (2015) concluded that the PPADA (2015) provide a number of rules of conduct for the whole procurement process which all the procuring entities need to comply with. The aims of the directives are, firstly, to avoid discrimination (for instance, on grounds of nationality) by providing a set of coherent rules (for instance, on objective specifications, types of award procedures and time limits), and secondly to ensure transparency by requiring publication in the public media. KIPPRA, (2016) found out that sound public procurement policies and practices are among the essential elements of good governance. The basic principles of good procurement practice include accountability, where effective mechanisms and must be in place in order to enable procuring entities to comply with the set rules regulations.

Sustainable Supply Chain

The literature focusing on sustainable supply chain management (SSCM) has attracted enormous interest among academics (Dubey et al., 2021). The prior studies have found a significant relationship between attributes of supply chain and the sustainability of the entire chain. Identifying the critical contextual factors of for sustainable supply chain is very important, and there is a pressing need to have further research on this front. Sustainability in procurement is the administration of the procurement activities in the entire supply chain in the business with the precept of triple bottom line. Sustainable procurement (SP) coined with environmental purchasing or green purchasing, green procurement compares technology, price, the environmental impact of the product and quality, contract or service. Green procurement strategies apply to all organizations, irrespective of their size. Green procurement programs can be as easy as buying renewable energy or recycling office paper or more engaged as setting environmental demands for providers and contractors.

In addressing SP practices, Karim & et. al., (2016) indicated that the dimensions of SP include designing and Product packaging, purchase from tiny and local providers, recycling or reuse potential of products, reverse logistics, safety, labor rights, carbon reduction in product motion to equipment, operational excellence, product innovation, management, commitment of providers to waste reduction objectives. As a consequence, the organizations both locally and internationally have currently become interested in embracing the concept of SP in the purchasing process.

The focus has been specifically on e-procurement, ethical procurement, green procurement and agile practices as broader determinate of SP. Academics and professionals investigated how the environment, society and economy are affected by organizations and their vendors (Karim & et. al., 2016).

Research Methodology

A standard questionnaire was designed to explore the structural supply chain determinants for sustainable supply chain at the selected TVET institutions in Kenya. The study adopted a descriptive research design. Questionnaire was designed in a Five Likert Scale format for an economic data and analysis of the findings. A total of 40 sets of questionnaires were sent to persons working in procurement, finance and IT at Technical university of Mombasa, Shanzu TTC and Coast National Polytechnic. The respondents were given seven working days to fill the questionnaire items after which their responses were collected for analysis. A total number of valid responses received for analysis were 35 sets thus indicating a response rate of 87.5%. These responses were considered for further analysis through statistical techniques using SPSS (Vol. 20) Moreover, this study presented a structured framework for assessing the influence of supply chain structural design that can ensure sustainable supply chain when the chain has been disrupted by COVID 19. The TISM and Pareto principle were found vital in examining the hierarchical relationship for the selected variable in sustainable supply chain at the selected Tertiary Institutions in Kenya.

Findings

Table 1
Questionnaire Item, Findings and Conclusion

Variable (X)	Indicator	Findings	Conclusion
Supply Chain Agility (X ₁)	Are supply chain operated on a viable approach?	The supply chain operations are at fifty percent level of viability	Improve the viability for sustainable supply chain
	Are supply processes built on resilient approach?	The supply chain process lacks resilience from threats disconnection and risk of supply failure	Enhance resilience approach for sustainable supply chain
Supply Chain Virtualization (X ₂)	Does the concept of IoT applied in the entire supply chain process?	The concept is entirely not applied	IoT and automation technologies will get priority to prevent the transmission of future pandemic and enhance sustainable supply chain.
	Is the concept of bid data such as 3D printing for rapid manufacturing applied	The concept is entirely not applied	3D printing will help organizations to be more responsive to the changes in the supply chain
Policy Framework (X ₃)	Does Public procurement Act fully apply?	The Act is fully applied	The Act supports sustainable supply chain
	Do public regulations fully apply?	The Regulations are fully complied with	The Regulations supports sustainable supply

supports sustainable supply chain analytics in order to avoid any disruptions such as COVID 19.

Moreover, this paper has defined sustainable supply chain as a model metric that qualitatively and quantitatively leverages on all the organization resources. In reference to literature, the model for sustainable chain entails preservation of market share (Rajesh, 2017), resilience after disruption using backlog as a metric, readiness (Bode & MacDonald, 2017), expected disruption cost. Since supply chain involves many stakeholders and the process is supported by documentation, we propose a standard documentation structure enshrined with agility policy and virtualization policy.

On the bidding process, these policy structures (agility and virtualization) should form the basis of award criteria.

Discussions of the Findings

This study focused on determine the structures of supply chain sustainability in the selected TVET Institutions in Kenya amidst COVID 19 disruptions. As summarized in Table 4.1, the supply chain operations were found to be at fifty percent level of viability, further, the supply chain process were found to lack resilience from threats disconnection and risk of supply failure. On supply chain virtualization, the concept was found to be entirely not applied by the Tertiary Institutions. Moreover, on the supply chain Act, both the Act and the Regulations were found to be applied and copied with respectively. The COVID-19 pandemic has exposed several vulnerable areas in sustainability in many SCs of not any in the Tertiary Institutions; but in all sectors in the entire World.

The supply chain agility is required towards achieving sustainability after COVID-19. Because of COVID-19, the business environment and supply condition in the Tertiary Institutions has changed dramatically. Therefore, these Institutions must respond quickly by making their SCs agile. Dubey et. al, (2021) also mentioned in their study that without agility no an organization can achieve SCs. Yet the COVID-19 pandemic has created and increased customer more than ever. They further stated that there is a positive impact of external and internal customer awareness on the supply chain sustainability of firms Thus, customer support, will also drive these Tertiary Institutions to achieve sustainable supply chain.

Adoption of modern, automated technology and cloud computing will generate a huge amount of data. This will drive the Tertiary Institutions to increase the use of data analytics in the supply chain. Without understanding a post-pandemic future, it will be difficult for Tertiary Institutions to keep up the SCS.

Therefore, we justify that supply chain policies need to be revised to ameliorate areas of weakness and are still facing the impact of COVID 19. However, the Tertiary Institutions will require government involvement in order to develop and implement these policies successfully. Chen, Paulraj & Lado, (2015) emphasized the necessity of government subsidy in research joint ventures considering retailer and manufacturer for making the supply chain more sustainable. However, during this COVID19 pandemic, the government subsidy through offering incentives, tax cutting, low interest business loans has been valuable in enhancing supply chain sustainability.

Implications of the Findings

The outcomes of the study can be viewed as essential guidance for different management professionals and policymakers to ensure robust supply chain strategies towards sustainability in the TVET Institutions during and after COVID-19. The documentations' structure proposed give a directive effort towards achieving sustainability through supply chain. It would enable the decision maker, while interpreting the total structural model, to allocate the degree of impact of supply chain in the Tertiary Institutions.

Further, the study findings will help policymakers to limit the disruptions of the pandemic in the TVET Institutions by enacting policies that embrace technology and agile supply chain. The main focus here should include policy development to recover the impact of COVID-19 and development of health protocols for stakeholders across the supply chain to improve agility, flexibility, resilience, and disruption risk management capacity in the SCs, which would assist in business continuity. The Tertiary management must rethink supply chain policy development to be prepared for any future pandemic situation. In addition, organizations should adopt digital communication technologies: modern mobile platforms can play a major role in imposing sustainability policies, supply chain reconfiguration, real-time data collection, and quick response to COVID-19 outbreak. Technology has been considered a prominent factor in determining a firm's success or failure during COVID-19. In comparison to the technologies adopted, Tertiary Institutions should take action to adopt new mobile technologies that would provide them accessibility across the entire SCs. This will not only enhance efficiency and responsiveness but also reduce vulnerability and enhance sustainability.

Conclusions

This study integrates structural relationships and hierarchical levels of crucial sustainability aspects of supply chain in the tertiary institutions. The presented structure can be used to analyze and respond to the questions of what needs to be done in order to attain long-term supply chain excellence amid COVID-19. It is also presumed that during any unexpected outbreak, this work constitutes the groundwork for broadening research in the SCS area. The findings of this research work ultimately conclude that Policy framework to ensure supply chain sustainability amidst COVID-19.

Although this research indicates new insights into SCS at the tertiary institutions, the research inevitably has limitations regarding data collection and validation. As in this research work, only three concepts were considered for sustainable supply chain, there could be more underlying concepts that can be analyzed in the future.

Hence, the future outlook hinges on the ability to evaluate and validate this theoretical framework, incorporating statistical testing methods such as structural equation modeling as well as considering other variables. The results of this study can be contrasted with other methods, such as decision-making trial and evaluation laboratory, and fuzzy technique for order of preference by similarity to ideal solution.

Subsequently, weight allocation or prioritization of concepts can be achieved through the Analytic Hierarchy Process or Best-Worst Method. While the focus of this research is mainly on the TVET Institutions, its outcomes and implications still have a widespread impact on many sectors in the Country adversely affected by the COVID-19 pandemic.

References

- Bai, C., Kusi-Sarpong, S., Badri Ahmadi, H., & Sarkis, J. (2019). Social sustainable supplier evaluation and selection: a group decision-support approach. *International Journal of Production Research*, 57(22), 7046-7067.
- Balzarova, M., & Castka, P. (2018). Social responsibility: Experts' viewpoints on adoption of the ISO 26000 standard. DOI - 10.1002/csr.1497. *Corporate Social Responsibility and Environmental Management*.
- Bode, C., & Macdonald, J. R. (2017). Stages of supply chain disruption response: Direct, constraining, and mediating factors for impact mitigation. <https://doi.org/10.1111/deci.12245>
- Chen, I. J., Paulraj, A. & Lado, A.A. (2015). Strategic purchasing, supply management, and firm performance", *Journal of Operations Management*, 22(5)505-523.
- Chesbrough, H. (2020). To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective. *Industrial Marketing Management*,
- Dolgui, A., Ivanov, D., & Rozhkov, M. (2020). Does the ripple effect influence the bullwhip effect? An integrated analysis of structural and operational dynamics in the supply chain. *International Journal of Production Research*, 58(5), 1285-1301.

- Dubey, R., Gunasekaran, A., Childe, S. J., Wamba, S. F., Roubaud, D., & Foropon, C. (2021) Empirical investigation of data analytics capability and organizational flexibility as complements to supply chain resilience. *International Journal of Production Research*, 59:1, 110-128, DOI: 10.1080/00207543.2019.1582820
- Dun & Bradstreet (2020). Business impact of the Coronavirus. *Dun & Bradstreet Team*, 1-10.
- Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supplychain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, 58(10), 2904-2915.
- Jayalakshmi, B., & Pramod, V. R. (2015). Total interpretive structural modeling (TISM) of the enablers of a flexible control system for industry. *Global Journal of Flexible Systems Management* 16: 1, 63-85
- Karim, M.A., Smith, A. J. R., Halgamuge, S., & Islam, M. M. (2016). A comparative study of manufacturing practices and performance variables. *International Journal of Production and Economics*. 112, 841-859.
- KIPPRA. (2016). Public procurement policy in Kenya: The need for a coherent policy framework. *Policy briefno. 3/2006*
- Knut, A., Azcue, X., & Barribal, E. (2020). Supply-chain recovery in coronavirus times-plan for now and the future. *McKinsey Insights*. <https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-recovery-in-coronavirus-times-plan-for-now-and-the-future>
- Majumdar, A., Shaw, M., & Sinha, S. K. (2020). COVID-19 Debunks the myth of socially sustainable supply chain: A Case of the clothing industry in South Asian Countries. *Sustainable Production and Consumption*, 24, 150-155.
- Muendo, (2015), *Challenges Facing the Implementation of Sustainable Procurement in the Public sector*, A case of NAWASCO: Unpublished MBA project, University of Nairobi.
- Otto, C., Willner, S. N., Wenz, L., Frieler, K., & Levermann, A. (2017). Modeling loss- propagation in the global supply network: the dynamic

agent-based model acclimates. *Journal of Economic Dynamic Control* 83:232-269.

Rajesh, R. (2017). Technological capabilities and supply chain resilience of firms: A relational analysis using Total Interpretive Structural Modeling (TISM). *Technological Forecasting and Social Change*, 118, 161-169.

Remko Van, H. (2020). Research opportunities for a more resilient post-COVID-19 supply chain - closing the gap between research findings and industry practice. *International Journal of Operations and Production Management*, 40(4), 341-355.

Shishodia, A., Dixit, V. & Verma, P. (2018). Project risk analysis based on project characteristics. *Benchmarking An International Journal* 25(1):00-00. DOI: 10.1108/BIJ-06-2017-0151. https://www.researchgate.net/publication/32323231_O_Project_risk_analysis_based_on_project_characteristics/citation/download

Tu, M., Lim, M. K., & Yang, M. F. (2018). IoT-based production logistics and supply chain system-Part 1: Modeling IoT-based manufacturing supply chain. *Journal of Industrial Management Data System*, 118, 65-95.

Wang, S., Wan, J., Zhang, D., Li, D. & Zhang, C. (2016). Towards smart factory for industry 4.0: A self-organized multi-agent system with big data-based feedback and coordination. *Journal of Computer Network* 101, 158-168.