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Sustainable Supply Chains of Sri Lankan Manufacturing Organizations: A Study on Operational Excellence Models During the COVID-19 Pandemic

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ABSTRACT

This paper presents an investigation on operational excellence (OpX) models of sustainable supply chains (SSCs) in Sri Lankan manufacturing organizations during Covid-19 pandemic. This investigation consists of multiple case studies of Sri Lankan manufacturing organizations in following industries: rubber and plastic products, wearing apparels, paper and paper products. Based on a pre-existing OpX model, six Critical Success Factors (CSFs) were identified in terms of SSCs. This research was conducted as an exploratory case study where data is collected through in-depth interviews, company websites/reports. By using a deductive approach, findings of CSFs effecting behaviour of OpX models are displayed. Thematic and Content analysis on the behavior of OpX models in SSCs are non-generalizable beyond this research. The findings display the organization in respect to wearing apparels has a more sustainable approach to better manage their OpX model and more strategic Upper Echelons to gain better strategic outcomes before/during Covid-19 pandemic. The profile of a manager was vital in interpreting OpX models in their organizations. The study outcomes can inform organizations to prime their OpX model for a crisis of Covid-19 magnitude. The effects may be generalized further to other industries. The study describes connectivity of Upper Echelons Theory to OpX models and contributes to literature through a demonstration of CSF behaviours in OpX models of SSCs during the Covid-19 crisis.

Keywords: *Operational Excellence, Critical Success Factors, Sustainable Supply Chains, Manufacturing Organizations, Covid-19 Pandemic*

1. INTRODUCTION

Any organization strives for development to achieve their collective and individual goals and objectives, and among these organizations the path towards that achievement is through the popular term 'Operational Excellence' (OpX), which is described as a holistic discipline that considers all functions of a business and focus mainly on waste minimization and increase of service availability (Jamshidieni and Rezaie, 2020). In 2020, the global pandemic, which originated from China known as the novel Coronavirus Covid-19 hit the global economy to sharp decline (Donthu and Gustaffson, 2020). Accordingly, this pandemic caused supply chain disruptions in about 94% of the Fortune 1000 companies (Sharma *et al*., 2020; Ivanov, 2020; Sherman, 2020). The Covid-19 pandemic has proved that the best combinations of traditional strategies such as agility, flexibility, robustness, idle capacity, and surplus inventory cannot cope with its rippling disruptions to the supply chain (Majumdar *et al.*, 2020; Ahlqvist *et al*., 2020). Thereby, in order to improve their organizational capability, and increase productivity, agility, and quality, industrialists at a global scale are presently eager for the deployment of OpX (Elourat *et al*., 2011).

The core theme of OpX remains as the attainment of excellence, sustenance and continuous improvement to achieve greater cost efficiencies and reduce risks; so that successful handling of such involved risks requires considering variety of factors such as safety, reliability, productivity, operational efficiency, quality and cost optimization that are interrelated, often in contrasting manners and must be managed in an integrated way to make the business competitive as well as sustainable (Khan *et al*., 2018). The concurrent integration of economical, ecological, and social measures of operations in a supply chain are described as the basic concept in a sustainable supply chain (SSC) of a manufacturing organization. In a SSC, three metrics in terms of sustainability are generally called the Triple Bottom Line (TBL) (Mangla *et al*., 2020). By integrating the TBL concept which mostly focus on sustainable consumption, effective management of natural resources, optimization, and sustainable development, (Fragoso and Figuerra, 2020) contemporary organizations strive to directly associate or integrate the sustainability paradigm and in due process, efficiently design or redesign their supply chains.

In the case of the prevailing Covid-19 pandemic situation, world manufacturing output growth had undertaken a reduction of 6%, 11.2%, 1.1% and a slight increase of 2.4% in the first, second, third, and fourth quarters respectively, in 2020, compared to same periods of the previous year (United Nations Industrial Development Organization, 2020). In addition, many of the world's countries undertook a lockdown to protect against the pandemic by halting their operations from March 2020 onwards (Pujawan and Bah, 2021). As is in the global manufacturing sector, in a Sri Lankan context, due to the outbreak of Covid-19 pandemic, the manufacturing industry undertook a contraction of 11.3%, 29.5%, 2% and 1.2% of manufacturing activities in the first, second, third, and fourth quarters respectively of 2020, compared to the same quarters in 2019 (Department of Census and Statistics, 2020). Organizations in Sri Lanka have implemented OpX models for their functions and processes in the supply chains. However, when the novel coronavirus Covid-19 pandemic occurred, the manufacturing industry in Sri Lanka was affected as well. Even though studies have been conducted on OpX models in SSCs of manufacturing organizations (Mrash and Clinton, 1998; Basu, 2004i, Basu, 2004ii; Treacy and Wiersema, 2007; Sarkar, 2007; Liker and Franz, 2011; Talwar, 2011; Miller *et al*., 2013, Dahlgaard *et al*., 2013; Bhullar *et al*., 2014; Found *et al*., 2018) no researcher in Sri Lanka or any other country has made a comprehensive attempt to investigate the OpX models of manufacturing organizations in the face of a pandemic situation such as Covid-19 (Mangla *et al*., 2020). Thereby, this paper serves the main objective of conducting an investigation on OpX models of SSCs of Sri Lankan manufacturing organizations in the duration of the Covid-19 pandemic. From that, the sub objectives are derived, which are to study; the implemented OpX models in the SSC of a manufacturing organization, the behavior of the OpX models in the SSC of a manufacturing organization before the Covid-19 pandemic, and the behavior of the OpX models in the SSC of a manufacturing organization during the Covid-19 pandemic.

Although OpX has gained attention and growth in management view, due to an absence in a unifying theory for OpX, a range of numerous methodologies, definitions, models, implementing approaches have been identified, which in turn have stated issues in relation to OpX that are acknowledged by organizational managers (Found *et al*., 2018).

- There is a rise of models and concepts that partly describe OpX, however, there is a lack of an individual predominant transformation model that all-encompasses elements of OpX in implementation and maintenance.
- There is a lack of clarity for elements of OpX in terms of critical interdependence.
- There is a predisposition to rely heavily on consultants' acquired knowledge and tactical measures to understand the 'big picture' of the organization.

There is the theoretical framework, which addresses those issues known as the Sustainable model for OpX (Sony, 2019). However, there has been no research conducted to study multidimensional effects of OpX initiatives on the TBL, in relation to OpX (Sony, 2019). Additionally, the Sustainable model for OpX has not been qualitatively investigated through the point of view of top management in an organization. During the prevailing Covid-19 pandemic period, this research would assist to identify critical success/failure factors of a theoretical framework. Considering those factors, alongside the application of the Upper-Echelons Theory (UET) (Hambrick, 1984; Hambrick 2007), this study describes the role top management plays (Sehnem *et al*., 2019), specifically in context of a SSC. Therefore, an exploratory framework is proposed in this study, which contains propositions to prove their practices, and the adaptation of OpX models in manufacturing organizations. In the duration of this research, this issue was faced. It is dealing with the lack of literature works in relevance to Covid-19 pandemic.

2. LITERATURE REVIEW

2.1 Operational Excellence Models

Originating from the Shingo Institute at Utah State University (Sony, 2019), OpX is used by modern organizations universally (Found *et al*., 2018) to attain performance improvement (Sony and Naik, 2019) in global markets since customer needs in terms of obtaining better quality products and services have become increasingly more complex (Carvalho *et al*., 2017). While great names such as Henry Ford, Adam Smith, Genichi Taguchi, Taiichi Ohno, and Frederic W. Taylor hypothesized OpX concepts (Lu *et al.,* 2011), its contemporary meaning is derived from Lean (Found *et al*., 2018) along with the inclusion of main constituents such as Quick Response Manufacturing (Suri, 1998), which focuses on reducing product cycle times (Perry and Sohal, 2001), capability enhancement (Banerjee, 2000), and Single Minute Exchange of Die (Jit *et al*., 2009), and thereby, Shigeo Shingo established the concept of OpX (Found *et al*., 2018).

Through value addition activities (Kumar Ohja, 2015; Gyarmathy *et al*., 2020) OpX attempts to become the foundation to accomplish success in business functions (Bag *et al*., 2020), and has made itself an essential element for business excellence and industry architecture (Shehadeh *et al*., 2016). Considering manufacturing processes to be a core strategic function of an organization (Ahmed and Nuland, 2017), OpX is used to determine efficiency and yield in the processes (Jaeger *et al*., 2014). Its aim in leading the industry (Treacy and Wiersema, 1993, 1995; Morash *et al*., 1996) is beyond the usage of distinctive techniques and tools (Rusev and Salonitis, 2016). It seeks to improve the supply chain in terms of economic and operational efficiency, escalate social and environmental benefits through optimization (Thakur and Mangla, 2019), which assists the organization to open/attract new collaborations and sustain current ones (Sehnem *et al*., 2019). OpX contains an organizations' capability in the utilization of Block-chain technology (Zhang *et al*., 2020), employee productivity (Benitez *et al*., 2018), Internet of Things (Cui *et al*., 2020), monitoring product margins (Shehadeh *et al.*, 2016), Cloud Computing (Sartal and Vazquez, 2017; Gai *et al*., 2020), internal organizational excellence (Oakland *et al*., 2020), Communication and information technology, and processes in manufacturing (Ajamieh *et al*., 2016) and managerial aspects (Kumar Ohja, 2015).

2.2 Sustainable Supply Chain

SSC ensures the business processes joint-optimization in terms of economic, social, and environmental performance sustainably encompassing all elements in a supply chain (Li *et al*., 2006), which assist organizations to improve internal production and supplier/customer processes (Elcio and Wong, 2014) and implement programs (Lu *et al*., 2012) which structures dynamic organization development and innovation (Gosling *et al.*, 2017) to gain sustainability in organizational performance (Ortas and Moneva, 2014). SSCs focus on reduction in cost (Gurtu *et al*., 2019), preventing pollution (Wu *et al*., 2012), reduction in risk, by ensuring transparency in the supply chain networks (Carter and Rogers, 2008). It has substantial impact on organizational dynamic capabilities in a positive manner (Hong *et al*., 2018), however, the measurement of such initiatives in sustainability differs in each organization (Searcy *et al*., 2009). Sustainability concepts assist the organization to attain a significant position in the market in a global scale (Khodakarami *et al*., 2015) since organizations become progressively aware of their stakeholder responsibility (Presuss, 2005; Bai and Sarkis, 2010) in global competition (Raut *et al*., 2015).

Through this awareness, organizations gain knowledge on various aspects and measurement of sustainability in supply chain operations (Allen *et al*., 2012), and incorporate TBL to manufacturing (Linton *et al*., 2007) to manage operational decisions (Jabbour *et al*., 2019). This measurement is conducted through the development of key performance indicators (Mincer, 2008), and other performance measurement systems (Shepherd and Günter, 2006; Simchilevi et al., 2007) by considering the different views on sustainability various organizations may have, complex or otherwise (Salzmann *et al*., 2005; Hassini *et al*., 2012, Allen *et al*., 2012). Therefore, organizations face major challenges in terms of adopting sustainability due to its complexity, uncertainty, change in organization culture, and in maneuvering initiatives in sustainability (Kuik *et al*., 2011). Thereby, SSCs require interconnected channels in its networks (Brandernburg *et al*., 2014), by addressing issues in relation to planning, optimization of resources (Bag *et al*., 2020) to reduce lead times, save organizational funds, enhance satisfaction levels in customers through sustainability (Ghandimi *et al*., 2019). To create SSCs, manufacturing organizations implement systems of environmental management and cleaner production (Geissdoerfer *et al*., 2017), and further manage responsibility (Su *et al*., 2015) through SSC practices (Schaltegger and Burritt, 2014). SSCs revolutionize effectiveness within organizations (Seuring and Muller, 2008; Fahimnia *et al*., 2017), and OpX approaches on embracing sustainability (Govindan, 2018; Mani and Gunasekaran, 2018) improve the performance of a SSC significantly (Luthra and Mangla, 2018).

2.3 Sustainable Model of Operational Excellence

The proposed model of OpX states that organizations need to study the impact of TBL dimensions when implementing OpX programs in an organization (Dehghanian and Mansour, 2009; Sony, 2019) and identify their interaction effects to gain a clear 'big picture' viewpoint.

2.4 The Upper Echelons Theory

The Upper Echelons Theory (UET) is partial prediction of an organization performance levels and its outcome to strategic choices via background characteristics of top managers in an organization. The UET includes methodological suggestions and propositions (Hambrick and Mason, 1983). This theory emphasizes the values, personalities, experiences, and interpretations of situations, which impact any choices, made by top managers and consider their coalition in the organization (Hambrick and Mason, 1984; Hambrick, 2007). Based on the aforementioned model, and literature, the Critical Success Factors (CSFs) for sustainable OpX in a manufacturing organization can be proposed for this research.

- Economic sustainability of OpX
- Social sustainability of OpX
- Environmental sustainability of OpX
- Multi-dimensional impact of OpX initiatives
- Organizational agility
- Organizational culture

Considering these CSFs, an argument can be made in the context that their management ensures better implementation of OpX in a SSC of a manufacturing organization. Additionally, as a result of the literature works studied, exploratory propositions are put forth as follows.

Proposition 1: *Organizations with a more sustainable approach are inclined to better manage the sustainable OpX model.*
OpX connects sustainability through opportunities for change in drivers of profit, people, and planet (Kleindorfer et al., 2009). Long run sustainability in an organization can be achieved through a consistent component of the social, economic and environmental aspects in sustainability. Ability to identify and accordingly respond to requirements of stakeholders in terms of social, economic and environmental can be accomplished sustainably in a long run basis via OpX models (Sony, 2019).

Proposition 2: *Organizations with a less sustainable approach are inclined to face challenges in managing the sustainable OpX model.*
In order for an OpX model to be sustainable in the long run, the TBL aspects must be equally practicable in operation. Therefore, indulgence of a tradeoff among TBL pillars for a sustainable OpX model is discouraged (Sony, 2019).

Proposition 3: *Organizations with a more strategic approach to sustainable OpX are inclined towards more helpful Upper Echelons.*
The UET consists of the following inter-connected sections.
a) Managers take actions based on their perspectives of strategic circumstances.
b) This perspective is a resultant of the values, accumulated experiences, and personalities of the managers (Hambrick, 2007).
Therefore, a presumption was made such that managers differ, and the options available to them in terms of strategic decision-making differ as well (Hambrick, 2007). Literature works present the influence characteristics of managers have on the outcomes of the organization strategically (Chuang et al., 2009).

Proposition 4: *Organizations with a less strategic approach to sustainable OpX are inclined towards less helpful Upper Echelons.*
Characteristics such as age of a manager, tenure, background in terms of functionality, education qualifications, manager's roots in terms of socio-economy, and financial status (Chuang et al, 2009; Ahmad, 2020; Ameer and Khan, 2020), are utilized to gain expertise on prediction of forthcoming events, alternative measures, and resulting consequences (Hambrick and Mason, 1984). Therefore, the responding approach undertaken by an organization would depend upon manager's experiences and context of the situation at hand (Sehnem, 2019).

3. RESEARCH METHODOLOGY

In relation to past studies, the usage of existing literature from sources such as Wiley Online Library, Elsevier, Emerald, Science Direct and Sage were taken into consideration for this study. It can be stated that it is difficult to find research that have been conducted in which the UET has been integrated with the identified CSFs of the sustainable OpX model (Sony, 2019). Six CSFs were introduced in this model, and they have not yet been tested in live case studies. Furthermore, it is difficult to identify research where the integration is conducted in three separate manufacturing industries; manufacture of rubber and plastic products, manufacture of paper and paper products, and manufacture of wearing apparels, and it is difficult to find research which investigate any OpX models during the Covid-19 pandemic emergency (Mangla *et al*., 2020). Therefore, this study is conducted as an exploratory qualitative research, which is based on a multiple case study strategy. Accordingly, in-depth qualitative research works are needed to gain an understanding on the manner of which SSCs work (Pagell and Shevchenko, 2014), and thereby, there are not many supply chain management exploratory studies in existence (Carter *et al*., 2014). In recognition of these research gaps in literature, this study is conducted as a qualitative exploratory research. Furthermore, in respect to an exploratory case study, ideologies of Yin (1981), Yin, (2010) and Barratt *et al*., (2011) are included in context. Thereby, the use of exploratory propositions is presented in accordance with the literature review. Based on the exploratory propositions, the analysis of data on the investigation of OpX models in SSCs are non-generalizable beyond this study.

The Sri Lankan manufacturing industry cases in this research are taken as representatives of their respective manufacturing industry, based on a purposive sampling technique in which the sample size is selected by considering the highest impacted industries in the index of industrial production (Department of Census and Statistics, 2020). The company in manufacture of wearing apparels (referred to as MO1) which has had one of its factories as one of the first apparel manufacturers to be certified Carbon Neutral® and is aligned with United Nations Sustainable Development Goals (UNSDG). The second case study is conducted in relation to an organization in the manufacture of paper and paper products (referred to as MO2), which are focused on the production of sustainable corrugated cartons in Sri Lanka. The final case study is conducted on an organization in the manufacture of rubber and plastic products (referred to as MO3) in which they focus on natural tires by partaking sustainability in its production. For the data collection, the main method utilized is the conduction of in-depth interviews from a manager of each representative manufacturing organization. In addition, organization websites, company reports were utilized as secondary sources. The interview was conducted to take into consideration, the insights of the top managers of the organization who are knowledgeable in terms of the OpX models utilized in their SSCs. The interviews were conducted on highly experienced managers versatile in the functions of quality, operations, and production of their individual organizational SSCs. The methodology of in-depth interviews was such that interviews were conducted

and the collected data transcribed with additional notes taken down. Furthermore, data obtained from the organization websites and reports were triangulated to enhance trustworthiness of the study. A summarization on data collection through the in-depth interviews and secondary sources are displayed in **Table 1**. The processes followed in deriving findings were the conduction of in-depth interviews, secondary data, and thematic analysis and content analysis on data, which was collected, transcribed, triangulated, coded and arrived at findings. Through the data analysis, six themes based on CSFs (Sony, 2019) were selected in order to identify the behaviour of OpX models in SSCs. The findings derived were compared with the UET, which predict the strategic outcomes of organizations based on the characteristics of their respective managers.

Table 1 Data Collection Sources

Source	Evidence		
	MO1	MO2	MO3
Organization Details	This organization has a past of more than 100 years, which means this company was founded the in 1900's. Today, the organization employs more than 3000 people. This organization is globally based in 3 South Asian international countries.	This organization was founded in 1994. This organization has taken a lead in the corrugated carton production in industry. Today, the organization employs more than 1000 people. Their products are largely exported to Middle Eastern countries.	This organization was founded in the 1990's. The organization employs more than 1000 people. The organizations' products such highway tires are exported in large quantities for European and Asian countries.
Interviews	The interview was conducted with the senior Quality Control manager. The interview was conducted via Zoom, and 2 phone calls, which all took more than 1 hour. The interviewee has been in the organization for more than 5 years.	The interview was conducted with the senior General manager. The interview was conducted via Zoom, which took more than 1 hour. The interviewee has been in the organization for more than 20 years and has experience as a manager for 10 years.	The interview was conducted with the senior Production manager. The interview was conducted via Zoom, and 2 phone calls, which all took more than 1 hour. The interviewee has been in the organization for more than 15 years and has experience as a manager for more than 5 years.
Secondary Data Collection	Organization websites, Organization annual reports and documents	Organization websites, Organization annual reports and documents	Organization websites, Organization annual reports and documents

6. RESULTS

The findings aim to fulfill the main research objective of conducting an investigation on OpX models of SSCs of Sri Lankan manufacturing organizations in the duration of the Covid-19 pandemic. From the derivative sub objective 1 (to study the implemented OpX models in the SSC of a manufacturing organization), the in-depth interviews and secondary sources were utilized to accomplish it. Additionally, the derivative sub objectives 2 and 3 (to study the behavior of the OpX models in the SSC of a manufacturing organization before the Covid-19 pandemic, and the behavior of the OpX models in the SSC of a manufacturing organization during the Covid-19 pandemic) were accomplished through the CSFs identified from the Sustainable OpX model (Sony, 2019).

4.1 Operation Excellence Model in Cases Studied

In the comparison conducted, rather than the cases of MO2 and MO3, MO1 has the most sustainable OpX model in implementation, which was implemented before the year 2010. This case operates in the wearing apparel manufacturing sector, in which possibility of implementing more OpX practices is higher. These practices include high performance work teams (coaching skills, facilitation skills, organizational culture and value design), strategy deployment (Vision and mission, agile, IT implementation), process excellence (Lean, 3S, 5S, Six Sigma, Total Quality Management (TQM), Kanban, Kaizen, problem solving techniques), and performance management (process management, key performance indicators, balanced scorecard). This statement was confirmed by the interview of MO1 "Our main goals of using OpX models should be customer satisfaction, quality, on-time delivery and cost control" (Interviewee company MO1). Furthermore, in MO1, OpX models are utilized in their supply chain from the extent of procurement, material and inventory, planning, production, technical, human resources, marketing/sales, accounting and finance, information technology, shipping to distribution.

In the case of MO2, the implemented OpX model has a more sustainable approach, in comparison to MO3. Similar to MO1, however not in the exact manner, MO2 operates towards sustainability in the paper and paper products manufacturing sector, in which the OpX model was implemented before the year 2010. The identified OpX models implemented in this sector are mainly operating in high performance work teams (coaching skills, facilitation skills, and organization culture and value design) and process excellence (Lean, Six Sigma, 5S, TQM, Kaizen, and problem-solving techniques). This statement was confirmed by the interview of the MO2 "We are consisting of a fully

skillful labor force and OpX models in order to ship our orders on time" (Interviewee company MO2). In addition, in MO2 the OpX models are utilized in the supply chain from the extent of procurement, material and inventory, planning, production, shipping to distribution.

In case of MO3, the implemented OpX model is less sustainable than the other two previous cases since they are still in a stage of implementation of OpX models in their SSC, and they have started implementation in the duration of 2016-2021. They are mainly focused on process excellence (Lean, Kanban, Kaizen, six sigma, TQM, and problem solving methods). This statement was confirmed by the interview of MO3 "Our Company is still looking into implementation of OpX models and considering about cost reduction" (Interviewee MO3).

4.2 CSFs of Sustainable OpX before and during Covid-19

Table 2 and **Table 3** illustrate the behaviour of OpX model CSFs in SSCs of manufacturing organizations in a color-coded format (Jabbour et al., 2017) both before and during the Covid-19 pandemic accordingly.

Table 2 Before Covid-19

	CSFs before Covid-19					
Cases	SS	ES	ES	MD	OC	OA
MO1	🟢	🟢	🟢	🟢	🟢	🟡
MO2	🟡	🟢	🟡	🟡	🟢	🟢
MO3	🟡	🟢	🟡	🟡	🟡	🟢

Note: 🟢 More sustainable 🟡 Partially sustainable 🔴 Not sustainable SS - Social sustainability of OpX, ES - Economical sustainability of OpX, ES - Environmental sustainability of OpX, MD - Multi-dimensional impact of OpX initiatives, OC - Organization culture, OA – Organization Agility

Table 3 During Covid-19

	CSFs during Covid-19					
Cases	SS	ES	ES	MD	OC	OA
MO1	🔴	🟢	🟢	🟢	🟢	🟡
MO2	🟢	🟡	🟡	🟡	🟡	🟡
MO3	🔴	🟡	🟡	🟡	🟡	🟡

Note: 🟢 More sustainable 🟡 Partially sustainable 🔴 Not sustainable SS - Social sustainability of OpX, ES - Economical sustainability of OpX, ES - Environmental sustainability of OpX, MD - Multi-dimensional impact of OpX initiatives, OC - Organization culture, OA – Organization Agility

4.2.1 Social Sustainability of OpX

MO1 was the best performer before Covid-19 since their management adopted a hands-on attitude in the implementation of OpX so that the people in the society would be able to understand their business model, and attract, and sustain a qualified and ethical workforce in their organization, and during the Covid-19 period, their management took decisions to establish a safe working environment, which enabled a healthy work force to bring new customers in order to fulfill the capacity of the organization. However, MO1 lost skillful workers who are not willing to adjust to new thinking. In MO2 and MO3 cases, most of the employees have been working since the start of the organizations, and compared to MO1, MO2 and MO3 organizations have launched their OpX models recently which took a longer time for their employees to adjust to the new OpX models. During the Covid-19 period, MO1 and MO3 companies lost their skillful employees, and they had to pay compensation compared MO2, MO2 was the best performer during the Covid-19 period, when considering the social sustainability factor since they did not lose any employees and managed their workforce well during the Covid-19 period.

4.2.2 Economic Sustainability of OpX

MO1 established a lean 'house' to reduce their wastage through lean manufacturing and continuous improvement practices such as the red tag system, flag system, signal light system, process and people engagement to improve cost of failures which directly impacted profitability, and the management establish a healthy environment to reduce the absenteeism and labor turn over. During the Covid-19 period, waste elimination projects such as water management system, waste food management system and solar power system were utilized by MO1 to further avoid unnecessary costs. MO2 and MO3 achieved their profitability as well however, before Covid-19. In comparison to MO1, MO2 and MO3 have not implemented waste management projects in their premises, therefore during the Covid-19 period; they were not able control unnecessary costs.

4.2.3 Environment Sustainability of OpX

MO1 was able to achieve environment sustainability before and during Covid-19 period, since their top management contributed to the establishment of a healthy

environment in order to reduce the absenteeism and labor turn over, which directly impacted to the business productivity, and they maintained positive mindsets of society for the company. Additionally, MO1 supported to the global warming improvements for future generations. In comparison to MO2 and MO3 the location of MO1 is very environmentally friendly and very advantageous for transportation facilities as well.

4.2.4 Multi-Dimensional Impact of OpX Initiatives

MO1 was able to achieve all three aspects of sustainability before Covid-19 since they are aligned with United Nations Sustainable Development Goals with their sustainable model and was highly productive in satisfying customers and sustained a happy work force in the company as well. MO1 was able to establish a responsive OpX model in which there was a short lead-time taken to deliver manufactured goods to their customers and had an added advantage with the location of the organization. However, during Covid-19 period all companies were not able to achieve multi-dimensional success in OpX implementation due to the loss of experienced workforce, lack of waste management systems, and lack of infrastructure facilities.

4.2.5 Organizational Culture

MO1 and MO2 were able to better manage their company culture before Covid-19 compared to MO3 since MO1 and MO2 cultures were result oriented through best practices while maintaining business ethics and policies. However, MO1 was the best performer during Covid-19 since they have a well-disciplined work force that is respectful to the process in order to get quality products to satisfy customers and add value to the business. Furthermore, MO1 performance systems are well established to review the business directions.

4.2.6 Organizational Agility

MO2 was the best performer before the Covid-19 period since they mainly focused on value added business rather than undertaking a low-cost strategy by supplying value added products to their customers, and they increased their customer portfolio by providing a variety of products. MO1 and MO3 mainly focused on low cost, and they targeted their regular customer base. During the Covid-19 period, all three companies had to face difficulties in market changes such as delays in supply materials, order cancelations, curfew, and travel restrictions.

As a result, the analysis conducted was able to identify that the top management of MO1 was able to face and successfully implement the sustainable OpX models effectively before and even during the Covid-19 pandemic, in comparison to MO2 and MO3, which were less successful.

4.3 UET Analysis

The analyses on the cases display the background characteristics of the managers, which are considered to determine strategic outcomes. **Table 4** presents the interviewed managers' details, in consideration of organization's upper echelons characteristics. In the case of MO1, the manager is at a level, which is more advanced in terms of education; however, he is 5 years below in terms of experience as a manager, in comparison to MO2 and MO3. The manager in MO1 is a masters' degree holder and a Lean black belt holder and is highly knowledgeable on OpX models towards sustainability. This characteristic of Upper Echelons of MO1 manager displayed that the background profile of a manager can pose a significant change in the level of understanding in management and functionality of a SSC. A statement of the MO1 manager revealed the ability to critically think in terms of OpX models in a SSC, "The aspects such as leadership, people, process product, customer and suppliers are needed to gain maximum benefits from OpX models towards a SSC." The MO2 manager is a master's degree holder and they explained about the adaptation of SSC in their organization, which is specific towards that organization, and displays less UET characteristics compared to the MO1 manager. In the case of MO3, the manager is a Bachelors' degree holder, and has accumulated 8 years of managerial experience, and is well versed in terms of sustainability. The MO2 and MO3 managers' share a lack of UET characteristics on OpX models in SSC's, compared to MO1 management. The results acquired from this case study are exploratory since it was considered to be separate from each other in terms literature of OpX on SSC. Therefore, these results are not extendable beyond the case studies conducted in this research.

Table 4 UET Aspects

UET Aspect	MO1	MO2	MO3
Manager Age	30 - 40	40 - 50	40 - 50
Management Experience	• Management Trainee • Executive • Manager • Senior Manager - Quality	• Shipping Manager • General Manager	• Production Executive • Production Manager
Other Career Experience	Experience in Asian countries Lean Black-belt holder	Experience in Asian countries	Local manufacturing industry organizational experience
Education	Masters' degree holder	Masters' degree holder	Bachelors' degree holder

5. DISCUSSION

During this study, research issues such as dealing with a lack of literature works in relevance to Covid-19 pandemic was encountered. Furthermore, there was difficulty in contacting managers due to their hectic schedules. In the context of the propositions aforementioned, results related to proposition 1 (organizations with a more sustainable approach are prone to better manage the sustainable OpX model) and proposition 2 (organizations with a less sustainable approach are prone to face challenges in managing the sustainable OpX model) were addressed.

In the context of proposition 1, in comparison to MO2, and MO3, MO1 is the best performing organization which has more sustainable approaches to the OpX model of their SSC, since their planning system is highly versatile and they manage the OpX model with the full support of their employees, top management, team leaders, processes, and suppliers. Their cooperate objectives of the organization are aligned with their OpX model in terms of sustainability, and their OpX model played a major role in the organizational survival during the Covid-19 pandemic.

In MO1, the modifications to online communication, and coordination with suppliers were more effective in comparison to in-person visitations. These favorable consequences resulted due to suppliers being more responsive in terms of processing online purchase orders, real-time online bank transactions, and systematic tracking of inventories. Furthermore, MO1 employees had improved their productivity compared to before the Covid-19 period due to online functionality, and processes. Before the Covid-19 pandemic, the organization usually solved their issues through physical conference meetings, which were postponed to the next day in numerous instances. On the contrary, meetings were scheduled online, and any issue was swiftly resolved within a short period of time during the Covid-19 pandemic. The MO1 organization's energy conservation, waste management, and other precautionary measures, taken in order to pursue pollution prevention, were not halted in action during the Covid-19 pandemic. The employees were able to maintain positive mind-sets due to assurance of job security, and MO1 making necessary supplier payments on time. Processes such as quotation approvals, order placements, and communication, which undertook 2-3 days prior to the Covid-19 period, were conducted within hours during the Covid-19 pandemic. In terms of production, MO1 was more efficient due to the process excellence achieved pertaining to new product developments, product approvals, commencement of organization meetings, and problem-solving procedures. Additional products such as the manufacture of lighting equipment, and telecommunication poles were added to organization's extensive portfolio, during the Covid-19 pandemic. This action consequently expanded the customer base and market opportunities.

The Covid-19 outbreak adversely affected almost all organizations represented in the case studies, resulting in varied behaviour in OpX models. Therefore, in the context of proposition 2 the behaviour of the OpX models of MO2 and, MO3, vary due to issues faced in managing the SSCs, during the Covid-19 pandemic.

MO2 had to deal with a lack of feedback from their global customer range due to lockdowns and closing of offices. Communication and coordination with suppliers resulted in a similar predicament, during the Covid-19 pandemic. Profits diminished to a considerable extent due to shipment delays, cargo capacity issues, and increase of freight costs to the Australian, Canadian, European, and New Zealand customers and product markets. By foreseeing a material unavailability in case of a lockdown situation within the country; MO2 managed to bulk-purchase raw materials sufficient for 3-4 months of production during the months of January, and February 2020. Therefore, MO2 incurred a high purchasing cost i.e., a high amount of working capital tied in inventory, and holding inventory cost, in terms of warehousing, utilities etc., compared to previous years. Although, layoffs within the organization did not occur, due to high costs incurred by MO2, the regular training programs held in previous years, bonus schemes, and employee welfare projects were halted in the duration of Covid-19 pandemic. MO2 was not able to achieve responsiveness to orders from most of the local customer industries (except in the industries of tea, and Fast-Moving Consumer Goods), during the Covid-19 pandemic period. Moreover, MO2 was not able to successfully respond to the global customer base due to travel restrictions, and different country lockdowns.

In MO3, the lockdown restrictions in various countries led to shutdowns of most of the suppliers' manufacturing organizations abroad. MO3 faced errors in maintaining coordination, and communication. The overdependence of MO3 imported raw materials led to material unavailability and thereby; customer orders were not completely fulfilled, during the initial period of Covid-19 pandemic and MO3 was unable to send even a single shipment during the entire month of April 2020 due to the closure of factories. The holding of inventories postponed due to shipment delays increased expenditure to the organization. Although lay-offs within the organization did not occur, bonus payments and increments to employees were held up due to unexpected additional expenses incurred, during the Covid-19 period. The employees' mind-sets were changed to adhere to maintain health, and safety continuously with the intention on further prevention of spreading the Covid-19 virus.

In the context of proposition 3 (organizations with a more strategic approach to sustainable OpX are prone towards more helpful Upper Echelons), MO1 has the more strategic Upper Echelons in order manage a sustainable OpX model before and during the Covid-19 pandemic since MO1 management are well versed on OpX models in SSCs, and the MO1 top management introduced a new 7 0's systems, net zero gas system, and water recycling systems. Therefore, MO1 was prepared to face an emergency such as the Covid-19 pandemic. Furthermore, MO1 did not lay-off employees, and made the necessary salary and bonus payments on time. This management decision resulted in high efficiency compared to before the Covid-19 period due to guaranteed job security, and creation of trust among a satisfied, and motivated workforce and the organization. Investments were made possible through incentives of the government; offered to expand local production for the provision of value-added products and services to increase and satisfy local/export consumption. MO1 managers made the strategic choice to minimize profit margins during the Covid-19 period in order to encourage purchases and satisfy the local customer base. Although MO5 heavily invested in process improvements,

cost savings in terms of overall wastage within the organization have improved during the Covid-19 pandemic.

In the perspective of proposition 4 (organizations with a less strategic approach to sustainable OpX are prone towards less helpful Upper Echelons) results are addressed here. The management of the MO2, and MO3 organizations both made decisions to undertake pay cuts on employees, and halt involvement in community projects in the duration of the Covid-19 pandemic. The management of MO2 made the decision to bulk-purchase raw materials, which incurred a heavy burden in terms of holding inventory. The MO2 organization ceased bonus payments to employees and training and development programs as these usually incur high cost. MO1 was the only organization that was able to sustain the behaviour of their OpX models to gain successful outcomes in terms of UET during the Covid-19 pandemic. This was made possible due to MO1 younger manager in comparison to the other interviewees, in which being a recent graduate heavily assisted the implementation of sustainability in the OpX model. Although, the rest of the managers made decisions suitable to respective OpX models, the outcomes of the organization were not impacted in a strategic manner.

6. CONCLUSION AND FUTURE RESEARCH

As the foundation for success of functions in an organization, OpX models are responsible to meet on-time delivery, quality production, elimination of wastage, processes etc. in a SSC to achieve organizational goals and objectives. Although several studies have been conducted on OpX models, there is a noticeable absence of literature on sustainable OpX models and an absence of a defined theory for OpX. This study was significant in its provision of exploratory propositions, which investigated the behaviour of OpX model CSFs through case studies conducted in Covid-19 affected Sri Lankan manufacturing organizations. The investigations were carried out through the use of a sustainable OpX model (Sony, 2019), which assisted in identifying CSFs for the case studies, before, and during the Covid-19 pandemic. The findings illustrate that before the Covid-19 pandemic, the organization OpX models were sustainable to considerable extents. However, in the Covid-19 pandemic period, fluctuations of the OpX models in terms of more, partially, or not sustainable were indicated, in which MO1 was identified to be the most sustainable OpX model with a SSC. The UET was utilized to indicate the impact of strategic decisions on organizational outcomes in terms of managerial characteristics, and background. Through these findings, the research questions of the study were answered. The research contributed to the existing gap of a lack of Covid-19 pandemic related to literature works. The limitation faced in respect to the research was the adaptation to an absence of Covid-19 pandemic related literature works, specifically in the context of OpX in SSCs. For potential scholars, future studies may be conducted through similar investigations in a broader scale beyond the manufacturing industry. By enhancing the scope of the study, the sustainable OpX model can be tested for further generalized viewpoints in conformance with any industry.

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