THE BARRIERS ANALYSIS OF SUPPLY CHAIN MANAGEMENT DURING COVID-19 PANDEMIC IN INDIAN INDUSTRIES: COVID-19 PANDEMIC IN INDIAN INDUSTRIES

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ABSTRACT

In today's supply chain, information sharing and accountability for goods is critical, accordingly to the principles of fiscal, environmental and social security, which have been also concentrating on in recent years, prioritize business process openness. The economic consequences of the COVID-19 outbreak and prevention strategies incorporate factors such as supply and demand shocks as a result of COVID-19. This paper investigates the sensitivity of the supply chain to the unfolding pandemic crisis by identifying the five main barriers for Indian manufacturing industries in the new COVID-19 time by employing a hierarchical approach, based on multi-criteria analysis. A hierarchical process-based multi-criteria approach has been used to evaluate COVID-19 influence and prioritized by Entropy and TOPSIS technique. The findings shows that local law enforcement obtained the highest weights among all the supply chain barriers operations in the COVID-19 time, and among the industries, airline, hotel, and automobile sectors have been most affected by the global crisis. The obtained findings will provide the strategic outputs for decision-makers to strengthen the supply chain following COVID-19 protocols.

Keyword COVID-19; Supply Chain Management; Barriers; Entropy; TOPSIS.

1. INTRODUCTION

As the COVID-19 triggers worldwide economic turbulence, contemporary supply chains facing new types of difficulties in the managing the logistic. In order to define minimum lead times at a cheaper price, today the globalized supply chain network is looking for optimization. Nevertheless, swift political changes, a move to customers purchase specialty goods and global pandemics have exposed the flaw at the core of this paradigm. Manufacturing nowadays, in contrast with only a few decades earlier, is much more

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complicated than that of a sub-component that has to assemble a single element from many locations all over the world. The raw materials used to make these parts may also be imported from many areas of the globe, and the final products will then need to be shipped all over the world. This huge logistics dependence makes buying, processing and shipping a complicated proposition when supply chains are disrupted.

The supply problem for the manufacturing company falls on the opposite side of the coin. The growing consolidation of the output at low cost, especially in China, Taiwan, and Vietnam and other low-cost economies, has been motivated by a drive towards productivity in a globally interconnected environment. The pandemic that has started in China has now reached other countries world-wide and the consequent consequences and vulnerabilities have shown an increasing need for risk in distribution more than ever.

The holding of vital commodities/stocking of non-commercial products on the customer side resulted in unusual pressure in the supply chains. Panic on food and other main items during d times is not an uncommon occurrence for consumers. Since this adds to stress if the stockpile goes past several weeks, customers are naturally worried about supply and recourse to such behaviors. These unnatural demand swings and essential supply volatility are incredibly difficult to manage and produce a bullwhip effect in the whole supply chain and sometimes results in an artificial shortage.
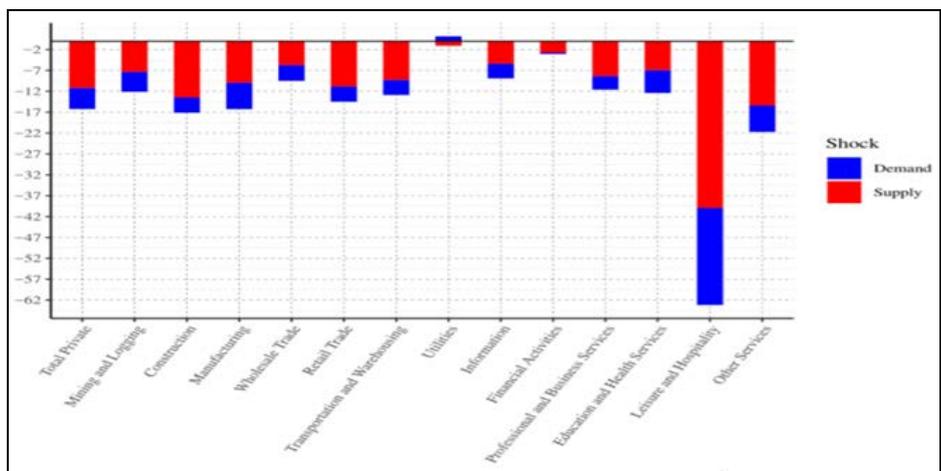

Figure 1: April 2020 shock decomposition
Source: Brinca et al., (2020)

First and foremost, our study is closely related to research investigating the impacts on commodity demand and availability of natural hazards such as geological incidents, earthquakes and snowfalls (Cavallo, Cavallo & Rigobon 2014). According to WHO (2020) reports that the world's supply chain poses an immense challenge in preserving smooth food

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sources and medical devices such as masks and medicines that are very important to manage, secure and monitor the pandemic.

Carvalho et al. (2016) illustrated in the context of supply chain disturbances following the Great East Japan earthquake the role of input and output links using company-level data. Mahajan and Tomar (2020) looked at disruptions in food supply chains as a result of the COVID-19 economic shutdown in India and found that supply networks for long distances were most seriously affected during the latest pandemic, with social gains for cities and farmers.

The international pandemic prevention policies have blocked the movement of finished products and raw materials from manufacturers into many parts of the world. Wuhan, the COVID-19 epicentre for example, is a cluster of car factories with foreign marks like General Motors, Hyundai, and Toyota, among others (Yu & Aviso, 2020). The five major supply chain hurdles, including lack of personnel, the local implementation of regulations, lack of traffic, shortened of raw materials, and cash flow deficits, were studied by Biswas and Das (2020).

Information sharing is recognised as a significant source of competitive advantage, and hence the interest of academics and practitioners to understand and isolate certain factors which contribute to the successful transfer of knowledge between supply chain actors during the pandemic has been increased (He, Ghobadin, & Gallear, 2013). The creation of SC based on knowledge depends on the essence of the knowledge flow in the whole chain. It would be very helpful for SC collaborators to exchange decision-making details in due course. Although administration and business culture are the biggest hurdles (Shih, Hsu, Zhu, & Balasubramanian, 2012).

A further challenge to the supply chain is that businesses should identify specific strategies and procedures that are planned and shared to all stakeholders to efficiently handle logistics activities (Badenhorst, 2016). In addition, businesses need to combine both the reverse and forward logistics to handle goods, money flows and knowledge and improve a reliable and efficient supply chain for an integrated loop (Prakash & Barua, 2015). Agrawal et al. (2020) analyzed the impact of COVID-19 on Indian supply chain and economy and identified 18 main obstacles affecting supply chain operations in India.

Despite an important proportion of Indian importers across a wide variety of industries, frequent trips to Chinese processing hubs have been used to position orders for goods. These visits are now postponed or scrapped off and importers worry that they will lose as things stabilize and importers from other countries fight to get their own orders. The move from production to trading and over reliance on the Chinese inputs led to the closing of several firms in India.

After COVID-19, the planet must shift to the new standard. This current normal would take a new look at the globalization framework. The critical mass of value chains developed into China is absolutely decimated by COVID-19. Experts warn that vast numbers of producers are having problems of supply as a result of the outbreak, as businesses expand the use of unforeseen circumstances' a contract rule relating to exceptional circumstances that prohibit or impede the fulfilment of their obligations.

Companies across the globe are trying to diversify their procurement policy, with India benefiting from this step that cracks the focus supply chain mound into effective and efficient supply chain mounding. After COVID-19 led deconstruction, India is bound to prosper from this re-structure supply chain surge. The survey result from online sources has been gathered to accomplish this paper and 100 manufacturing experts have been asked to fill the questionnaire using purposive sampling.

The online mailing, telephonic interviews, and two follow-ups fetch 87 usable responses. The time period of data collection was Oct – Nov 2020. A questionnaire was developed to collect the data from the academicians (who are teaching operations in various institutions, colleges and universities) and industry experts. The layout of the questionnaire was as follows:

(1) Introduction to supply chain and COVID-19 impact

(2) Description of supply chain barriers

(3) Guidelines on how to fill in the questionnaire tables

(4) Pairwise comparison matrix of the factors.

Since, the objective of the paper is to identify supply chain barriers and their impact on different Indian industries during the COVID-19 times. Therefore, this paper investigates the sensitivity of the supply chain to the unfolding pandemic crisis by identifying the five

main barriers for Indian manufacturing industries in the new COVID-19 time by employing a hierarchical approach, based on multi-criteria analysis, *i.e.,* Entropy and The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) approaches. The paper is organized in five sections. Section 2 discusses research methodology for study and covers both Entropy and TOPSIS method. Section 3 covers application of the proposed work. And, section 5 concludes the study, and discusses implications of the study.

2.   METHODOLOGY PROCEDURES

Though several studies have been conducted on obstacle difficulties in the supply chain, no research has been conducted during COVID-19 assessment and classification of these deficiencies. This study aimed to rank the barriers encountered in supply chain due to COVID-19 by importance of degrees, using the integrated Entropy and TOPSIS approaches. Classification of the barriers encountered in supply chain due to COVID-19 is shown in Figure 1, and have been identified after several rounds of brainstorming and discussion.

The second aim of this study is to prioritize attribute and sub-attributes that can be used for the evaluation of the different economic sectors of India. Integration of Entropy and TOPSIS (Salehi et al. 2020; Liu et al. 2019; Wang et al. 2007) approaches are evidently used in numerous applications of real life study. These approaches are chosen because they offer straightforward solutions for difficult decision-making problems and produce precise and efficient outcomes. However, no research has been done on the challenges to newly developed studies focused on COVID-19 effect on supply chain systems.

The primary objective is to recognize the barriers and prioritize them, and their effect on manufacturing industries during COVID-19. The Entopy and TOPSIS have been chosen as the most suitable form for determining the impact of COVID-19 on supply chain and supply chain performance in different manufacturing industries. The data analysis part was divided into two sections. The first section comprised of application of Entropy to assign weights to various attributes (section 2.1).

The second section involved application of TOPSIS to assign ranks to different attributes as per closeness index value (section 2.2). In the current study, Entropy is used to calculate the weightages, which will serve as a primary input to TOPSIS analysis. The steps of the methodology we apply is given below:

2.1. Determination of Weight

The Entropy weight approach from thermodynamics to information systems was initially implemented (Shannon, 2001). In communication systems, the vagueness of signals is called "information entropy". The smaller the entropy, the larger the weight. Assume *m* alternatives are available for the evaluation of *n* assessment requirements, let S_{ij} is the initial assessment value of the decision matrix. The Entropy weight approach for determining the rank of the attributes is described below:

Step i) The decision matrix is standardized as follows:

$$R_{ij} = S_{ij} \bigg/ \sum_{i=1}^{m} S_{ij} \quad , i=1,2,3,...,m \text{ and } j=1,2,3,...,n \tag{1}$$

Where R_{ij} is the normalization value of the decision matrix.

Step ii) The information entropy for each index is defined as:

$$A_j = -(In\,m)^{-1} \sum_{i=1}^{m} S_{ij} In(S_{ij})$$

And the information entropy for each index is defined as:

$$w_j = \frac{(1-A_j)}{(n - \sum_{j=1}^{n} A_j)} \tag{2}$$

Where $0 \le w_j \le 1$ *and* $\sum_{j=1}^{n} w_j = 1$. Here w_j is the weight attached with each of the attributes.

2.2. Determination of Criteria and Attributes

TOPSIS procedure (Hwang et al., 1993; Dwiedi et al., 2018) for determining the rank of the attributes is described below:

Step i) Use the equation (3) to construct the normalized decision matrix

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$$R_{ij} = \frac{S_{ij}}{\sqrt{\sum_{i=1}^{m} S_{ij}^2}}, \quad i=1,2,3,...,m \text{ and } j=1,2,3,...,n \tag{3}$$

Step ii) Calculate the weighted normalized decision matrix (V_{ij}) after obtaining the normalized matrix, by using equation (4)

$$V_{ij} = R_{ij} * w_j \tag{4}$$

Step iii) Determine the ideal solution of each of the attributes *i.e*, assume that v_j^+ be the positive ideal solution of the attribute's and v_j^- be the negative ideal solution of the attribute's.

$$V_j^+ = \left\{ \left(\max_i V_{ij} \mid j \in J_- \right), \left(\min_i V_{ij} \mid j \in J_+ \right) \right\} \tag{5}$$

$$V_j^- = \left\{ \left(\min_i V_{ij} \mid j \in J_- \right), \left(\max_i V_{ij} \mid j \in J_+ \right) \right\} \tag{6}$$

Where, J_+ and J_- have a favourable and detrimental effect correlated with the attribute's.

Step iv) Compute the equidistant measure from each of the positive and negative ideal solutions, *i.e.*,

Use the equation (6) to determine the equidistant of each alternative from the positive ideal solution:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^+ \right)^2} \tag{7}$$

Use the equation (8) to determine the equidistant of each alternative from the negative ideal solution:

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^- \right)^2} \tag{8}$$

Step v) Use the equation (9) to determine relative proximity to the ideal solution and rank them.

$$R_i^* = \frac{d_i^-}{d_i^+ + d_i^-}, \quad 0 \le R_i^* \le 1 \tag{9}$$

Note that, the higher the relative proximity value, the higher the rating order and hence the better the alternative results.

3. APPLICATION OF THE PROPOSED FRAMEWORK

The supply chains are in the global spotlight while the world is confronting the human and economic crises and pose complex problems. This year's COVID-19 pandemic has triggered unparalleled global health and economic distress worldwide. Several countries have implemented and continue to impose comprehensive lockdowns to reduce the quick spread of infection across their population.

This has contributed to major global disturbances in demand and supply. When the pandemic crisis deepened and nations started lockdowns, supply chains encountered something totally new: Structural bursts in demand, where individuals stock in commodity staples to meet with mass deportations, often purchase months' worth of merchandise in one day. Naturally, this lockdown presented major obstacles to industries that supply 'relevant' products and services, such as the healthcare industry.

The fast reaction from internal departments, business bodies, and policymakers has helped those businesses mitigate disruption. The supply chains are broken or seriously affected with widespread disturbances. The supply chains in India will be experiencing major transitions in the near future as the effect on production and consumption systems continues to threaten due to COVID-19. As existing problems on the supply side continue to be resolved, demand will decrease in some sectors of industry, causing more disturbance. Organizations should react to this current reality and learn about creating supply chain sustainability in certain ways.

Disruptions in terms of the size and magnitude of supply chain is unparalleled and are further compounded by the multinational existence of the underlying supply chain. The present situation has really brought to the fore the interconnectedness and interdependence that happens in all facets of our lives, but this has been experienced more than in the global marketplace in no other respect. In addition, a supply chain has to be implemented seamlessly with many separate elements and a large human workforce that supports and facilitates it.

The COVID-19 pandemic exposed the vulnerabilities of those supply chains and highlighted the importance of supply chains to the public and to the world economy. As the Indian lockdown began, demand for vital goods forced some organizations to scramble for

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supplies and raw materials, while other organizations saw their demand totally stagnated or deteriorated.

After reviewing the literature, we have identified number of barriers occurring in the supply chain during the COVID-19 times, it includes, lack of man-power (Prakash & Barua, 2015; Katiyar et al. 2018; Mahajan & Tomar, 2020; Biswas & Das, 2020;), local laws enforcement (Badenhorst 2016; Kaur et al., 2018; Biswas & Das, 2020), lack of transportation (Khurana et al. 2011; Mahajan & Tomar, 2020; Biswas & Das, 2020), scarcity of raw materials (Cavallo et al., 2014; Kaur et al., 2018; Biswas & Das, 2020), and deficiency in cash flow in the market (Parkan & Dubey, 2009; Prakash & Barua, 2015; Cavallo et al., 2016; Biswas & Das, 2020). Classification of the barriers encountered in supply chain due to COVID-19 is shown in Figure 2 along with industries.
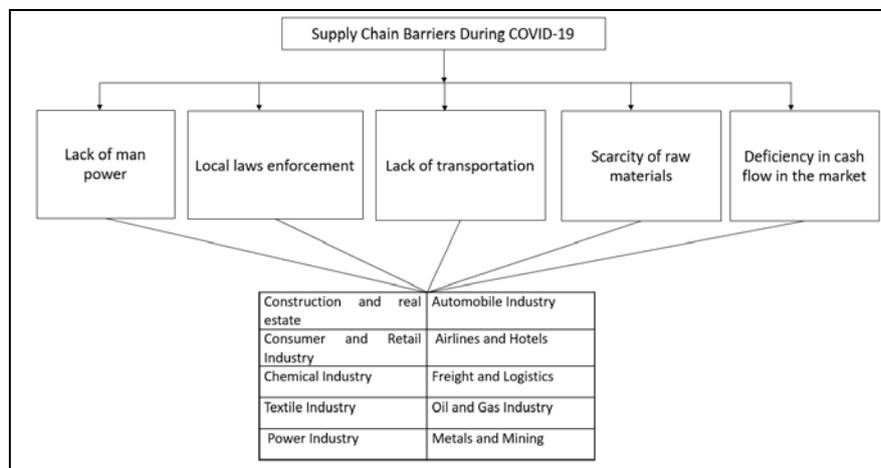

Figure 2: Supply Chain Barriers

During the 21-day cycle of locking, the ongoing unavailability of employees affects the most important supply chain of industries. Despite being one of the key resources and enabling production to continue, a lot of manufacturing plants fail to operate their capacities because the number of employees is not sufficient. At present and even after COVID-19, the lack of labor, since most jobs in the manufacturing hubs relocate, is clearly a big concern. This heat map of trucking movements in the country shows very simply the effect of COVID-19 on the logistics business.

Although transport is the cornerstone of logistics, the industry acts as a hub for other main business sectors, such as material processing, storage, packaging, shipping protection, warehouse control, supply chain administration, acquisition and customs services. While the Center has kept the country's key ports and airports open for freight transport despite a

current crisis, restricted evacuation of the imported raw material to factories would create production barriers for FMCG firms.

Owing to the small potential of both sea and air freight ports in India, businesses face a shortage of imports of goods that are exceedingly difficult to find for a domestically manufactured substitute. In these tough times businesses are collaborating together with the government and local authorities to make sure that our nation's peoples enjoy consistent and uninterrupted distribution of critical products.

The disruption from COVID-19 is not limited to select market pockets, but is a prevalent disease that is likely to keep the economy sick for long indefinitely. Although the severity of the effect will vary from industry to industry, some industries have suffered more and are still suffering. The impact of COVID-19 on the following industries, Power Industry, Consumer and Retail Industry, Chemical Industry, Construction and Retail Industry, Freight and Logistics, Metals and Mining, Textile Industry, Oil and Gas Industry, Automobile Industry, Airlines and Hotels have been observed.

4. RESULTS AND DISCUSSION

The survey questionnaire has three sections. Section A seeks to obtain details regarding the participant in specific. In Section B information regarding the effect of lack of man-power, local laws enforcement, lack of transportation, scarcity of raw-materials, and deficiency in cash flow in the market in specific industry have been mentioned. In Section C, these factors are rated on the five scale Likert scale (1= Not at all effective, 2=slightly effective, 3=moderately effective, 4= very effective, 5= extremely effective) and also in the questionnaire the effect of COVID-19 on the following industries, Power Industry , Consumer and Retail Industry, Chemical Industry, Construction and Retail Industry, , Freight and Logistics, Metals and Mining, Textile Industry, Oil and Gas Industry, Automobile Industry , Airlines and Hotels and have been surveyed and the problem faced by it rated on the five scale Likert scale.

Table 1: Descriptive Statistic of barrier's

Factors	Mean	Standard Deviation	Kurtosis	Skewness
Lack of man-power	4.32	0.61	0.11	-1.44
Local laws enforcement	4.48	0.99	-0.83	-0.56
Lack of transportation	4.26	0.91	0.66	-0.19
Scarcity of raw-materials	4.45	0.45	2.87	-1.36
Deficiency in cash flow	4.11	0.84	-0.26	-0.48

Table 1 shows descriptive statistics of the considered barrirers in supply chain during COVID-19. Among them, the mean value of Local laws enforcement and scarcity of raw-materials is found to be higher than all the considered barriers. The hierarchical structure of the case under consideration were characterized by various number of barriers and affected industries, as seen in Figure 1. According to the obtained survey result, the criteria and attributes with highest total rank have been used to form the hierarchy table to evaluate the barriers of supply chain and their impact due to COVID-19 on the different industries of India.

A total of five major criteria's were chosen for estimating the COVID-19 impact on ten industuries of India. The main criteria of barriers of supply chain have been evaluated pair-wise and comparison matrix has been built and their weights determined by using the Entropy method is been given in Table 2.

Table 2: Normalize matrix of barriers

Barriers	Lack of man-power	Local laws enforcement	Lack of transportation	Scarcity of raw-materials	Deficiency in cash flow
Lack of man-power	1.000	1.241	0.917	0.971	1.051
Local laws enforcement	0.806	1.000	0.739	0.782	0.847
Lack of transportation	1.090	1.353	1.000	1.058	1.146
Scarcity of raw-materials	1.030	1.279	0.945	1.000	1.083
Deficiency in cash flow	0.951	1.181	0.873	0.924	1.000

Table 2 shows the normalization of the barriers and Table 3 shows result of the weightage of each barriers obtained after applying the Entropy method. Table 3 indicated that the local laws enforcement have the most significant weightage with 33%, and deficiency in cash flow have the least significant weightage with 13%.

Table 3: Weighatge of the barriers

Barriers	Lack of man-power	Local laws enforcement	Lack of transportation	Scarcity of raw-materials	Deficiency in cash flow
Entropy Value	0.0602	-0.7387	-0.0955	0.1456	0.2954
Weightage	0.1762	0.3260	0.2054	0.1602	0.1321
Weightage (%)	18%	33%	21%	16%	13%

After obtaining the barriers weight, our next task is to find out which industries are affecting most during the COVID-19 pandemic. The relative proximity of the considered industries is determined by after applying the TOPSIS, and the obtained result is given in Table 4. It indicates that the Airlines and Hotels is the most affected industries, followed by Automobile Industry, and Construction and Retail Industry while the least affected industries during the COVID-19 time is Chemical Industry.

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Table 4. Ranking of Industries

Industries	d_i^+	d_i^-	R_i^*	Rank
Airlines and Hotels	0.065	0.422	0.8665	1
Automobile Industry	0.038	0.218	0.8516	2
Construction and Retail Industry	0.042	0.179	0.8100	3
Textile Industry	0.197	0.442	0.6917	4
Freight and Logistics	0.0543	0.058	0.5165	5
Metals and Mining	0.098	0.091	0.4815	6
Oil and Gas Industry	0.071	0.037	0.3426	7
Power Industry	0.122	0.018	0.1286	8
Consumer and Retail Industry	0.43	0.047	0.0985	9
Chemical Industry	0.654	0.066	0.0917	10

Centered on lessons that are improved and tested in the ongoing economic crisis, organizations will build robust supply chains in the post-COVID environment in a number of ways. Firstly, it is urgent that physical labour is minimized across shipping, procurement and processing. This can be achieved by using crucial emerging technology such as Internet-of-things, block-chains, controls, quantum computing learning for the estimation of production, regulatory and self-adjusting inventories, individual robots like AGVs, drones, among others.

The standard would be factories capable of modularizing manufacturing and shifting/adapting lines in view of changing demand. They would be assisted by supply networks that would constructively connect with each other and make their productivity and agility better. Enterprises will concentrate much on delivering essential systems on the cloud that enable staff to access them remotely when operating at home.

We will need to see more of the cloud migrants taking the last leap to the other hand and eventually switch into the cloud to allow business processes. Protection will also be a crucial aspect and the risk control of suppliers will be central to all the strategy efforts. One of the few promising facets of COVID-19 has opened us to the possibility of remote working through markets, sectors and enterprises, and this development will lead to a renewed emphasis on the ideals of environmentally sustainable activities as it is preserved in the post COVID world.

In conclusion, our capacity to learn from our accumulated experiences and to apply these learning strategies more powerfully than any other sentient mode of life. In exclusively commercial words, COVID-19 poses a range of significant obstacles, often unparalleled, to companies, including a potential cash crisis, worldwide supply chain interruptions, increased trade barriers and changing customer preferences. However, emerging technology will play a vital role in developing companies in the post-COVID era, including more resilient supply

chains, better customer interface, and intelligently optimized systems to achieve market performance.

5. CONCLUSION

The instability of dynamic global supply chains based on lean production theory has been established by COVID-19. This is especially true in the healthcare sector where the scramble for protective gear has demonstrated that inventory and single supplier versions are exposed primarily to the risks associated with cost management. The effects of the lockdown of China and its domination in main production areas have further exposed the issue with supply chain management. When the Chinese and other factories in developed countries were shutdown down to COVID-19 pandemic, global suppliers were unable to swing because the supply base was lacking in versatility.

One potential outcome is that multinational companies will in the future diversify supply chains, rather than depending exclusively on China and other developed countries. New manufacturing hubs such as Vietnam, Mexico and India would possibly benefit from this move. A swift, full-scale digitization of the paperwork accompanying global trading would underpin the transformation into a modern paradigm of supply chains.

The ties between buyers and suppliers remain largely paper dependent, despite quick advancements in technology. Digitizing the interaction between customer and seller is a crucial factor in creating robust supply chains and far less time intensive to find and hire new vendors. Supply chains will easily migrate to substitute vendors using technology, such as machine learning and the internet of things, if suppliers are constantly interrupted. The current crisis is a chance to re-establish a structure that relies on redundant processes. The construction of smart and scalable supply lines is a key to creating a global network to handle potential storms.

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