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TRANSPORTATION CHALLENGES ON SCM IN POST COVID 19 SCENARIO: A STUDY ON INDIAN CONTEXT

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Abstract

In a supply chain operation, disruption is a normal phenomenon due to unforeseen occurrences of natural disasters, vehicle breakdowns, and accidents. Hence, some amount of agility and robustness is always incorporated into the supply chain (SC). But the outbreak of the Covid 19 pandemic has changed the scenario of business and so of the supply chain. Large-scale disruption, with almost global lockdown, has forced business entities and researchers to look beyond the resilience and think of a long-term practical measure. Transport, which is the backbone of SCM, need to be tackled on a first-hand priority. In this paper, the study focuses on exploring the present transportation system of the Indian business scenario and its disruption due to Covid 19. This research is based on secondary data. A simple regression method was used to analyze the data and make predictions. An attempt has been made to understand the scenario of post-Covid19 transportation logistics and a model has been proposed to mitigate SC risk to withstand any disaster like Covid 19 in the future.

Key words: Railway transport, Risk Mitigation, Road Transport, SCM risk, Transport Risk Mitigation Model and Triangulation method

INTRODUCTION

The devastating spread of Covid 19 has shaken the world in a pervasive manner leading to lockdown and ultimate closure of manufacturing activity. This led to supply chain disruption, disturbing the flow of goods and services, and transport disruption. This resulted in escalation of prices of raw materials as well as intermediaries on a global level. And the declaration of containment zones impeded though temporarily, the movements of both human and goods leading to disruption of freight mobility and international trade. The net effect was felt in the form of disturbance in goods flows, finished product mobility, and turbulence in the supply chain, resulting in the shutdown of operations, untimely delivery, lost sales, and a question mark on organizational capability

The surge in transportation costs has directly affected the supply chain with cascading effect on overall production and trading activity. As transportation is prime driver in logistics operation, it influences the overall performance of supply chain and its resilience too. Though, a temporary or localized issue like breakdown or weather generally affects transportation, but the disruption due to COVID19 halted the transportation, shaking the fundamental of supply chain with uncertainty beyond conceivable imagination. The fall out was clear; one could feel the pinch of disrupted transportation with varying degrees of impact across air, rail, road, and sea sectors.

The consequence of these disruptions needs to be addressed using more innovative supply chain strategy, robust operational

planning with effective risk management practice to bring back business from slump to normal operation. This study is an attempt to understand the Covid 19 induced transport disruption, and possible remedial action to accelerate the recovery of Indian firms from disrupted SCM scenario as a fallout of this with pragmatic short term and long-term measures.

LITERATURE REVIEW

According to Hendricks and Singhal (2003) a supply chain disruption (SCD) used to have a varied impact on operational and financial performance of a firm based on its severity. As global completion increased, the business enterprises are entering an era of uncertainty and vulnerability. This uncertainty is more accounted to supply chain functioning and its resilience. Hence more emphasis is now on supply chain risk in SCM research (Zsidisin, 2003). Craighead et al. (2007) observed that on the other way business risk also lead to supply chain disruption. To mitigate this, there need to effective co-ordination between backward and forward supply agents making the whole SCM more complex and sensitive (Blackhurst et al., 2005).

In last few years natural disasters are impeding the flow of transportation severely affecting logistics operations (Tang and Musa, 2011; Sheffi, 2015). Disruption has given rise haphazard flow of materials (raw, semi-finished, and finished) leading to delays in point-to-point delivery in the SCM network (Zhen et al., 2016).

The COVID-19 pandemic was all-pervasive neither limited to

the geographical region nor to any specific time horizon; affecting all human activity, it did jeopardize the supply chain affecting industrial production, distribution, delivery, and the overall market. Its ripple effects have forced the industrial entities to design a robust Supply Chain Resilience Management (SCRM) strategy (Chen et al., 2019; Pournader et al., 2020) backed by data and digitisation (Choi, 2020; WEF, 2020a,b) focusing on the better response (Ivanov et al., 2019).

COVID-19 had jeopardised the global entities depending on the lean concept of manufacturing (Ivanov, 2020). It completely destroyed the so-called resilient supply chains and brought a near complete halt to production and logistics activity leading to flow breakdown/disruption. With perpetual lockdown throughout the globe, demand shows a downward slope due to loss of employment (resulting in low demand for material, and labour, as also the supplies, and delivery). This has severely affected the supply chains as no standard supply chain resilience mechanism like reserve inventories for contingency, outsourcing, alternate supplier, and stand by transport infrastructures, backup channels of distribution, and FMS operation (Araz et al., 2020) could function at desired level. The supply chain resilience could have been achieved by earmarking contingency inventories, effective channel partners (subcontractors), backup logistics (mostly transportation) mechanism, and a web-based digital control system for visibility (Dolgui et al., 2020; Xu et al., 2020). Disruptions leading to near halt of production, haphazard distribution, and transportation break down have definite consequences on, the economy with impeded mobility resulting in supply chain disruption and hence the disruption in normal business operation (Lin et al., 2020). The imposed restriction due to the COVID-19 pandemic resulted in destabilized economical operations and hampering all modes of transportation be it maritime, rail, air, or road severely affecting the transport (trucking) industry. (de Vos, 2020; Gössling et al., 2020). No doubt, this catastrophic economic shutdown with disruption in the supply chain has propelled many firms to nothing less than bankruptcy (Tucker, 2020). Even automotive giants like Fiat and Hyundai have to temporarily halt their manufacturing activity due to the restrictions for COVID-19- and consequent supply chain disruptions (Ivanov, 2020).

To be precise the aftermath of Covid 19 giving rise to trade restrictions, reduced demand, and disruption in transportation have negatively affected the supply chain and there was a drastic reduction in freight volumes. With the cancellation of flights, the air-cargo movement was cramped, and the temporary closure of ports led to delayed customer clearance. Global circulation (both labour and material) was hampered leading to shortage of material and workforce. As a net effect, neither production could happen, nor could consignments reach their destination. Everything led to waste in transit.

Hence, the crisis of the magnitude of COVID-19 requires effective policy modifications to address the SCDs, which demands a different approach incompatible with earlier experiences of disruption. In an unprecedented scenario, both

demand and supply have declined substantially in all business activities. The Covid -19 instigated the first global Supply Chain Disruption (SCD) in modern business scenario forcing the business entity to think and devise robust Global Supply Chains(GSCs), properly backed with risk prediction in a scientific manner and the remedial measures too.

The new emergent of e-business (e-commerce) economy supplemented with the quick shipment (e.g., FedEx, DHL, and UPS) have brought a paradigm shift in supply chains and logistics. It has been found that during pandemic not only these e-business companies survived but had shown a positive growth. It is expected that these entities are expected to register a compound annual growth rate of 19.6% between 2019 to 2023. By the end of 2023 they are expected to hit US\$98.4 billion market in India.

Therefore, undoubtedly, for a resilient supply chain to withstand unprecedented pandemics like the COVID-19 a robust transport and logistics service is a vital component in the global business scenario. However for a pandemic like Covid19 which dismantled the total transport scenario, neither the practicing managers nor the researcher has focused any attention to its perceived impact on logistics and transport operation. To be precise a systematic analysis yet to be made on the disruptive impact of Covid 19 on logistics, transportation and overall supply chain (Sarkis et al., 2020). In the past researchers like Mamani et al. (2013) and Büyüktaktakin et al. (2018) have made studies on possible fallout of any outbreak of epidemic and its fall out on normal business operation. According to Baghalian et al., 2013; Chen and Chen, 2014; Tan et al., 2020 any disruption on transportation vis a vis logistics leads to severe impact on supply chain performance. In this context of Covid 19 many retail buying became online, there happens to be a steep increase in this segment with e-commerce payment gateways registering a growth of 26.9% during this period (GD, 2020). In this article the researchers are trying to understand and cement the information gap in the area of supply chain disruption (SCD) due to pandemic particularly emphasising on transport and logistics scenario in Indian business scenario.

OBJECTIVES

There is supply chain disruption (SCD) due to pandemic and that is to be recognised and tackled with effective risk mitigation techniques. In order to explore the SCD and it's after effect this study is an attempt to:

- Propose effective remedial (short term) as well as preventive (long term) strategies and prediction of transport risk management in order to bring back business to track.
- Analyze the operational challenges in implementing the proposed model and its utility in optimizing the available transport and logistics resources by the firms.

METHODOLOGY

This is an exploratory study based on secondary data collected through a web search, journals, magazines, and desktop documentation. The researchers have used data triangulation method with theoretical back up. Information gathered from various sources of literatures in a structured manner were used for data triangulation. This is more comprehensive and can be credibly validated. Since data is secondary in nature the data triangulation method would be helpful in testing the risk mitigation model developed in the context of Covid 19 for any such identical situation. The prediction for the next cycle is done by using the simple regression method.

Observation and Analysis

India's Performance

A. Transportation

While observing cargo handling by sea routes, railways, and air for the last five years it has been observed that the steady growth

has been hampered in FY 2020-21. The decline in cargo is a direct fall out of national lockdown during that period. In 2021-22 it is predicted (by simple regression method) that there would be an increase in cargo handling on rail and sea routes as economic activities started resuming.

Air cargo activities in India are relatively small and the impact of covid 19 and resumption of economic activities are insignificant either for decline or for growth (Figure 1). To augment this infrastructure massive work has been undertaken. The airfreight traffic is likely to reach 3.75 MT in FY2021-22. An FDI inflow of the tune of INR 200 billion or more has been made in India's air cargo sector in the span of 20 years (i.e. 2000 to 2020) and another investment of the tune of INR 400 billion is expected by year 2024. This is also expecting a substantial investment (INR of 100 billion by 2026) in peripheral infrastructure for air cargo handling. Going by IBEF, 2020(b) report the National Air Cargo Policy Outline 2019 is going to remarkably place India as one of the most efficient and effective air cargo and logistics player in global scenario by the end of 2030. Table 1 gives a regression model for predicting air cargo transportation in India.

Table 1. Regression Model - Air Cargo

<i>Regression Statistics</i>								
Multiple R	0.9304							
R Square	0.8656							
Adjusted R Square	0.8321							
Standard Error	0.1483							
Observations	6.0000							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1.0000	0.5670	0.5670	25.7727	0.0071			
Residual	4.0000	0.0880	0.0220					
Total	5.0000	0.6550						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	2.6700	0.1381	19.3363	0.0000	2.2866	3.0534	2.2866	3.0534
X Variable 1	0.1800	0.0355	5.0767	0.0071	0.0816	0.2784	0.0816	0.2784

As an impetus to cargo handling strategy a significant FDI (of the tune of INR 148 billion from 2000 to 2020) has been pumped to establish seaports to boost maritime infrastructure. In the period of 2016 to 2019 INR 172 billion has been spent to upgrade major ports of India. And around INR 16 billion was spent to develop peripheral infrastructure of Indian seaports from year 2020 to 2021. It is an ambitious attempt expecting a compound annual

growth(CAGR) of 5 to 6% of Indian seaport facilities with cargo handling capacity enhanced by 275 to 325 MT by the end of 2022. Going by IBEF, 2020(a) report the cargo movement in Indian sea ports is expected to go up to 1695 MT in the FY 2021-22. Table 2 gives a regression model for predicting maritime cargo transportation in India.

Table 2. Regression Model Maritime Cargo

Regression Statistics								
Multiple R	0.7311							
R Square	0.5345							
Adjusted R Square	0.4181							
Standard Error	68.3191							
Observations	6.0000							
ANOVA								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1.0000	21437.5000	21437.5000	4.5929	0.0987			
Residual	4.0000	18670.0000	4667.5000					
Total	5.0000	40107.5000						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	1061.0000	63.6016	16.6820	0.0001	884.4136	1237.5864	884.4136	1237.5864
X Variable 1	35.0000	16.3314	2.1431	0.0987	-10.3432	80.3432	-10.3432	80.3432

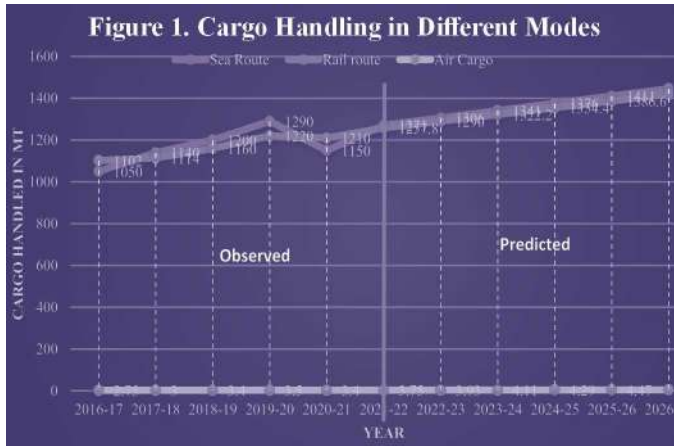
Looking at India’s rail network, which consists of 123,236 km of railway tracks, caters to 9416 goods carriers handling three MT of freight per day. The COVID- 19 pandemic has compelled, at the same time opened an opportunity for Indian railways to improve their freight carrying capacity. There is significant enhancement of rail freight traffic going up to 1257 M in FY 2021-22 as compared to 1210 M in FY 2020-21. This is realized with enhanced carrying capacity, in cost effective manner and better service operation resulting revenue generation. Restrictions and consequent disruption in road transport due to COVID-19 have given rise to an increase in rail freight loading. It can be understood from the fact that in October 2019, freight loading and consequent revenue generation was 93.75 million

tons and INR 96 billion has increased to 108.16 million tons with a revenue of INR 130 billion respectively in October 2020. There is a substantial increase in railway infrastructure investment (from US\$31.03 billion during 2012-18 to US\$58.96 billion during 2013–2018) with an ambitious plan of attracting investment to the tune of US\$124.13 billion during 2018– 2022. Indian railway network planned to increase the dedicated freight corridor to make it capable of transporting 182 MT in FY2021-22. In 2016-17 the capacity used to be 40 MT. For this type of mega expansion and modernization, India is going to mobilize INR3500 billion by 2032. Table 3 gives a regression model for predicting rail cargo transportation in India.

Table 3. Regression Model-Rail Cargo

Regression Statistics								
Multiple R	0.9684							
R Square	0.9378							
Adjusted R Square	0.9222							
Standard Error	17.3522							
Observations	6.0000							
ANOVA								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1.0000	18144.7000	18144.7000	60.2614	0.0015			
Residual	4.0000	1204.4000	301.1000					
Total	5.0000	19349.1000						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	1064.6000	16.1541	65.9030	0.0000	1019.7492	1109.4508	1019.7492	1109.4508
X Variable 1	32.2000	4.1480	7.7628	0.0015	20.6834	43.7166	20.6834	43.7166

After carefully observing the scenario it was found that there is steady growth in railway and maritime cargo in India with minor jerk during the Covid 19 Further there would be linear growth in both rail and maritime(sea route) cargo handling with sea route probably surpassing railway cargo in terms of volume. Though there would be growth in air cargo, the impact would not be significant (Figure 1).



Ref: Authors’ presentation based on Port Data Management Portal, Ministry of Ports, Shipping & Waterways, Government of India, New Delhi (2021) and Ports Sector Update, CARE Ratings, Mumbai (2021).

In India road network is primarily focused on passenger transportation. The road network in India stands at 5.89 million

km, taking care of 90% and 65% of inland passenger and goods transport respectively. Hence looking at goods transport potential and taking note of the unstable investment in Indian road infrastructure since 2017, the government took an initiative to construct 65000 km of national highways with an ambitious investment plan of whopping INR 5000 billion in F Y 2022-23. All the monitoring and toll collection on national highways has been digitised with cloud computing and AI executed BDA platform in the mid-2020. Again, going by IBEF, 2020(d) report India could foresee an investment of INR 4000 billion by 2032 for approach road and other peripheral development to principal road infrastructure. However no systematic study could be found to make a prediction on road logistics of India.

B. Logistics

Logistics is conglomeration of various activities connected in a systematic manner to deliver the output. It requires innovation based on ground reality and that affects the performance of logistics.

In India the logistics was recognized officially as an infrastructure in the year 2017. Prior to that it was just another transport operation or an extension of the same. Aftermath of COVID-19, the importance of logistics was compulsively felt primarily due to spike in demand of medical and healthcare products and essential commodities. This led to demand in logistics sector, and it is estimated that the global logistics market size shoot up from US\$2,734 billion in 2020 to US\$3,215 billion by 2021 (IBEF, 2020e). The logistics performance and its regression model for prediction is shown in table 4.

Table 4. Regression model for global Innovation and Logistics Performance Index

Regression Statistics								
Multiple R	1							
R Square	1							
Adjusted R Square	1							
Standard Error	6.20634E-							
Observations	18							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	0.0546875	0.02734375	7.09884E+32	7.36005E-			
Residual	5	1.92593E-34	3.85186E-35		82			
Total	7	0.0546875						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-6.5	2.65516E-16	2.44806E+16	2.15869E-81	-6.5	-6.5	-6.5	-6.5
USA	2.5	7.16646E-17	3.48847E+16	3.6739E-82	2.5	2.5	2.5	2.5
China	-2.94392E-	4.74017E-17	6.210590034	0.00158119	-4.16242E-	1.72542E-	4.16242E-	1.72542E-
	16				16	16	16	16

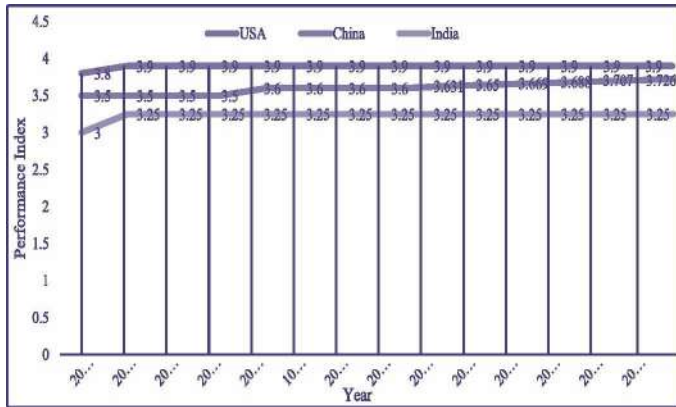
It is observed and consequently predicted that as far innovation is concerned in logistics USA and China are becoming close to each other though USA has an edge (Figure 2). India is running with low index in parallel to USA. And the correlation (Table 5) of change among India and USA is perfectly correlated as India has

highest volume of foreign trade with USA and readjust itself as per USA requirement. With China the correlation is loosely positive. But since China is a trade giant it very much important for to readjust itself and enhance the innovation in logistics.

Table 5. Co-relation on Global logistics and performance Index

	USA	China	India
USA	1.000	0.378	1.000
China	0.378	1.000	0.378
India	1.000	0.378	1.000

Figure 2. Global Innovation and Logistics Performance Index



(Created by researcher with data input from Cornell University, INSEAD, and WIPO, 2020 published work)

Figure 2 shows the global innovation and logistics performance index which indicated that India needs to make better innovations in order to be an effective logistic operational hub. As per the Government India report in 2018, there are only 10 to 15% of organised players in the logistics industry. This indicates that India’s logistics industry is dominated by unorganised

players. As 14% of India’s GDP goes in logistics it warrants immediate attention for structuration In developed countries like Japan and US, this expenditure amounts to only 11% and at around 9–10% of their GDP respectively. Hence, it is very much necessary to reduce the logistics costs with upgraded infrastructure and incorporate modern technologies like artificial intelligence and effective digitalization for efficient freight management, cargo handling, better supply chain performance and reduced logistics cost.

COVID-19 IMPACT ON INDIA’S TRANSPORTATION AND LOGISTICS

It is no secret that, COVID-19 and consequent lockdown measures have severely disrupted the mobility, impended the global trade and destructively retarded the logistics sector. At the beginning, with the onset of lockdown the delivery schedule got disrupted rather completely halted as intermodal movement of goods became dysfunctional. Under capacitated vessel movements led to shortage in supply severely affecting domestic and international trade in a negative manner. Business entities worldwide learnt that this type of global disruption necessitates a robust response system after being caught off-guard and rendering substantial loss. Hence robust transport infrastructure is very important for achieving seamless supply chain. Based on historical data the following are expected regression model (rank in table 6 and score in table 7) and consequent prediction as far as India’s market accessibility and infrastructure is concerned.

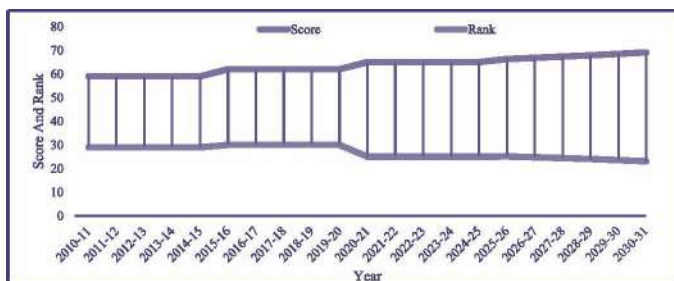
Table 6. Regression Model of India's Rank on Transport Logistics

<i>Regression Statistics</i>								
Multiple R	0.7143							
R Square	0.5102							
Adjusted R Square	0.4725							
Standard Error	1.6240							
Observations	15.0000							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1.0000	35.7143	35.7143	13.5417	0.0028			
Residual	13.0000	34.2857	2.6374					
Total	14.0000	70.0000						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	30.8571	0.8824	34.9691	0.0000	28.9508	32.7635	28.9508	32.7635
X Variable 1	-0.3571	0.0971	-3.6799	0.0028	-0.5668	-0.1475	-0.5668	-0.1475

Table 7. Regression Model of India's Score on Transport Logistics

<i>Regression Statistics</i>								
Multiple R	0.9449							
R Square	0.8929							
Adjusted R Square	0.8846							
Standard Error	0.8613							
Observations	15.0000							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1.0000	80.3571	80.3571	108.3333	0.00000011			
Residual	13.0000	9.6429	0.7418					
Total	14.0000	90.0000						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	57.7143	0.4680	123.3292	0.0000	56.7033	58.7253	56.7033	58.7253
X Variable 1	0.5357	0.0515	10.4083	0.0000	0.4245	0.6469	0.4245	0.6469

Figure 3. Market Accessibility and Transport Infrastructure in India



[Created by the researcher with input from Legatum Institute, London (2020)]

Figure 3 indicated that though the score is increasing there is slow growth in rank as far as market access and transport infrastructure in India. Hence, some effective measures are needed to take care of this scenario.

TRANSPORT RISK MITIGATION MODEL

Taking cue from preceding observation a Transport Risk Management model has been proposed to take care of any disruption big/or small due to outbreak of any disaster(Figure 4).This model is structured in FOUR stages i.e Cause, Effect,

Strategy and Action. These factors are to be co-ordinated to achieve a proper mitigation strategy.

CAUSE

In this, we try to understand the reason for an SC disruption. The cause may be localised disasters like power failure, flood, cyclone, or, political unrest. It may be an accidental reason like a vehicle breakdown or maybe a more catastrophic global pandemic like Covid 19. In all situations, there would be transportation disruption leading to disrupting the supply with cascading effects on procurement and production. This ultimately affects the demand pattern. Non-essential items generally see a decline in demand whereas essential items experience a surge or maybe a spike in demand (in case of disasters).

EFFECT

The disruption in the supply chain would be affecting all entities of supply chain management. The supplier will not be able to provide ingredients for operation (manufacturing/service) affecting the output. The warehouse will have inventory instability so also the distribution centre, finally affecting the end-users i.e. retailers and consumers.

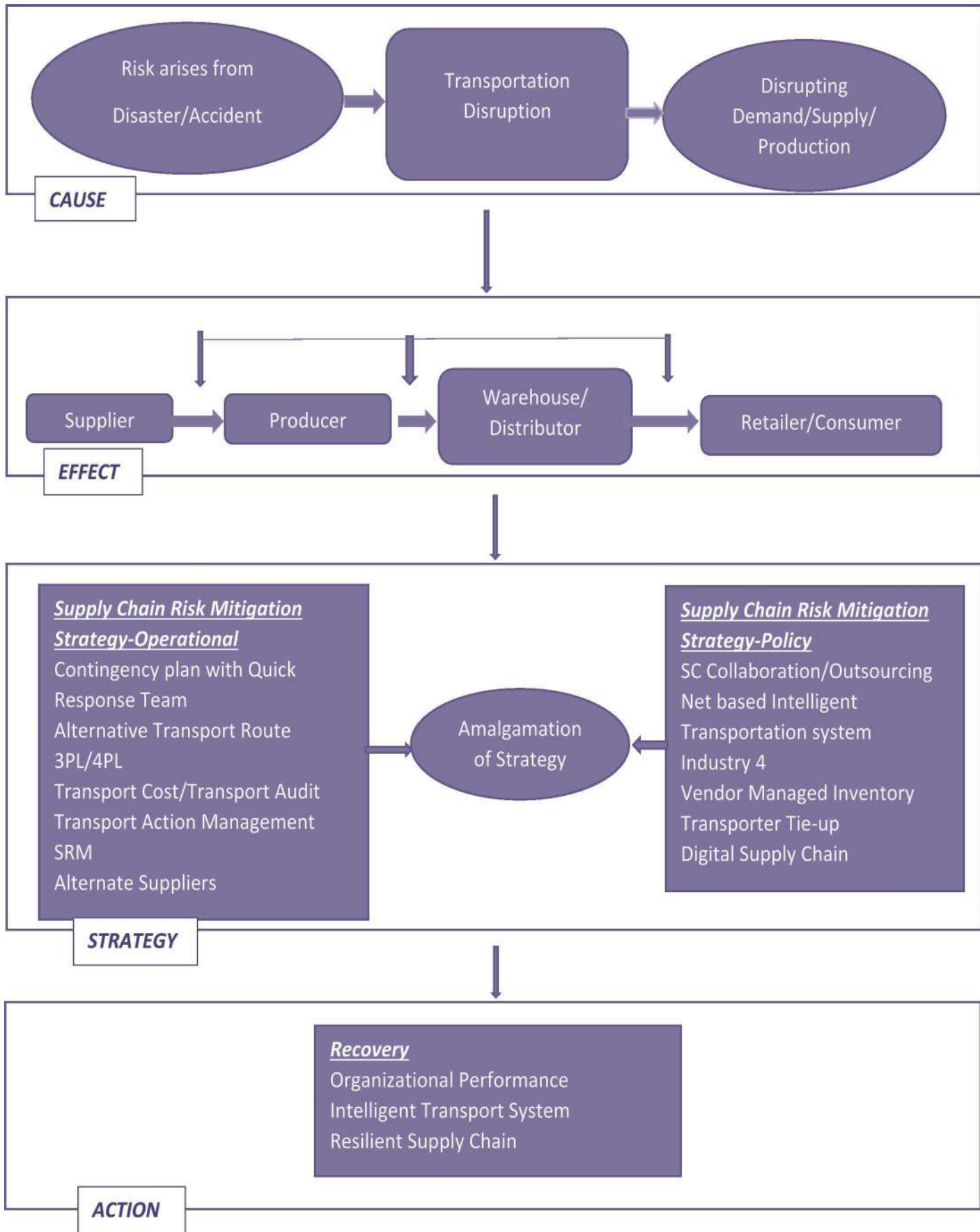


Figure 4: Proposed Transport Risk Mitigation Model

RISK MITIGATION STRATEGY

The risk mitigation in the supply chain is to be a two-pronged approach; a short-term to bail out the immediate situation and a long-term policy to take preventive and curative action.

Supply chain risk mitigation strategy-Operational Contingency Plan / Rapid Action Team

A rapid action team need to be functional in order to detect and fix the gaps in planning and effectively coordinate internal and external activities so that the operational defects are under control and fixed quickly. One need to be cautious on the issues of own capability and possible consequences for not being able to respond in timely manner. This would help to design a mitigation system with proper financial outlay and effective networking to thwart any disruption in transportation system and other related contingencies

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Alternative Transport Route

The transportation and logistics strategies need to be diversified with adequate investments in advance to take care disruption due to gigantic eventuality like COVID19. To take up an alternative transport mode or route is accompanied with direct and indirect cost higher than existing one. The business entity must understand this financial implication and scout for alternatives to existing transportation system with sole aim at reducing the risk of lead time disruption in most optimal way.

3PL/4PL

3PL is one of the viable alternative to reduce transport disruption in situation like Covid 19 as they have the expertise and resources to take up the eventuality to a large extent bridging the gap in delivery schedule between suppliers, manufacturers, and consumers. The 3PL service providers have the logistic infrastructure and information network with a data-driven strategy to provide transportation support irrespective of volume and type of product. In the event of 4PL which is IT backed data-driven operation the work becomes more AI-based availing all possible expertise for transport optimization. Collaborating with a 3PL/4PL will be beneficial in taking care of disruptions in transportation on short term basis.

Transport Cost / Transportation Audit

It is need of the hour that firms must evaluate their routine transportation cost in order to face and survive in a Covid 19 like situation leading to lengthy disruption. It's high time now to understand the criticality of transportation, improve transport responsiveness and visibility in a supply chain. For this an effective transport network needs to be designed; and it must take into account the cost of carrier being fair and equitable. To achieve this a proper transport audit is needed taking into account modes of transport and geographical area encompassed. Routine transport audit not only helps in complying to technical and regulatory requirement but helps in making a foundation to work on other areas of transportation operations like sourcing, planning and execution.

Transport Action Management

Transport Action Management deals with daily operation and minute details on waste generation and its management. This also includes a daily action plan on transportation and its execution as per actual situation or ground reality. Any incompatibility (waste of effort) needs to be accounted for with follow up action to mitigate any disparity with effective remedial action. There needs to be real time information on daily basis in quantified manner .Even outsourcing needs to be documented.

Supplier Relationship Management (SRM)

Harmonious networking with local or domestic supplier is of prime importance for effective SCM. This will be particularly helpful when transportation disruption occurs. This inculcates flexibility in getting contracts to easy and effective transit between different modes of transportation like land, air and sea to with stand disruption in a situation like Covid 19.

Alternate Suppliers

Firms having supplier base diversified in varied geographical locations need to identify and develop a network of second line of supplier. This would help to get the required supply even with a premium so that the system does not get disturbed.

Supply chain risk mitigation strategy- Policy

Policy framework in risk mitigation can help the firms in restart after the disruption. This can be achieved through supply chain networking (collaboration), the intelligent transportation system (ITS), Industry 4.0, vendor-managed inventory, transporter tie-up, and effective digitisation i.e developing an effective supply chain network.

Supply Chain Collaboration

Collaboration is essential to ensure the undisrupted flow, proper transport, and adequate warehousing networking in the supply chains. It is immensely helpful in reducing supply chain transportation costs and can be useful for both B2B and B2C operations. Effective collaboration demands robust cooperation between different stakeholders, the originator, the suppliers, and the end user. This is achieved through resource & information

sharing, along with technical collaboration so that all will be in sync to bounce back from disruptive scenario and become competitive.

(Net-Based) Intelligent Transportation System (ITS)

Logistics and transportation systems can be prudent and effective with the use of IT, and other managerial tools of operation management and decision-making. ITS is a cloud-based interconnection of different information protocols that captures, analyses (computes), and propagates to assist the decision-making in order to prudently manage the flow of vehicles and other transportation devices. This is done through the integration of technologies such as the internet, electronic data exchange, wireless communications, computer technology, programming, and technologies designed to capture and analyze the required information. This helps in administrative payments, freight visibility through RFID, traffic management, border transition, emergency breakdown support, and vehicle data collection. The use of ITS helps in effective and safe navigation and provide real time information to all stake holders so that any traffic or congestion can be taken care of beforehand.

Industry 4.0

It is imperative to integrate an entity in industry 4 to logistics 4 for seamless operation. Logistics 4.0 is a system which combines logistic with innovation being backed by web based digitally controlled physical system. Typically logistics 4 is a combination of ERP and WMS (warehousing management system) in coordination with transport management system (TMS) backed by AI and data security. Being software controlled it provides agility in decision making and recovery becomes relatively easier after a disruption. According to Parast and Shekarian, (2019) the resilience in the supply chain of a firm can be strengthened through operational flexibility, agility, and identifying redundancy of action.

Vendor Management Inventory

Vendor-managed inventory (VMI) helps the different business entities (i.e supplier, producer, distributor and retailer) to work in tandem for achieving the common goal. It is basically an information-sharing approach where information is shared with all stakeholders about the demand pattern and stock situation with lead time to procurement. Being real-time information through EDI, this helps to make a realistic logistics planning. VMI takes out the burden of inventory from the producer and helps in reducing the inventory carrying cost. In a disruption scenario with effective collaboration, VMI can help in mitigating disruption to a large extent.

Transporter tie-up

When shippers, providers, and carriers joined hands for balancing cost and performance, the net result is bound to be positive in the long run. Termed as transporter tie-up/carrier relationship management, this strategy helps team members to understand and respects each other's expectation, gives a broader perspective to the situation, and facilitate the team to

visualize and explore the shared solutions. For example, if there is capacity constraint (limited but predictable) then an agreed upon service demand can be worked out. In today's inter dependency business scenario the bulk shipper and small carrier must come in terms to understand the common aspiration, complementary requirements, and pragmatic operational strategy to arrive at win-win solutions in the long run. This would help the enterprise to effectively adjust to the dynamism of demand and tap opportunities due to risk associated with large scale disruption as a fall out of COVID-19 crisis.

Digital Supply Network (DSN)

Most firms fail to understand the end-to-end structure of the supply chain and the required agility to face the present volatile market. Through DSN, digitized information and transportation networks help a firm to get unlimited real-time visibility. This helps in taking appropriate and practical decisions to avoid any disruption. The DSN is rapid, scalable, intelligent, and connected. With the use of AI, it can help in decision making by effective integration of physical and financial infrastructure for collaboration and open communication in both upward and downward streams of suppliers. All of these will assist a firm to thwart the risks of transportation disruption in the event of a mega disaster like Covid-19.

CONCLUSION

In normal business operations, the interconnected and lean supply chain is the norm in the Indian business scenario. The unprecedented lockdown due to covid 19 has led to massive SCD and businesses faced unimaginable vulnerability shaking the very root of business operation. The dynamism and volatility now go hand in hand and disruption cannot be an exception but a norm. Hence the business entities need to prepare for an alternate logistics system. The business cannot be an isolated operation and hence effective communication is key to any firm along with sharing of real-time information. The proposed model provides an insight into the business vulnerability and possible measures to avoid any type of SCD in the future. The model suggested in this work is a case of an ideal situation. The parameters mentioned there are to be analysed holistically to get optimal output

BIBLIOGRAPHY

1. Araz, O. M., Choi, D. O., and Salman, F. S. (2020). *Data analytics for operational risk management. Decision Science. Vol.51, pp 1316–1319.*
2. Baghalian, A., Rezapour, S., and Farahani, R. Z. (2013). *Robust supply chain network design with service level against disruptions and demand uncertainties: a real-life case. Euro. J. Oper. Res. Vol.227, pp 199–215.*
3. Blackhurst, J., Craighead, C. W., Elkins, D., and Handfield, R. B. (2005). *An empirically derived agenda of critical research issues for managing supply-chain disruptions. Int. J. Prod. Res. Vol. 43, pp4067–4081.*
4. Büyüktaktakin, E., des-Bordes, E., and Kibi, s, E. Y. (2018). *A*

- new epidemics—logistics model: insights into controlling the Ebola virus disease in West Africa. Eur. J. Oper. Res. Vol.265, pp1046–1063.*
5. Chen, H. Y., Das, A., and Ivanov, D. (2019). Building resilience and managing post-disruption supply chain recovery: lessons from the information and communication technology industry. *Int. J. Inf. Management. Vol.49, pp330–342.*
 6. Chen, Y., and Chen, Y. (2014). Strategic outsourcing under technology spillovers. *Naval Res. Logist. 61, 501–514. doi: 10.1002/nav.21599*
 7. Choi, T. M. (2020). Innovative 'bring-service-near-your-home' operations under coronavirus (COVID-19/SARS CoV-2) outbreak: can logistics become the messiah? *Transp. Res. E Logist Transp Rev 140:101961. doi:10.1016/j.tre.2020.101961*
 8. Craighead, C., Blackhurst, J., Rungtusanatham, M., and Handfield, R. (2007). The severity of supply chain disruptions: design characteristics and mitigation capabilities. *J. Decision Sci. 38, 131–156. doi: 10.1111/j.1540-5915.2007.00151.x*
 9. de Vos, J. (2020). The effect of COVID-19 and subsequent social distancing on travel behavior. *Transport. Res. Interdiscip. Perspect. 5:100121. doi:10.1016/j.trip.2020.100121*
 10. Dolgui, A., Ivanov, D., and Rozhkov, M. (2020). Does the ripple effect the bullwhip effect? An integrated analysis of structural and operational dynamics in the supply chain. *Int. J. Product. Res. 58, 1285–1301. doi: 10.1080/00207543.2019.1627438*
 11. GD (2020). Covid-19 to further drive e-commerce payments in India. *Global Data. Available online at: https://www.globaldata.com/covid-19-to-further-drive-e-commerce-payments-in-india-says-globaldata/ (accessed December 17, 2020)*
 12. Gössling, S., Scott, D., and Michael Hall, C. (2020). Pandemics, tourism and global change: a rapid assessment of COVID-19. *J. Sustain. Tourism 29, 1–20. doi:10.1080/09669582.2020.1758708*
 13. Hendricks, K. B., and Singhal, V. R. (2003). The effect of supply chain glitches on shareholder wealth. *J. Operat. Manage. 21, 501–522. doi: 10.1016/j.jom.2003.02.003*
 14. Ivanov, D. (2020). Predicting the impact of epidemic outbreaks on the global supply chains: a simulation-based analysis on the example of coronavirus (COVID-19 / SARS CoV-2) case. *Transport. Res. E 136, 19–22. doi: 10.1016/j.tre.2020.101922*
 15. Ivanov, D., Dolgui, A., and Sokolov, B. (2019). The impact of digital technology and industry 4.0 on the ripple effect and supply chain risk analytics. *Int. J. Prod. Res. 57, 829–846. doi: 10.1080/00207543.2018.1488086*
 16. Lin, Q., Zhao, S., Gao, D., Lou, Y., Yang, S., Musa, S. S., et al. (2020). A conceptual model for the coronavirus disease (2019). (COVID-19) outbreak in Wuhan, China with individual reaction and governmental action. *Int. J. Infect. Dis. 93, 211–216. doi: 10.1016/j.ijid.2020.02.058*
 17. Mamani, H., Chick, S. E., and Simchi-Levi, D. (2013). A game-theoretic model of international influenza vaccination coordination. *Manage. Sci. 59, 1650–1670. doi:10.1287/mnsc.1120.1661*
 18. Pournader, M., Kach, A., and Talluri, S. (2020). A review of the existing and emerging topics in supply chain risk management literature. *Decision Sci. 51, 867–919. doi: 10.1111/dec.12470*
 19. Sarkis, J., Cohen, M. J., Dewick, P., and Schr, P. (2020). A brave new world: Lessons from the COVID19 pandemic for transitioning to sustainable supply and production. *Resour. Conserv. Recycl. 159:104894. doi: 10.1016/j.resconrec.2020.104894*
 20. Tan, Z., Xu, M., Meng, Q., and Li, Z. (2020). Evacuating metro passengers via the urban bus system under uncertain disruption recovery time and heterogeneous risk-taking behaviour. *Transport. Res. C Emerg. Technol. 119:102761. doi: 10.1016/j.trc.2020.102761*
 21. Tang, O., and Musa, N. (2011). Identifying risk issues and research advancements in supply chain risk management. *Int. J. Product. Econ. 133, 25–34. doi: 10.1016/j.ijpe.2010.06.013*
 22. Tucker, H. (2020). Coronavirus Bankruptcy Tracker: These Major Companies are Failing Amid the Shutdown. *Forbes.*
 23. Available online at: <https://www.forbes.com/sites/hanktucker/2020/05/03/coronavirus-bankruptcy-tracker-these-major-companies-are-failing-amid-the-shutdown/> (accessed December 16, 2020)
 24. WEF (2020a). How China can Rebuild Global Supply Chain Resilience After COVID-19. Geneva: World Economic Forum.
 25. Available online at: <https://www.weforum.org/agenda/2020/03/coronavirus-and-global-supply-chains/> (accessed December 23, 2020).
 26. WEF (2020b). What Past Disruptions Can Teach us About Reviving Supply Chains After COVID-19. Geneva: World Economic Forum.
 27. Available online at: <https://www.weforum.org/agenda/2020/03/covid-19-coronavirus-lessons-past-supply-chain-disruptions/> (accessed December 23, 2020).
 28. Xu, S., Zhang, X., Feng, L., and Yang, W. (2020). Disruption risks in supply chain
 29. Management: a literature review based on bibliometric analysis. *Int. J. Product. Res. 58, 3508–3526. doi: 10.1080/00207543.2020.1717011*
 30. Zhen, X., Li, Y., Cai, G., and Shi, D. (2016). Transportation disruption risk management: business interruption insurance and backup transportation. *Transport. Res. E Logistics Transport. Rev. 90, 51–68. doi: 10.1016/j.tre.2016.01.005*
 31. Zsidisin, G. A. (2003). A grounded definition of supply risk. *J. Purchas. Supply Manage. 9, 217–224. doi:10.1016/j.pursup.2003.07.002.*