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Supply chain resilience vs. COVID-19 disruptions during the second wave

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Abstract

The majority of companies around the world suffered severe supply chain disruptions since the first wave of the pandemic. This paper, in contrast, focuses on how prepared were companies when the second wave struck. We focused our study on the impacts of COVID-19 disruptions on Supply Chain Management during this second wave in Saudi Arabia, though not clearly defined by a rise in number of cases, we will rely on the dates the lockdown took place during. The purpose of our study is to understand how resilient different companies supply chains were and if that resilience impacted their recovery level. We conducted our study on Saudi companies from different industries and multiple sizes. We excluded international companies operating globally, in order to focus the findings and ensure our analysis covers the local scene. We collected the data using survey questionnaires answered by employees involved in the Supply Chain, Procurement, and Project Management or C-suite level personnel. We conducted our data analysis using SPSS to run a correlation analysis between our findings on the Supply Chain Resilience and our sample Recovery Level. We used a Resilience Testing Model which consists of linking correlations derived from analysing data collected.

We have found through our descriptive analysis that, even though companies vary in their scores of understanding, importance, availability of alternatives and preparedness, they all exhibited a disruption from COVID-19. The lessons learned from the correlation analysis is that companies are expected to begin searching for a more diversified supplier base in the near term, thus looking to build a versatile, but cost-effective, supply chain. Shifting supply chains nearby, decreasing the suppliers base, increasing the digitalization of supply chains are essential tactics companies have to start committing to.

Keywords: supply chain; resilience; disruption; second wave; Saudi Arabia.

1. Introduction

COVID-19 is one of the most researched topics in the world, it affected governments, economies, corporations, and every single individual on planet earth. The majority of companies around the world suffered severe supply chain (SC) disruptions when the pandemic struck. This is pertaining to the first wave. This paper, in contrast, focuses on how prepared were companies when the second wave struck.

Many researchers consider COVID-19 to be the black swan event that forces organizations to reshape and transform their local and global supply chain models [4, 6]. During 2020, the pandemic has revealed many organizations′ vulnerabilities to fulfill customer demand or reach their target markets during lockdowns. Indeed, COVID-19 pandemic has tested the resilience and flexibility of supply chain management (SCM) within organizations.

The repurposed and reshaped supply chains of the future will need to be both resilient and responsible, as the COVID-19 crisis pushes supply chain leaders to accelerate the adoption of agile methods to work around uncertainty. Globally, and according to a research conducted by the consulting firm Accenture, 94% of Fortune 1000 companies see supply chain disruptions from COVID-19, while 75% of companies have had negative impacts on their business, and 55% of companies plan on downgrading their growth [1].

However, it is crucial that we understand the meaning of Supply Chain Resilience (SCR). SC is defined as the flow of material, information, money, goods and services from raw material suppliers through factories, offices, warehouses to end consumers [5]. While resilience is defined as a supply chain system′s ability to reduce the probabilities of disruption, reduce the consequences of those disruptions and reduce the time to recover to normal performance [3]. Understanding the aforementioned definitions leads us to asking why do supply chains have

to be resilient during such times? According to [9], the less re-silience, the more vulnerable firms will be, where it is proposed that firms will be the most profitable in the long term the more resilient they are. While companies represent the players in the economy, the resilience of the economy relies on the speedy recovery of the institutions within the economic system.

In our attempt to understand SCR in the Kingdom, measure-ment of SCR remains a challenge. According to [7], resilience is a multidimensional performance construct and is thus unable to be accurately characterized or measured by a single metric. However, evaluations of post-pandemic performance data over time can be used to measure SCR. Furthermore, we attempt to measure Resilience through the SC′s recovery levels, compar-ing overall results from the first wave [2] to the second wave too shall give us a clearer picture into the learning curve of lo-cal companies.

The purpose of our study is twofold: (i) to understand how resilient different Saudi companies SCs were during the second wave and if that resilience impacted their recovery level and (ii) to build a SCR model. The remainder of the paper is as fol-lows. We start by introducing the topic in Section 1. Section 2 describes the methodology of this research while Section 3 is devoted to present and discuss the results and findings. Conclu-sions are presented in Section 4.

2. Research and data collection methods

We focused our study on the impacts of COVID-19 disrup-tions on SCM during the second wave, though not clearly de-fined by a rise in number of cases, we will rely on the dates the lockdown took place during. We conducted our study on com-panies from different industries and multiple sizes. We avoided surveying companies which are operating globally, to ensure that our analysis covers the local scene. This helped us avoid instances where international firms operating in Saudi Arabia reporting the location of their international headquarters or giv-ing the total revenue of the firm as opposed to the Saudi office.

We collected the data using survey questionnaires answered by employees involved in the SC, Procurement, and Project Management or C-suite level personnel. We conducted our data analysis using SPSS to run a correlation analysis between our findings on the SCR and our sample recovery level. The sur-vey was distributed personally to potential respondents and not publicly shared. After cleansing the data collected, our sample size was set to 10 companies. The field and average number of employees of each category are presented in Table 1.

Table 1. Sample details

Field	Telecom	FMCG*	Raw Material	Advertising	Retail	Government
# companies	3	2	2	1	1	1
# employees	33,500	11,500	70,400	70	220	400

*FMCG: Fast-moving consumer goods

3. Data analysis and results

We have conducted data analysis using the software SPSS for correlation analysis and descriptive analysis. We propose a resilience testing model as presented in Figure 4. It consists of linking correlations derived from analyzing data collected. The findings provided by testing the proposed model are discussed below.

3.1. Disruption sources

The disruptions of COVID-19 on the SC vary from one com-pany to another. Half of respondents had identified that both immediate suppliers and the presence of multiple entities in the SC represent a major source of disruption while in a pre-vious research we conducted during the first wave ([2]), 44% of respondents consider that both immediate suppliers and im-mediate customers were a major source of disruption. In addi-tion, during the second wave, not a single company recognized themselves as a source of disruption, as opposed to the previous research, in which 16% admits that the disruption came inter-nally from their own processes. These two findings show that companies are more aware about the challenges that SC may face during the second wave and are more prepared to manage disruption.

3.2. Impact of the company size on disruption

60% of our respondents indicated that the major disruption reason was delays in shipment from suppliers in addition to unavailability of transportation capacity. To further understand the different dimensions impacting the respondents answers, we have compared the companys size (based on number of employ-ees) to the score that was given to four dimensions defined as follows:

- The extent of understanding the environment to manage SC disruptions,
- The level of importance of SC management in following different network design decisions,
- The level of preparedness of the company and its SC to deal with the pandemic situation caused by COVID-19, and
- The availability of SC alternatives within the SC model.

The companies are categorized based on the average number of employees in this field as follows: large (more than 25000 employees), medium (between 500 and 2500 employees), small (below 500 employees). While the above dimensions included multiple variables scored from 1 to 5, we have calculated the average scores to reach an overall score for each category and for each dimension as shown in Figure 1.

The results show that the larger the company is, the more prepared it is against COVID-19 disruptions, and the higher the importance it places on its SC risk management (SCRM). This finding is consistent with our results in the research con-ducted on the first wave [2]. Also, the larger the company is,

Company Size (Employees) (Indicators - Size Summary)	Availability of SC Alternatives Average Score	Importance of SC Risk Management Average Score	Preparedness to Deal with Disruptions Average Score	Understanding of Environment Average Score
Large	3.300	3.630	3.980	3.150
Medium	3.330	3.330	3.780	3.130
Small	3.050	3.080	2.830	3.130

Fig. 1. Companies sizes (employees) vs. average scores on different dimensions

less available alternatives it has for its SC, something that is still not quite resolved yet as we see medium-sized companies have slightly better alternatives than big companies. We believe the reason could be the instability of demand or the lack of strategic alliances struck between big companies and suppliers. Overall, we found that all company sizes have suffered from similar sources and impacts of disruptions. The question remains if the companies learned how to become more resilient and go through a speedy recovery compared to pre-pandemic times and to the first wave. Therefore, we compared our results on the two waves as presented in Figure 2. Results demonstrate that large and medium companies are now enjoying a better current recovery level than wave 1. Almost 70% of both large and medium companies are reporting increasing performance of their SC, compared to 43% and 38% respectively, during wave 1. On the other hand, small companies performance is deteriorating, this can be explained by the fact that they were unable to fully come back and recover from the consequences of wave 1, and thus are still witnessing disruptions caused by the first wave.

Figure 3 discussed this recovery issue. Indeed, after wave 1 (represented in blue color), companies with different sizes were more optimistic, claiming that the worst was behind them. However, the orange color representing the second wave shows less confidence in recovery and looks more realistic. This could also be the cause of a double-down effect of disruptions caused by wave 1.

3.3. Supply chain resilience

Resilience is the ability of a SC system to reduce the probabilities of disruption, to reduce the consequences of those disruptions and to reduce the time to recover to normal performance [3]. The SCM literature do not define a specific measure of resilience. We have found through our descriptive analysis that, even though companies vary in their scores of understanding, importance, availability of alternatives and preparedness, they all exhibited a disruption from COVID-19. We define the recovery level our measure of resilience. First, we propose a resilience model which indicates that the higher the level of the company's understanding of the environment to manage SC disruptions, the higher the level of importance it places on SCRM, the more prepared the company's becomes to deal with pandemics which creates more SC alternatives and increases the recovery level hence the SCR. To test the resilience model presented in Figure 4, we ran a Spearmans Rho correlation analysis to understand the strength and the direction of relationships between the variables discussed in Section 3.2.

Spearmans Rho, or Spearmans rank correlation coefficient is a non-parametric measure of rank correlation, which measures the strength and direction of the monotonic relationship between two variables [8]. As the proposed model variables are monotonic and our data is in a ranking order, Spearmans Rho is the most suitable correlation test for our model.

We propose to test five different relationships between our variables and we compare the results on the second wave with our previous results on wave one as discussed in [2].

Relationship 1: Understanding Environment to Manage SC Disruptions vs. Importance of SC Risk Management. Contrarily to wave 1, results presented in Figure 5 confirm the absence of a significant relation between understanding the environment and the importance of SCRM. Yet, a moderate negative correlation (2-tail significance level at 6%) between the importance of SCRM for site selection, and understanding the events in external environment that are likely to cause disruptions.

Relationship 2: Importance of SC Risk Management vs. Preparedness to Deal with Pandemics. Results shown in Figure 6 demonstrate the following findings:

- Strong positive correlation (2-tailed significance level at 5%) between the importance placed on SCRM for supplier of raw materials and parts, and the level of preparedness expressed in terms of (i) having employees with the needed skills to deal with the disruption and (ii) having procedures to protect their goods from criminal activity and contamination. The latter is the only finding consistent with our results on wave 1.
- Strong positive correlation (2-tailed significance level at 5%) between the importance placed on SCRM for site selection and the level of preparedness pertaining to SC visibility.
- Strong positive correlation (2-tailed significance level at 1%) between the importance placed on SCRM for transportation decisions, and the level of preparedness expressed by (i) having SC partner alternatives, (ii) having employees with the needed skills to deal with the disruption, and (iii) having procedures to protect their goods from criminal activity and contamination.

The findings show that companies are more aware of the SCRM and have developed more strategies and searched for alternatives to be more prepared to deal with the pandemic.

Relationship 3: Preparedness to Deal with Pandemics vs. Availability of SC Alternatives. Results presented in Figure 7 show
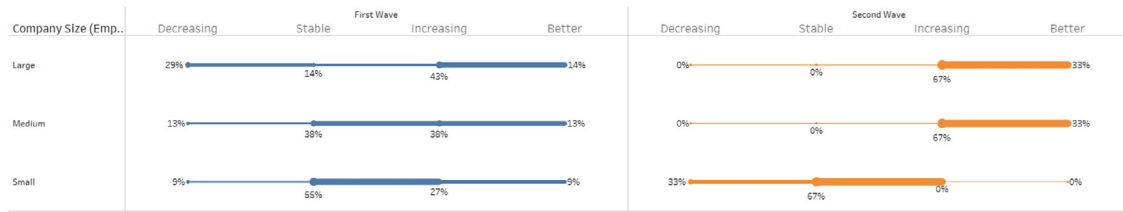
Fig. 2. SC Performance Level compared to before COVID reporting on both wave 1 and wave 2, factoring in companies sizes

Fig. 3. Supply chain recovery reporting on both wave 1 and wave 2, factoring in companies sizes

Fig. 4. Resilience model

Fig. 5. Test relationship 1 on wave 2

that the availability of alternative distribution channel options is strongly and positively correlated with the level of preparedness of employees and being ready to protect goods from criminal activity and contamination.

Relationship 2 – Wave 2			Preparedness: We had supply chain visibility	Preparedness: We had procedures and plans in place	Preparedness: Our employees had the skills to deal with the disruption	Preparedness: We had procedures to protect our goods from criminal activity and contamination
Importance: Supply chain risk management for supplier selection for raw materials and parts	Correlation Coefficient				.640*	.640*
	Sig. (2-tailed)				0.046	0.046
	N				10	10
	Bootstrap[c]	Bias			-.007[d]	-.009[d]
		Std. Error			.223[d]	.224[d]
	95% Confidence Interval	Lower			.118[d]	.118[d]
		Upper			.986[d]	.986[d]
Importance: Supply chain risk management for site selection	Correlation Coefficient		.692*			
	Sig. (2-tailed)		0.027			
	N		10			
	Bootstrap[c]	Bias	-.023[e]			
		Std. Error	.150[e]			
	95% Confidence Interval	Lower	.272[e]			
		Upper	.913[e]			
Importance: Supply chain risk management for transportation decisions	Correlation Coefficient			.886**	.769**	.769**
	Sig. (2-tailed)			0.001	0.009	0.009
	N			10	10	10
	Bootstrap[c]	Bias			-.023[g]	-.016[g]	-.015[g]
		Std. Error		.104[g]	.156[g]	.156[g]
	95% Confidence Interval	Lower		.548[g]	.418[g]	.418[g]
		Upper		.986[g]	1.000[g]	1.000[g]
		Upper	.888[d]	1.000	1.000	1.000

Fig. 6. Test relationship 2 on wave 2

Relationships 4 & 5: Preparedness to Deal with Pandemics & Availability of SC Alternatives vs. Recovery Level. Results show a strong positive correlation (2-tailed significance level at 1%) between the recovery level and the level of preparedness pertaining to having procedures and plans in place and SC visibility. However, there is no significant correlation between the availability of SC alternatives and the recovery level as the confidence interval shows -0.111 on the lower bound, and 0.947 on the upper bound. Therefore the availability of SC alternatives and markets could not be considered as a factor in the resilience model especially that this relationship was proven to be negative in wave 1 as the pandemic was global and was not market specific.

To summarize our findings, it is noteworthy that different sectors have witnessed different disruptions due to the pandemic. Also, there is no clear second wave in Saudi Arabia, the country in focus of this paper. True, there has been 2 lockdowns, the big and first one during the first wave, and the second is a limited lock-down in which few industries have seen more disruptions than the others. Since the first wave of the virus, lockdowns are the most effective strategy for dealing with the crisis. The reduced exposure of people to social interactions can reduce the spread of the virus in totality. However, the strategy has adverse implications for the global economy and could potentially shut down the SC.

4. Managerial recommendations

Overall, similar trends are visible in both the first and second waves in terms of resilience and sustainability of the SC. However, companies can better prepare for the eventualities of the second wave by undertaking specific measures to strengthen the SC as demonstrated by the resilience model discussed above. Some of these measures are briefly presented in what follows:

Relationship 3 – Wave 2			Availability of Alternatives: We have alternative distribution channel options to deliver the goods to our customers	Availability of Alternatives: We have alternative transportation options to deliver the goods to our customers
Preparedness: Our employees had the skills to deal with the disruption	Correlation Coefficient		.718*	
	Sig. (2-tailed)		0.019	
	N		10	
	Bootstrap[c]	Bias	-.014[d]	
		Std. Error	.174[d]	
		95% Confidence Interval — Lower	.286[d]	
		Upper	.976[d]	
Preparedness: We had procedures to protect our goods from criminal activity and contamination	Correlation Coefficient		.848**	.692*
	Sig. (2-tailed)		0.002	0.026
	N		10	10
	Bootstrap[c]	Bias	-.012[d]	-.013[d]
		Std. Error	.134[d]	.285[d]
		95% Confidence Interval — Lower	.509[d]	.000[d]
		Upper	1.000[d]	1.000[d]

Fig. 7. Test relationship 3 on wave 2

Relationships 4 and 5 – Wave 2			Preparedness: We had procedures and plans in place	Preparedness: We had supply chain visibility	Availability of Alternatives: We have alternative distribution channel options to deliver the goods to our customers
Supply Chain Situation: Current	Correlation Coefficient		.805**	.741*	0.584
	Sig. (2-tailed)		0.005	0.014	0.077
	N		10	10	10
	Bootstrap[c]	Bias	-0.033	-0.036	-0.028
		Std. Error	0.146	0.170	0.274
		95% Confidence Interval — Lower	0.407	0.286	-0.111
		Upper	0.974	0.968	0.947

Fig. 8. Test relationships 4&5 on wave 2

- As demonstrated by relationships 4 and 5 discussed above, it is crucial for an organization to forecast and plan for eventualities that could adversely affect the resilience and sustainability of the supply chain. Upon determining the events that can disrupt the supply chain, the organization can institute strategies that can guarantee their survival when they happen.

- SC managers should understand the changing SC environment and manage the SC risk. They can instill confidence in the employees, suppliers, and customers by reviewing their business plans to adopt contemporary business practices, such as e-commerce. By providing an option for online sales, customers can have confidence that they can shop from the comfort of their homes.

- Emerging logistics factors can also influence supply chains and their changes. Indeed, the digitization of supply chains and logistics using big data helps companies to prepare for changes in the post-pandemic business environment.
- SC managers should start searching for a more diversified supplier base in the near term, thus looking to build a multipurpose and cost-effective supply chain. Building long-term strategic supplier alliances and consolidating the supplier base into one or a few suppliers, resulting in a smaller supply base are essential tactics companies should consider.
- Companies should relaunch operations in nimbleness and consider the current policies to avoid the SC disruption such as shifting supply chains nearby or to different countries.

Overall, the virus could institute critical changes within the business landscape. Therefore, to support business operations, resilience in the SC should be sturdy to support new business strategies.

5. Conclusions and future research

In summary, the COVID-19 pandemic adversely affected the selected sector's SCR. The lockdown containment measure has created a disturbance in the SC. The participants interviewed from five industries indicated they had anticipated the second wave of the Corona Virus that happened early in 2021. The research utilized survey questionnaires, which were intended to reveal the five industries' level of preparedness, the importance of SC, and availability of alternative SC channels. The objectives were instrumental in determining the impact of the pandemic on the resilience capacity of the industries. Although the COVID 19 infection rate continues to increase, it appears that most organizations have learned from the first wave and are more prepared for any eventualities, have alternative SCs, and consider their SC significantly important.

The research indicates that those industries with a high level of preparedness had the highest resilience to the disturbance of the pandemic. It is, therefore, crucial for an organization to forecast and plan for eventualities that could adversely affect the resilience and sustainability of the SC. Upon determining the events that can disrupt the SC, the organization can institute strategies that can guarantee their survival when they happen. Therefore, the research has concluded that preparedness is the single most essential factor for determining an organization's SCR and sustainability.

In order to enhance our analysis in the future, we should first increase the sample size and query more companies from the Saudi market. Furthermore, we need to assess resilience against the complexity of product/service output and learn more about the degree of liquidity of firms during disruptions and whether this has any correlation to resilience. We can also investigate the level of digital sales maturity of firms during interruptions to check whether firms selling online have had less interruptions than those which do not.

6. Acknowledgment

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