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Investigating Barriers to Supply Chain Resilience Strategies: A Monte-Carlo Simulation Approach

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Abstract Nowadays, the term resilience has acquired significance in supply chain management (SCM) research studies. So, the importance of resilience was driven to study the implementation of supply chain resilience (SCR) in Egyptian industries, exploring its barriers and mitigation strategies. The purpose of this paper is to develop an information matrix and explore mitigation strategies that help managers and executives strategically deal with and overcome these barriers. This study offers insights to build resilient supply chains by identifying barriers and ways to minimize their effects. The paper is an empirical study that employs quantitative methodology. Initially, a literature review and discussions with academics are conducted. Subsequently, a Monte-Carlo Simulation Analysis (MCSA) is applied to examine the highest and most significant barriers to different sectors of the Egyptian industry. In total, 30 barriers are identified and then classified into five main clusters, namely: Operations; Sourcing; Information; Human and Judgmental; and Financial barriers. The Monte-Carlo Simulation Analysis prioritized these main barriers against five categories: Chemical and Petrochemical; Fast-Moving Consumer Goods (FMCG); Construction; Freight Forwarders; and Technological sectors in the Egyptian context.

Keywords: Supply Chain Resilience, Monte-Carlo Simulation, Mitigation Strategies, Egyptian Industries

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Introduction

Recently, as Supply Chains (SC) have become more integrated on a global scale; any disturbance could endanger the entire network. The Supply Chain Disturbance (SCD) can be caused by actions or events that originate inside the Supply Chain (SC). In this context, developing resilience in the supply chain is considered a crucial and determinant factor for any organization (N. O. Hohenstein et al., 2015).

Resilience in operation management is defined as the ability of an organization to respond rapidly to unforeseen changes, not only to adapt but also to anticipate, predict, and recover from disruptive events (Sabahi & Parast, 2020). All industries face disruptions that vary in severity and type. Therefore, being prepared for any future disruptive event permits companies to react efficiently and effectively, and consequently become more resilient to disruptions (Scholten et al., 2019). The most important factors to applying resilience in the supply chain are barriers that managers need to be aware of and acquire significant knowledge to overcome. The supply chain's resilience can be decreased by properly identifying, analyzing, and measuring barriers to resilience in the supply chain. This can aid in identifying the main barriers affecting supply chains and in putting plans into action to mitigate their effects in order to increase resilience.

There is a lack of studies exploring the adoption of supply chain resilience management (SCRM) in the context of Egyptian industries, according to a number of studies that have been highlighted. By covering numerous organizations of all sizes from various industries, the primary goal of this study is to investigate the barriers to the application of resilience within (SCM) in Egyptian enterprises. This study also attempts to offer suggestions for overcoming such barriers. Additionally, the study intends to point to the effect of these barriers in order to develop a simulation model for a mitigation strategy that offers techniques to control them. The simulation functionalities in a Decision-making analysis are an adequate approach to deal with the SC disturbances. Therefore, the purpose of this paper is to discuss the analysis of the effects of barriers on SC resilience and of the implementation of mitigation plans to reduce the negative outcomes of the disturbances, using a Monte-Carlo Simulation approach to support the decision-making process in the selection of the most adequate Strategies that resist disturbances in the worldwide complex SC. This study aims to explore how extent barriers prevent the ability of companies and organizations to be resilient by investigating those barriers and seeking to adopt a high-priority mitigation strategy to improve the supply chain resilience in the Egypt industry.

Literature Review

Supply Chain Resilience

The ability of a business to quickly respond to supply chain vulnerabilities and disruptions and resume normal operations after they have occurred is referred to as Supply Chain Resilience (SCR). The SCR degree can be estimated given explicit repetitiveness, continuous checking, accessibility frameworks, and recovery.

According to (Ponomarov & Holcomb, 2009), the SCR is defined as "The adaptability of a supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of activity at the desired level of connectivity and control of structure and function". Also, it can be described as "The capability of the system to anticipate, detect, and defend itself against risks before negative consequences occur (Hollnagel et al., 2017)". SCR capacity is taking place in two stages (Dolgui et al., 2018): resistance and recovery. "Resistance represents the ability of the supply chain to minimize disruption effects by avoiding the disruption or beginning to recover promptly", and "Recovery is concerning with the supply chain's ability to return to a steady or improved system state once a disruption has been encountered" (Melnyk et al., 2014).

The SCR idea for supply chains successfully decreases the chance of supply chain disturbances and the time expected to get back to ordinary execution.

Barriers to Resilient Supply Chains

The key issue in decision-making analysis towards further business resilience is to identify barriers that restrict the ability of organizations to respond in a effectively and timely manner to such environmental stimuli and disruptive events (Halkos et al., 2018) where the first study that concentrated on identifying barriers to a resilient supply chain was conducted by (Pereira et al., 2014). A detailed study focusing on barriers was made by (Rajesh, 2018) in which the barriers were categorized according to assets-related, operations-related, sourcing-related, barriers caused by wrong assumptions and corrections, human and judgmental barriers, and other miscellaneous barriers but despite a comprehensive analysis of the barriers, it only ranks the barriers recognizing the most important ones. (Halkos et al., 2018) used survey research to study the effect

of barriers on supply chain resilience and used structural equation modeling in the context of Greek small and medium-sized enterprises (SMEs).

Resilience barriers may arise either from the internal or external environments of the supply chain and their comprehension is essential to robust all supply chain drives supply chains. The internal barriers dealt with the availability of resources, understanding and perception barriers, implementation of resilience measures, and barriers related to attitude and organizational culture. The external barriers include barriers related to business continuity, the phenomena of the market, institutional conditions, and barriers related to support and guidance.

Through reviewing all significant barriers to supply chain resilience through different literature sources. These barriers were discussed with the experts who were supply chain managers of the case company and their supply chain partners (middle management). All the experts have more than ten years of experience in handling supply chains and have successfully led the firm through several internal and external supply chain disruptions.

With a deep analysis of the thirty barriers that are finalized for the review, we noticed striking commonalities and this prompted the categorization of the barriers into different bunches for analysis. This guides in the estimation of barriers to typical clusters, where they belong, and where they should be. Managers are prescribed to focus on the significant barriers per the methodology executed in this research. Likewise, they can work on the capabilities and performances of their supply chains over different bunches of barriers, as the barriers are assigned to different classes. Some of these barriers happen upstream of the supply chain, for example, obtaining related barriers; though some are process-related barriers, for example, operations and operational barriers, and different classes of barriers can occur throughout the stages of the supply chain. Different groups of order for the barriers to supply chain resilience and those barriers considered in each class are illustrated remarkably.

Table 1: Classification of Barriers per Criterion

Barriers per Criterion		
	Operations and Operational Barriers	B10: Inability to return to normal operating states rapidly B11: Inability to modify operations in response to challenges B12: Incapability to produce outputs with minimum resources B13: Capacity or inventory inflexibility B18: Complying with service level agreements B19: Underestimating the risks of outsourcing and vertical integrations B23: Inability to quickly change mode of delivering outputs B27: Weaknesses in the distribution and logistics B29: Complexity in organizational processes
	Sourcing Related Barriers	B14: Single sourcing B16: Poor quality or yield at supply source B17: Bullwhips due to uncertainties in supply
	Information Related Barriers	B2: lack of knowledge B5: Forecasting Issues B21: Unfamiliarity with the ways to manage supply chain risks B25: Lack of proper contingency plans B26: Information distortions B28: Lack of integrated IT system across the whole chain B30: Lack of Supply Chain Visibility
	Human and Judgmental Barriers	B1: Lack of cooperation, coordination B3: Non-commitment of top management B4: Shallow relationship with vendors B6: Unwillingness to share information B7: Mistrust among partners B8: Opposition to change and Innovation B15: lack of flexibility B20: Nature of the people to work on self-interests **B22: Poor judgments and inaccurate forecasts**
	Financial Barriers	B9: lack of financial resources B24: Incapability to absorb fluctuations in cash flow

Egyptian Industries Main Categories

After reviewing the data collected from the questionnaire by considering and gathering similar backgrounds of participants, we got five categories of industries in Egypt that will be the main source of this thesis, those five industry categories are:

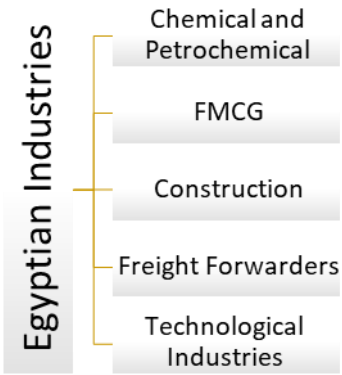


Fig 1: Egyptian Industries per Category

Possible Mitigation Strategies

Specific SC resilience strategies are how to increase SC capabilities are proposed in the literature (Li et al., 2017). More specific resilience strategies recognized in the literature include backup capacity and inventory, increased security, economical supply incentives, postponement, supplier relationship building, and demand forecasting, as well as the development of IT infrastructure and sharing of information (Chopra and Sodhi, 2004; Ivanov and Rozhkov, 2017; Melnyk et al., 2014; Tang, 2006a; Tomlin, 2006; Yilmaz et al., 2017).

(Mandal et al., 2016) surveyed SC professionals and found a positive effect of collaboration, flexibility, visibility, and velocity on SC resilience. The author also found a positive effect of integrated logistics capabilities on SC collaboration and visibility. (Yu et al., 2019) revealed a significant positive effect of the pace of changing products and processes on SC resilience.

To deal with risks and possible consequences, supply chains implement risk mitigation strategies, which are defined as "identifying and managing risks to CS, through a coordinated approach." among members of the SC, in order to reduce the vulnerability of the SC as a whole". Therefore, strategies, incorporating different recovery leverages, are varied and depend on the nature of the risk. Their common role is to allow the SC to return to its original state in the fastest and cheapest way possible.

Table 2: Supply Chain Resilience Mitigation Strategies

No.	Strategies
S1	Strategic stock with Demand Management
S2	Multiple sourcing
S3	Back-up supplier
S4	Substitution
S5	Assortment
S6	Collaboration
	Digitalization
S7	Supply Chain Knowledge and Awareness
S8	Cross Training and Mentorship Programs
S9	Cash Flow Forecasting and Accounts Payable Management
S10	

Strategic stock with demand management is one of the main drivers used to manage risk in a SC. To continue to hold costs sensible, firms can pool additional stock in strategic areas near plants and wholesalers.

Multiple sourcing strategy working with various providers share the risk and permit a preferable service rate over a single provider. Nonetheless, it decreases likely economies of scale made by mystifying orders.

Back-up supplier to supplement or temporarily replace the main provider.

Substitution of a usual raw material by a similar one, until the situation returns to normal.

Assortment arranging the location of products on the racks of a store can impact customer choices and subsequently impact customer demand.

Collaboration is characterized as two or more autonomous firms working mutually to design and execute supply chain operations. It can deliver significant advantages and benefits to collaborators.

Digitalization is the method involved with transforming supply chain processes into digital ones by laying out devoted master data that aggregates information from across your whole supply chain, as well as data from external sources.

Supply Chain Knowledge and Awareness inside the supply chain incorporates the skill created and utilized by individuals experienced in dealing with every one of these processes and cycles - from raw materials management to quality assurance, to inventory management and that's just the beginning.

Cross-training and Mentorship Programs are two strategies that can further develop cooperation in customer service operations. They can assist employees with growing new abilities, sharing knowledge, and supporting each other.

Cash Flow Forecasting and Accounts Payable Management The primary role of forecasting accounts payable is to prevent cash flow from unexpected disruptions. It also provides information on liabilities (costs and debts) that assist with cash management. Furthermore, it helps to optimize the remaining cash to spend on growth and investment.

Monte-Carlo Simulation

With Monte-Carlo simulation, which is based on statistical measures and probability distributions of the variables we address the stochastic (aleatory) uncertainty issue. In recent years, more research has been focused on supply chain simulation. For example, (Ramanathen, 2014) investigated the performance of supply chain collaboration using simulation. Also,

(Cigolini et al., 2014) studied supply chain configuration based on the performance by using discrete event simulation.

In general, Monte-Carlo simulation is a computerized mathematical technique that allows people to account for risk in quantitative analysis and decision-making. This approach depends on repeated random sampling to obtain numerical results. Disruptions in the supply chain (as a random event) can be simulated using repeated random sampling.

Aggregating the result values into bunches by size and showing the qualities as a recurrence histogram gives the estimated state of the probability density function of an output variable. The result values might themselves at any point be utilized as an experimental appropriation, in this manner computing the percentiles and different measurements. On the other hand, the result values can be fitted to a probability distribution, and the hypothetical measurements of the distribution can be determined. These measurements can then be utilized for creating certainty groups. The accuracy of the expected value of the variable and the distribution shape approximations work as the number of simulation trials increases.

Based on the previous discussion of the Supply Chain Resilience, Barriers, and Mitigation Strategies the following questions for this study are;

Q1. What are the main barriers impede to implement supply chain resilience in Egyptian industries supply chain?

Q2. How these barriers are cross tabulated per industry?

Q3. What are the mitigation strategies to each category of Egypt industry to achieve the supply chain resilience?

Q4. To What Extent supply chain resilience Strategy have a positive effect on Egyptian companies to survive among high competition?

Research Methodology

Research purpose and design:

The research used mixed design (quantitative and qualitative design) in order to answer the previous research questions; the study relied, in addition, on secondary data from previous studies and international reports.

Sampling:

The sample size is the exploration will utilize intentional examination and choosing associations that show particular social attributes. The sample size of this research consisted of 33 professionals from managers and experts who responded to the questionnaire (Population = 200 professional supply chain leaders, the questionnaire sent to them), and those associations have been guaranteed profundity and extravagance in information assortment.

The first quantitative method is conducting the online questionnaire with the following title Barriers to Implementation Supply Chain Resilience Strategies in Egyptian Industries.

The result has illustrated that the majority of participants have years of experience more than 10 years with 75.8% and 21.2% from (5-10) years of experience by the role increased the credibility of the questionnaire.

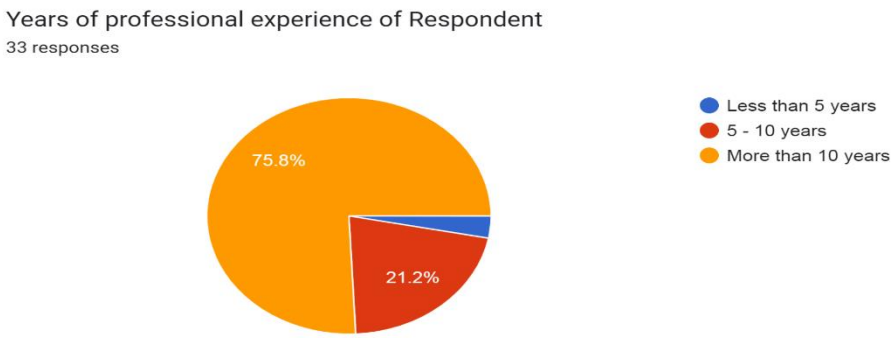


Fig 2: Years of professional experience graph

The questionnaire result explained that the Respondent Position is 54.5% for Managers and 42.4% for Experts which means there is approximately a percentage for participation between managers and experts.

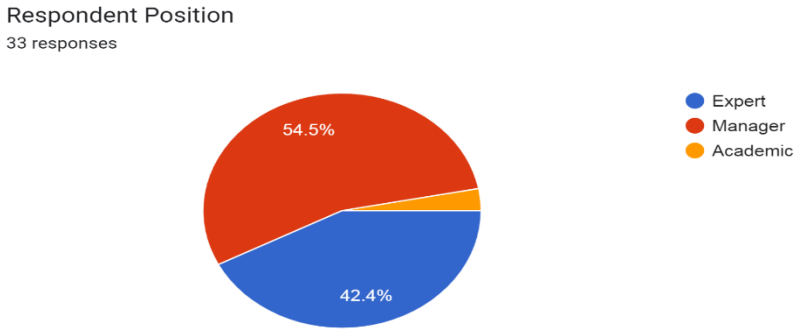


Fig 3: Respondent Position graph

Data Collection Tools

In this study, we used a hybrid strategy to collect data, collecting primary data through interviews (qualitative data) and questionnaires (quantitative data).

The vast majority of the data collection came from authentic published studies and related research by collecting 50 different barriers and 5 mitigation strategies, followed by conducting interviews with academics and supply chain professors to check the adaptability and to increase the credibility of the data selected for Egyptian industries and if any missing data needed to be added for selected barriers and mitigation strategies resulting in 30 barriers and 10 mitigation strategies being chosen for this study.

Data Analysis Technique

Monte-Carlo Simulation: The Monte-Carlo simulation is a mathematical method that predicts the potential results of an uncertain event with an advantage by generating data with high accuracy and credibility. PC programs utilize this method to examine past data and foresee a scope of future results given a decision of activity.

The Monte-Carlo simulation gives different potential results and the likelihood of each from a huge pool of random data samples.

Establishing the model consisting of all barriers ranging from 1 to 30 barrier as input values. Creating a sample dataset by doing 500 runs as a

range for each barrier using the Minitab program to run the random simulation.

Triangular Distribution: The triangular distribution is when there is a known connection between the variable data yet when there is moderately little data free to direct a full statistical analysis. It is often utilized in simulations when there is next to very little knowledge of the data-generating process and is frequently alluded to as a "lack of knowledge" distribution. The triangular distribution is an ideal distribution when the main information available is the maximum and minimum values and the most likely outcome. It is often utilized in business decision analysis.

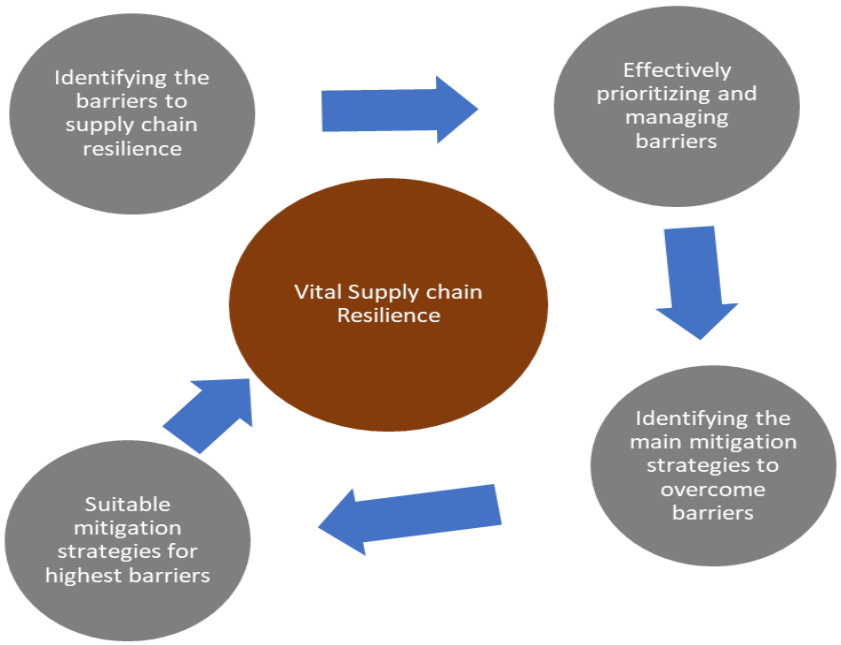
The Research Framework

This section discusses the adopted research Framework of the current study as well as data collection and analysis.

The research provides proposed an applied framework by conducting a questionnaire and critical empirical study that is related to the resilience in the supply chain by Identifying the barriers to supply chain resilience, then effectively prioritizing and managing barriers, after identifying the main mitigation strategies to overcome barriers, Suitable mitigation strategies for highest barriers, until Vital Supply chain Resilience. That explained Egyptian Industries' supply chain and the related barriers and the types of mitigation strategies to manage, control, and mitigate it.

It is a hybrid methodology for applied framework by collecting data that developed by conducting an empirical study through questionnaires with managers, experts, and academics who are related to supply chain sectors in Egypt, to Verify and improve the outcome variables and the empirical study that proposed in the conceptual framework.

Fig 4: The Research Conceptual Framework

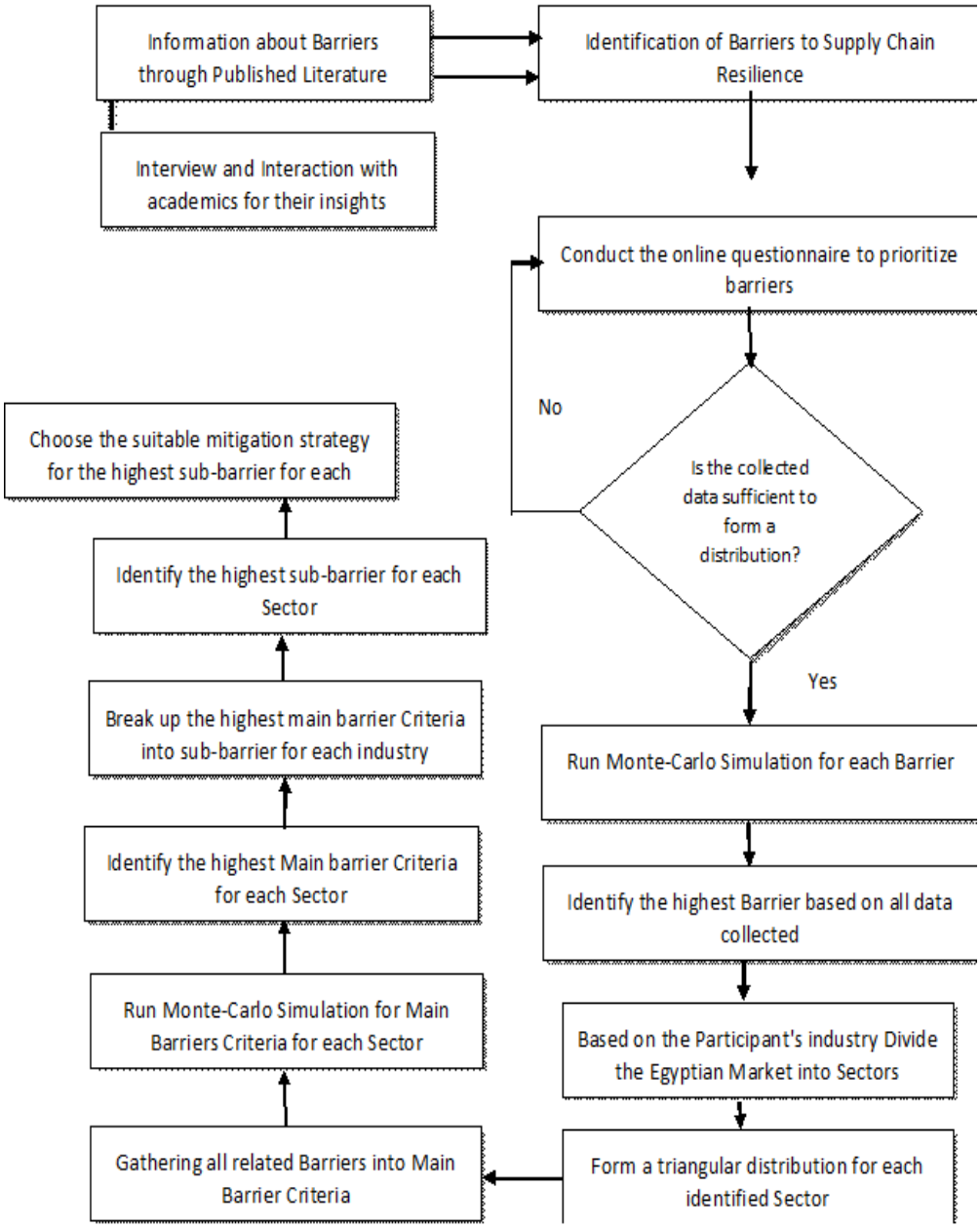


The Research Methodology Roadmap

Following conducting the questionnaire and identifying the frequency of barriers then applying the triangular distribution analysis by identifying min, max, and most likely points for each barrier. Then random runs using Monte-Carlo simulation that will confirm the outcome data, and propose a road map for supply chains in Egyptian industries to be resilient against related barriers. Finally, analyze the main barriers for each industry in the Egyptian Market.

Also, there is an empirical study on the supply chain resilience in Egyptian Industries will be conducted to investigate the adaptability of the theoretical, conceptual, and applied framework proposed in the research methodology chapter and then check its validity in the Egyptian context (figure 5).

Fig 5: The Research Methodology Roadmap **Fig 5**: The Research Methodology Roadmap



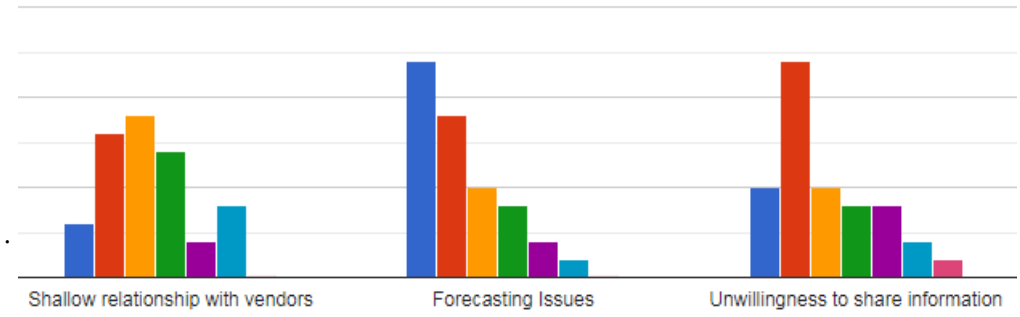
Findings and Analysis

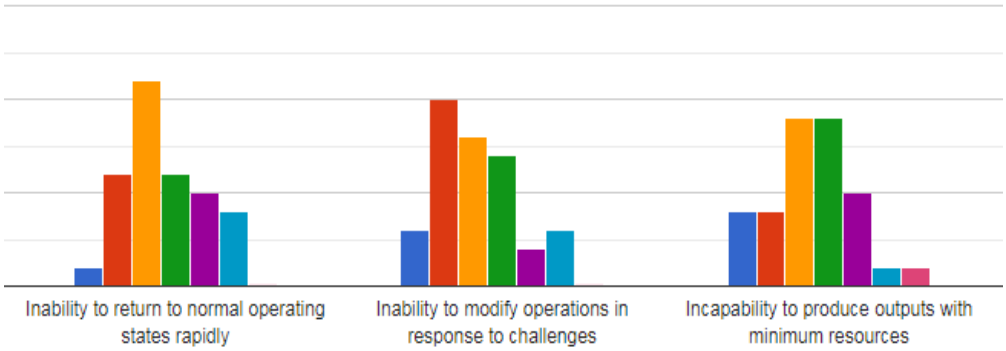
Barriers to the resilience supply chain in the Egyptian Industries

Using Monte-Carlo simulation to generate big data from a few data accurately and precisely to analyze and prioritize the highest main barrier that should be overcome in the Egyptian industry. Through running 500 random runs using the Triangular distribution to generate data for each barrier.

By using the previous Triangular distribution, we got from the questionnaire

Fig 6: Sample of the Triangular distribution used in analysis





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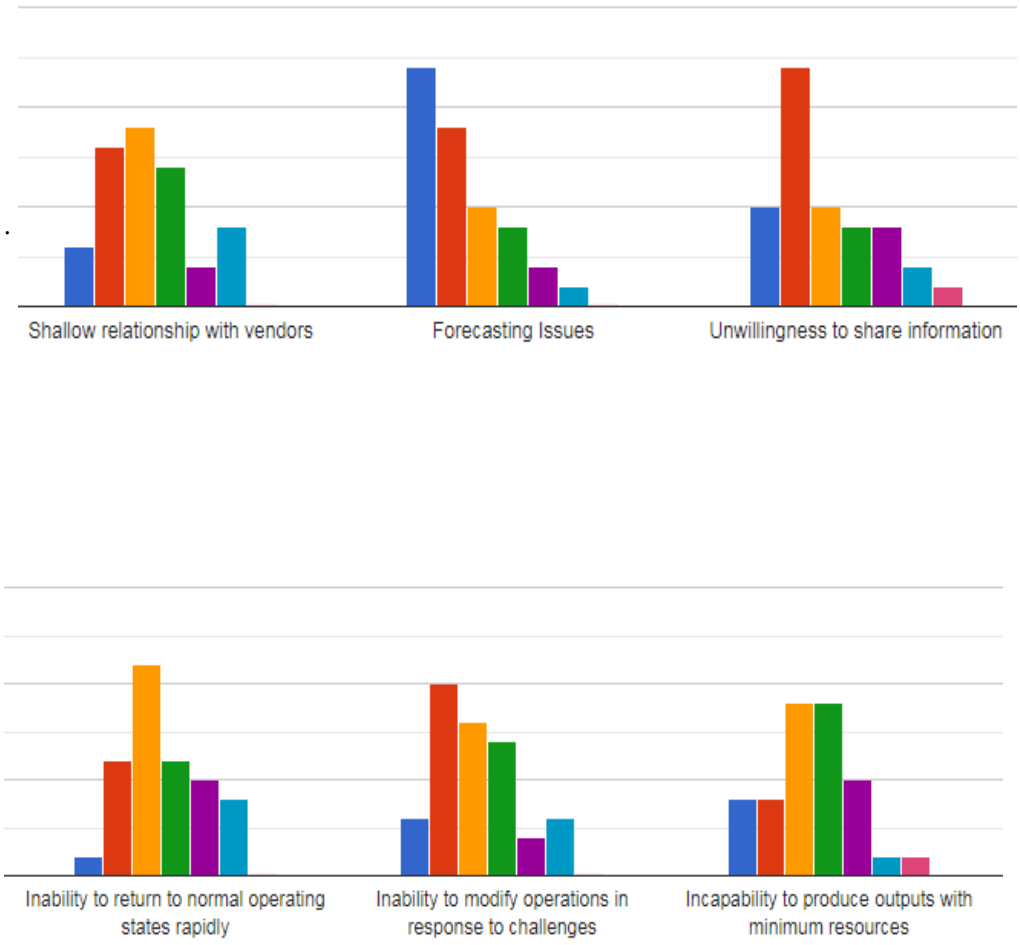
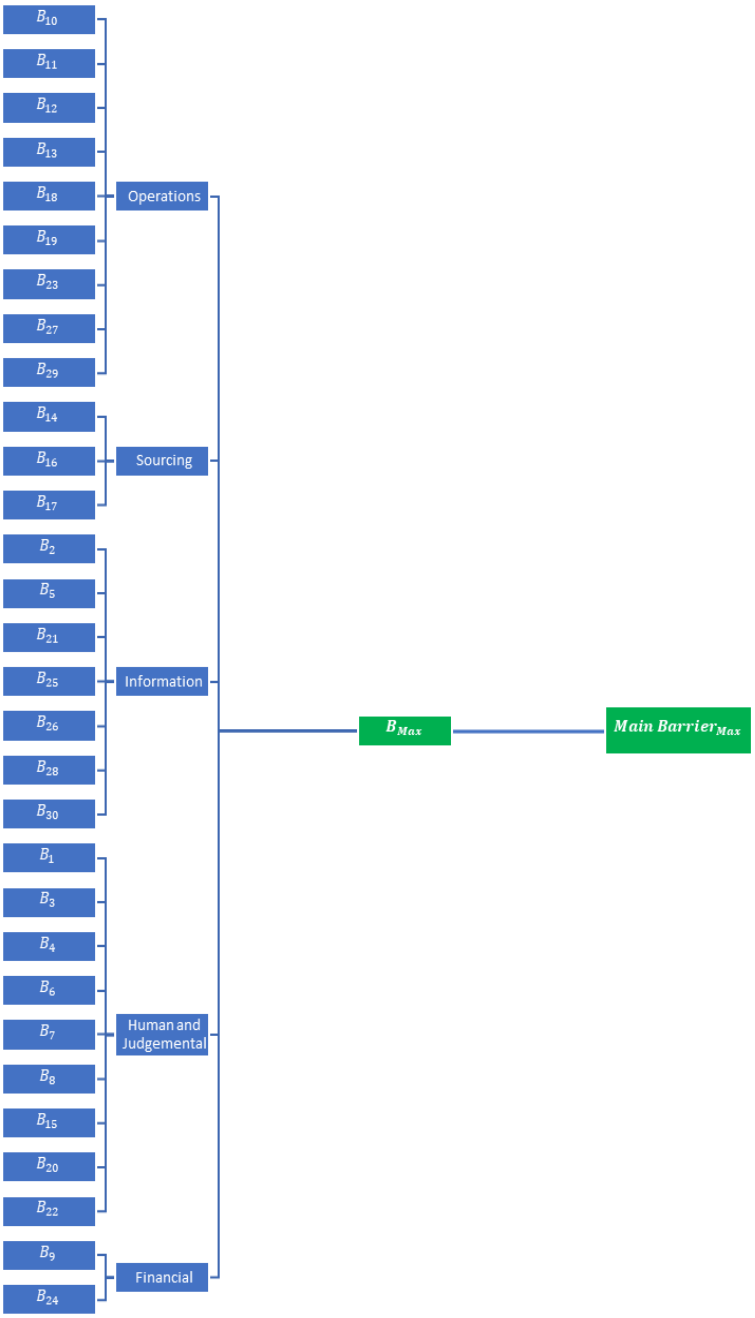
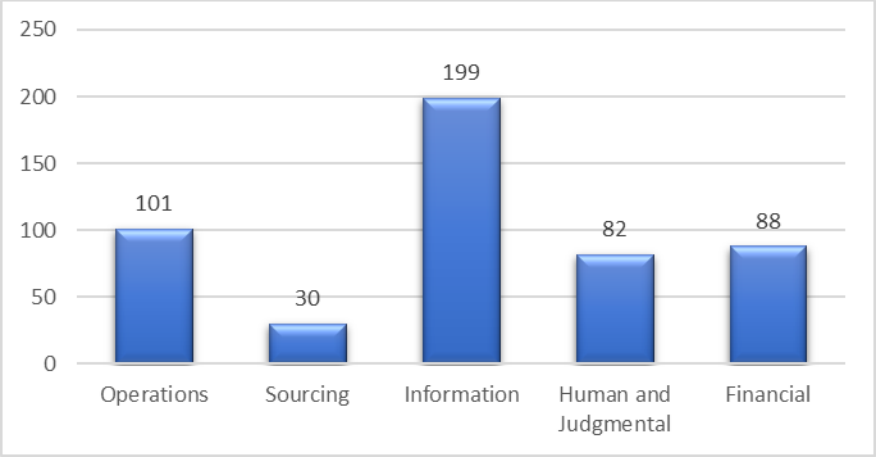


Fig 7: Main Barrier Selection steps



During simulation and after acting 500 random runs, we generate 500 rows for each simulation process and identify the Main Barrier Criterion based on the Maximum barrier selected from each row.

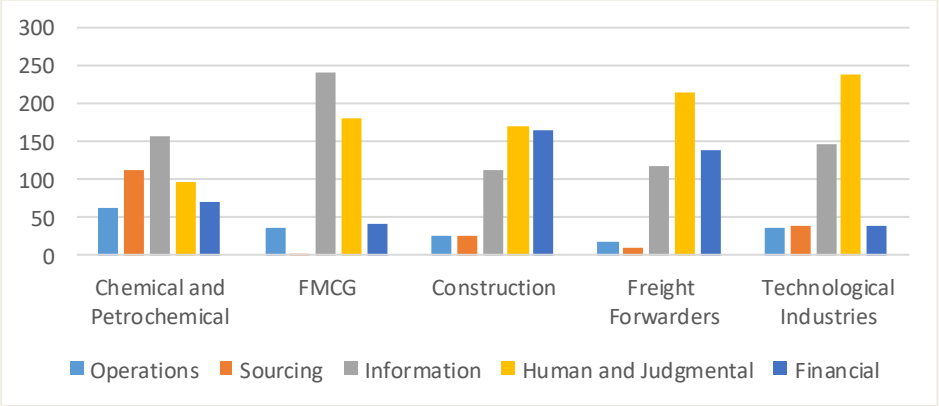
Fig 8: Main barrier ranking in the Egyptian Industry



We got the result after simulation and running 500 runs for barriers that the Information barrier is the highest main barrier criterion in the Egyptian Industry which means there is a lack of Knowledge, and incapability to share the information to overcome the implementation of a resilient supply chain in the Egyptian Market. Then, followed by Operation, Financial, and Human and judgmental barriers descending respectively. It is obvious that in total sourcing main barrier is the least main barrier that affects Egyptian industries.

With the specialization of participants who belong to the Chemical and Petrochemical, FMCG, Construction, Freight Forwarders, and Technological industries and doing 500 random runs for all barriers to identify the highest main barrier by drawing the triangular distribution for each barrier based on their votes only. In summary, that will have an effect on prioritizing of the main barrier frequencies and the random run of the Monte Carlo simulation. It's clear that in the Chemical and Petrochemical sector, the Information and Sourcing main barriers Criteria have the highest frequencies sequentially, and obviously, in the FMCG sector the Information main barrier Criterion has the highest frequency while the Sourcing main barrier Criterion has the lowest frequency.

Fig 9: Main barrier Frequency per each Industry



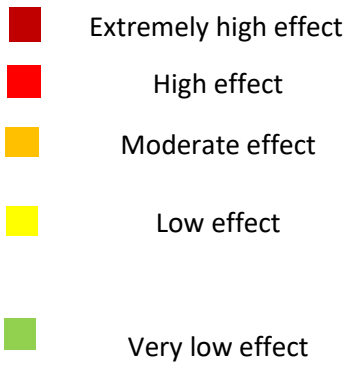
From the graph above the Human & Judgmental and Financial main barriers Criteria have the highest frequencies respectably in the Construction industry. It's obvious from the graph that the Human and Judgmental main barrier criterion is the highest barrier that should be overcome in the Freight Forwarders (Logistics and Transport) sector. The graph shows that the Human and Judgmental main barrier criterion is the highest barrier that should be overcome in the Technological Industry.

The Transition Matrix Spectrum

Depending on the deducing transition matrix and the industry category per the main barrier criterion spectrum that we got from the previous simulation process for each industry it's obvious and clear now for managers and executives in each of the five mentioned industries to set their hands on the extremely high and high Main Barrier's Criterion for their industries. For instance, in the Chemical and Petrochemical industry managers should pay attention to Sourcing and information-related main barriers while in the FMCG sector executives should find solutions to overcome Information-related main barriers. The Human and Judgmental main barrier has an extremely high effect on the Construction, Freight Forwarders, and Technological Industries. On the other hand, The Sourcing main barrier has a shallow effect in the FMCG and Freight Forwarders Sectors, and the Operations and Operational main barrier has a very low effect in the Freight Forwarders industry so managers and executives should be vigilant to keep those barriers low as possible to update the related strategies to keep the low record for the advantage track respecting to the low barriers criterion.

Table 3: The Industry category /Main barrier Criterion Spectrum

Category/Criterion	***Operations and Operational***	***Sourcing***	***Information***	***Human and Judgmental***	***Financial***
Chemical and Petrochemical					
FMCG					
Construction					
Freight Forwarders					
Technological					



The Mitigation Strategies Selection

Thirdly, the last mile in the research finding is the choice for the mitigation strategy which the supply chain mitigation strategies help to steer companies and organizations toward financial stability and resilience for each industry based on the Monte-Carlo simulation analysis technique according to the adopted applied framework, the methodology roadmap, and the research flowchart.

Choosing mitigation strategies is a very important step in choosing the suitable strategy to mitigate and overcome the highest barrier in each industry. There is a majority of research that stops at the identification and ranking barriers, but there is not enough to solve the issue and to reach for a resilient supply chain. Also, it's significant to mention that the adopted mitigation strategy can save a lot of money for organizations and save their chances of being in the market for a long time.

To deal with risks and possible consequences, supply chains implement risk mitigation strategies such as Strategic stock or safety stock, Multiple sourcing, Facility or supplier dispersion, Flexible transportation, Postponement, Back-up supplier, Rerouting, Make and buy, Revenue management, Substitution, Assortment, Collaboration, Digitalization, Supply Chain Knowledge and Awareness, and Cross-training and Mentorship Programs

Heading to another phase of the research examination by dismantling the Information main barrier (The highest Main Barrier Criterion in Chemical and Petrochemical, and FMCG simulation analysis) into the related sub-barriers to find the maximum sub-barrier in each row of 500 rows from the previous simulation analysis

Fig 10: Max Sub-barrier selection steps for Chemical & Petrochemical and FMCG Industries

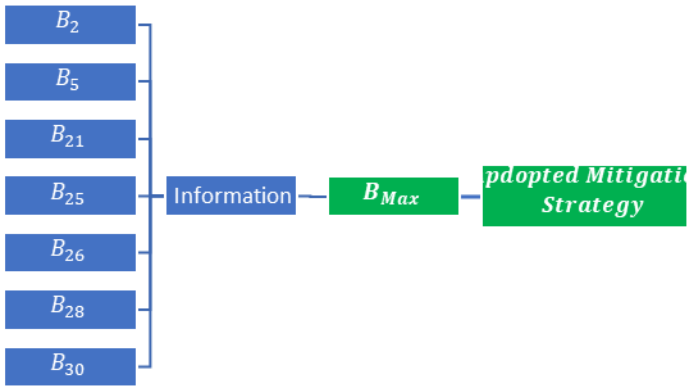


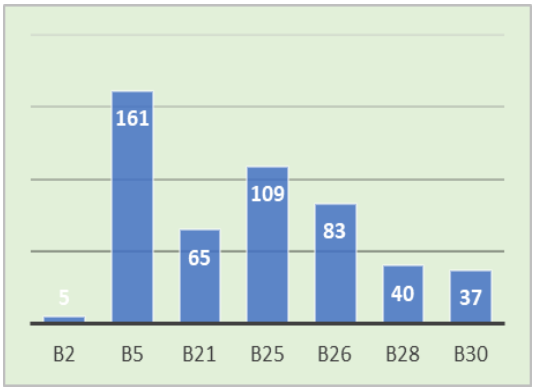
Table 4; 5: Mitigation strategy selection

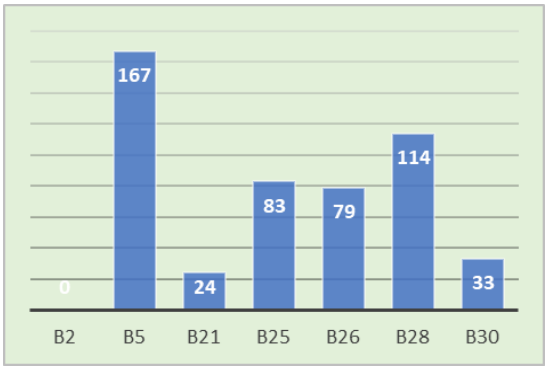
Chemical and Petrochemical Industry			
The highest Sub-barrier		Adopted mitigation strategy	
B5	Forecasting Issues	S1	Strategic stock with Demand Management
B25	Lack of proper contingency plans	S8	Supply Chain Knowledge and Awareness

FMCG			
The highest Sub-barrier		Adopted mitigation strategy	
B5	Forecasting Issues	S1	Strategic stock with Demand Management
B28	Lack of integrated IT system across the whole chain	S6,S7	Collaboration, Digitalization

Fig 11; 12: Max Sub-barrier Freq.

For Chemical & Petrochemical and FMCG





Furthermore, by splitting the Human and Judgmental main barriers (The highest Main Barrier Criterion in Construction, Freight Forwarders, and Technological simulation analysis) into the related sub-barriers to find the maximum sub-barrier in each row of 500 rows to pick the suitable mitigation strategy.

Fig 13: Max Sub-barrier selection steps for Construction, Freight Forwarders, and Technological Industries

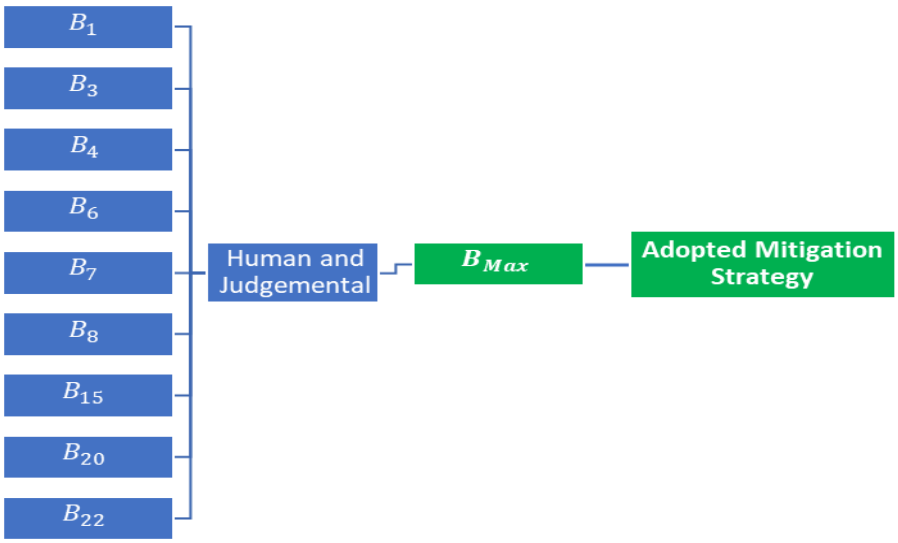


Table 6; 7; 8: Mitigation strategy selection

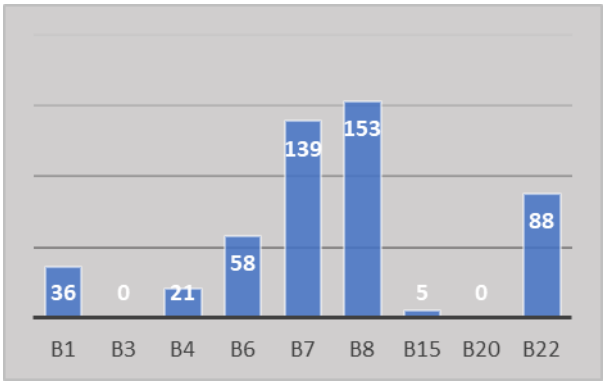
Construction			
The highest Sub-barrier		Adopted mitigation strategy	
B8	Opposition to change and Innovation	S8	Supply Chain Knowledge and Awareness
B7	Mistrust among partners	S6	Collaboration

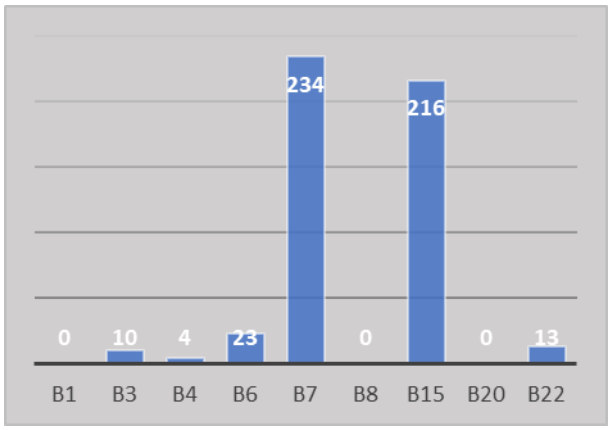
Freight Forwarders			
The highest Sub-barrier		Adopted mitigation strategy	
B3	Non-commitment of top management	S9	Cross Training and Mentorship Program

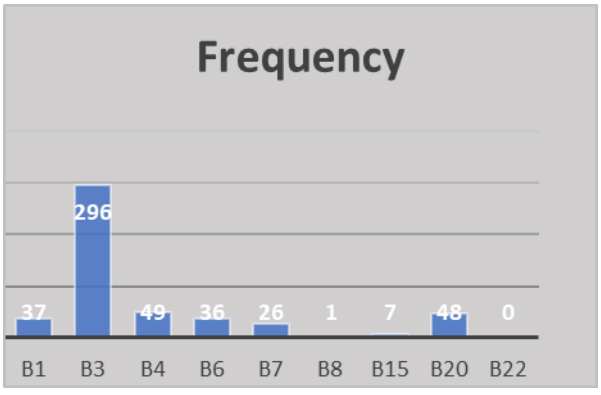
Technological			
The highest Sub-barrier		Adopted mitigation strategy	
B7	Mistrust among Partners	S6	Collaboration
B15	Lack of Flexibility	S8, S4,S5	Supply Chain Knowledge and awareness, Substitution, and Assortment

Fig 14; 15; 16: Max Sub-barrier Freq.

For Construction, Freight Forwarders, and Technological Industries







Conclusion

This research has provided an understanding of how supply chain resilience is affected by different sectors of Egypt industry. Relying on the analysis of the prior literature and exploratory studies, interviews with academics, and the applied model that was developed to examine; the identification of barriers to implementing a resilient supply chain and the mitigation strategies to overcome those barriers.

In the simulation analysis, the examination of the significant barriers in each industry among the proposed five industries, revealing the following:

- The Information main barrier has a significant impact and effect on the chemical & petrochemical, and FMCG sectors.
- In the Construction industry, there is a high effect of both human & judgmental and financial main barriers.
- The human and judgmental main barrier is the highest major barrier in the Freight forwarders and Technological industries.

By going deeply into the Egyptian industry as a whole market, it's revealed that the currency fluctuation represents a headache for managers, experts, and all interested partners in the supply chain. The high rate of fluctuation and rapid movement of the national currency appears in the choice of managers to the highest obstruction and barrier from their point of view is the Incapability to absorb fluctuations in cash flow. The other part is the information-related barrier in the Egyptian industry as a whole market, which is the second obstacle to applying supply chain resilience considering increasing knowledge and awareness of the importance of supply chain resilience the second aspect is sharing the information, doing accurate forecasts, and preparing a contingency plan.

The strategic stock with demand management is a mitigation strategy that should be adopted in the Chemical and Petrochemical industry and for the FMCG industry. Collaboration as a mitigation strategy should be considered in FMCG, Construction, and Technological industries. It is obvious, in the freight forwarders industry (Logistics and transport sector) that the main issue concluded in the disengagement and non-commitment of top management, which is needed to give them training and mentorship programs. To sum up, it is a beneficial result and finding for managers and

professionals who work or are interested in the Egyptian market because it identifies which variables are more effective strategies to apply chain resilience in each mentioned sector.

Limitations and Recommendations

The limitation of this research could be concluded in the next points,

- There are several industries that won't be included in this research such as Textile, Automotive, and obviously the agriculture sector. Further research can focus on those areas.
- This research purpose is to study several sectors in the Egyptian industry, not specific sectors. Studying the specific sector could be more accurate to deduce results more deeply.

This study offers a wide range of recommendations that can be considered as a guide for the enhancement of the resilience of the Egyptian supply chain; they can be summed up as follows:

- The research findings suggested cross-training and mentorship programs, so it's important to give training for employees not only the organization's staff but also the top management training program to increase awareness and knowledge of the importance of supply chain resilience in the Egyptian industry and to enhance the level of flexibility for all Egyptian sectors.
- Building trust and cooperation between supply chain partners in each sector will help to increase the integration between them which means fewer disruptions through the value chain, less loss in profit, and minimization of supply chain risk.
- It's necessary for all the decision-makers in the Egyptian industry to build a contingency plan for their organization to save the organization from future risks and unprecedented disruption. That ensures the continuity for those organizations and offers them the survival pendant.

In the end, it is beneficial to conduct further studies into the supply chain resilience and supply chain sustainability in the industry market of Egypt to provide solutions and recommendations for all managers and executives who work in Egyptian industries. Using different tools and analysis techniques will enrich the upcoming studies and proposals for the resilient supply chain in Egyptian sectors.

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