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Insights on Resilience and Flexibility During COVID-19 Pandemic: A Study on Wheat Supply Chains in Pakistan

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The Covid-19 pandemic has disrupted global supply chains, including those in the food industry, posing significant challenges to food security and sustainable production. This study focuses on investigating the resilience of Pakistan's wheat supply chain during the pandemic, with a particular emphasis on the concept of supply chain flexibility. Through structured interviews with 50 individuals involved in the wheat supply the study examines the impact of proactive capability, supply chain design, and reactive capability on the resilience of the wheat supply chain. The findings reveal that proactive capability in the wheat supply chain demonstrated flexibility in various aspects, except for sourcing. Integration among departments showed collaboration, but issues were encountered in information sharing and efficiency. The readiness of the supply chain showed detection ability but lacked training and strong security measures. Supply chain design complexities were observed in direct dealings and a lack of flexibility in flow. Reactive capability indicated challenges in quick response, crisis mitigation, and recovery, emphasizing the importance of response teams and financial readiness. The study provides valuable insights for supply chain managers, highlighting areas for improvement such as sourcing strategies, information management, quality control, and financial support. Future research could explore other sectors and agricultural products, investigating different geographical areas, and increasing the sample size. By further understanding the dynamics of supply chain resilience and flexibility, organizations can better prepare for and respond to disruptions, ensuring the continuity of critical food supply chains during crises.

1. Introduction

The recent coronavirus epidemic has taken a traditional approach to business, putting food supply chain actors at greater risk. Before the coronavirus epidemic, the food business was generally concerned about operational and foods related performance including food quality, safety, quality, security, and food integrity (Manning & soon, 2016; Smith et al., 2016; Bakalis et al., 202). Nevertheless, the coronavirus epidemic hits the business process across the world increasing concerns about the ability of food firms to survive which may have unlimited effects on food security and sustainable production or safe for consumption, especially regarding the accessibility, availability, and uses (Nicola et al., 2020; Cappelli and Cini, 2020). Governments across the globe and international organizations like the Food and Agriculture Organization of the United Nations (FAO) and WHO (World Health Organization) are under pressure to make sure the security of food supplies in cities and towns during the coronavirus epidemic (WHO & FAO, 2020: Ivanov and Dolgui, 2020). Food security for consumers is difficult to achieve if food firms are unable to respond effectively to the pandemic (Falkowski, 2015).

Given supply chain resilience's enormous importance in descriptive events abroad, the concept of supply chain flexibility is of paramount importance. Organizations and their supply chain must develop proactive and reactive resilience skills to increase the required level of recovery, readiness, and response capability during the pre-disaster and post-disaster phases. In other cases, Supply chain functioning will be disrupted, affecting the whole chain's cost and revenue. (Ponomarvo and Holcomb, 2009). In addition to reactive and proactive aspects, some studies (Falasca et al., 2008; Craighead et al., 2007; and others) Highlight the supply chain design quality in developing SCRE.

The COVID-19 pandemic, which originated in Wuhan, China in December 2019 and was declared a global health emergency by the World Health Organization (WHO) in March 2020, has affected millions of people and caused thousands of deaths worldwide (WHO, 2020). To contain the spread of the virus, many countries implemented various measures such as wearing masks, social distancing, and lockdowns, which had a negative impact on the economy and the supply chain (Kumar & Manage, 2020). Several studies have explored the resilience of supply chains in different sectors and regions during the pandemic, such as small and medium enterprises (Alite et al., 2021), food value chains (Ozdemir et al., 2022), and maritime supply chains (Lam & Bai, 2016). However, there is a lack of research on the flexibility of the supply chain in the wheat industry in Pakistan, which is an important aspect of resilience.

The basic evidence of the dynamic capability view is a firm's range to integrate, reconfigure, and build resources using its process to counter environmental uncertainties and changes and to design new value-creating strategies (Teece et al.,1997; Eisenhardt and Martin, 2000). In the same order, we declare that an institution's supply chains need to develop dynamic capabilities to reduce vulnerabilities in an undetermined environment, which necessitates resilience abilities to survive in the long run. The current study tried to find out two question, (1) Does the proactive and reactive capability affect the wheat supply chain in Pakistan? (2) Does the supply chain design help the wheat supply chain?

The term resilience comes from “resilio” a Latina word that refers to the ability of something to regain or recover its original form or condition after exposure. Holling, (1973) funded the definition of resilience which was recognized as a part of “the continuity of system and its capacity to retain disturbance and continue to preserve the similar connection among population and factors”. A strong supply chain is described by its pliability and capacity for recovery and resistance. This means the ability to sustain and even survive the effects of a disruption in the supply chain and the ability to recover quickly from a disruption. The interruption and risk can put multiple areas of a supply chain at risk.

A global crisis, as we’ve seen with the coronavirus, can be extensive or wide-ranging effects on supply chain workforces, suppliers, and logistics around the world. Another supply chain can come in the form of expected competition, a sudden market, or even a leading researcher, flexibility is the ability of a system to absorb changes. Flexibility is a multidisciplinary concept. Holling (1973), one of the well-known researchers of flexibility/resilience is the ability of a system to absorb changes. Many authors have since defined the concept of resilience as the ability of a system to recover and return to its original state (Christopher and Peck; Mitroff and Alpasan, 2004). According to the institutional perspective, flexibility/resilience can be distinguished from institutional flexibility to survive in a volatile environment (Ates & Bitici, 2011). It has become very important in the supply chain domain due to disruptions in the global supply chain. Nevertheless, researchers debate how SCRE should be measured and indicated (JUttner & Maklan, 2011), as studies are inconsistent in defining the measurement and antecedent construct of SCRE. Chowdhury and Quaddus (2017), showed that supply chain resilience is a dynamic and inherent concept construct. The three basic dimensions of this concept are; one is proactive capabilities, second is reactive capabilities and the third one is supplying chain design.

2. Literature review

The concept of supply chain resilience, derived from the Latin term "resilio," refers to the ability of a system to recover its original state after exposure, and its significance has been recognized through a variety of viewpoints in the literature. Holling (1973) laid the foundation for resilience, framing it as the continuity of a system's capacity to withstand disturbances and maintain interconnectedness. A robust supply chain is characterized by its ability to sustain and recover from disruptions, encompassing factors like pliability and quick recovery (Hohenstein et al., 2015). The three resilience types—engineering, ecological, and revolutionary—are outlined by Adobor and McMullen (2018), each with distinct attributes shaping resilience strategies. Flexibility, inherent in resilience, is the capacity to absorb changes (Holling, 1973). Supply chain resilience encompasses both proactive capabilities, such as adaptability and integration, and reactive abilities, including recovery and response (Juttner and Maklan, 2011; Brusset and Teller, 2017; Wieland and Wallenburg, 2013). The design of a supply chain, influenced by node density, complexity, and criticality, contributes to its vulnerability (Craighead et al., 2007). In the context of medium and small-sized enterprises (SMEs), empirical research emphasizes resilience's dual role as both a measure and capability (Durach et al., 2015). Collaborative activities and SCRE building elements are discussed by Hohenstein

et al. (2015), while SCRE is conceptualized as agility and robustness by Wieland and Wallenburg (2012, 2013). Literature also showcases diverse perspectives on resilience, with studies focusing on proactive aspects (Juttner and Maklan, 2011; Pal et al., 2014; Ero et al., 2010) and others considering both reactive and proactive dimensions (Christopher and Peck, 2004; Sheffi and Rice, 2005; Falasca et al., 2008; Vugrin et al., 2011; Martin, 2004; Pettit et al., 2013). Ultimately, the relationship between supply chain design and resilience is explored, where the proactive or reactive design responds to supply chain disturbances and is integral to the overall resilience strategy (Vonderembse et al., 2006; Fiksal, 2006; Chowdhury and Quaddus, 2015).

2.1 Pro-Active Aspects of SC Resilience

SC requires proactive capabilities to be resilient to disturbance/ disruptions (Christopher & Peck, 2004; Pettit et al., 2010, Juttner & Maklan, 2011) when we discuss a proactive aspect of the supply chain. Hollnagel et al., (2006) said that pro-active resilience has the capability to accept, anticipate, and defend the risk before negative results happened. Tenhiala and Salvador (2014) gave importance to the need for the communication channel to cope with upgrades and interference the flexibility. Supply chain research focused on proactive capabilities such as redundancy, collaboration, robustness, capacity, flexibility, integration, visibility, financial capability, market capability, efficiency, & diversity to measure supply chain resilience (Fiksel, 2003; sheffi & Rice, 2005; Ponomarov & Holcomb, 2009; Pettit at al., 2010, 2013; Pal et al., 2014). Additionally, Juttner and Maklan (2011) gave importance to proactive capabilities which are velocity, visibility, collaboration, and flexibility. For that reason, this study confirms supply chain capability and their sub-direction within higher order SCRE scale.

2.2 Re-active aspects of SC resilience:

According to/in line with sheffi and Rice (2005), Ponomariov and Holcomb (2009) the reactive aspect of supply chain resilience (SCRE) can be settled based on the recovery & response abilities of the institutions/ organizations.

- **Supply chain response** concerns reducing disturbance in the shortest possible and limited time and with the smallest impact (Pettit et al., 20013). Quick response-ability to the market during critical situations is important of supply chain resilience (SCRE) (Sheffi & Rice, 2005; Wieland & Wallenburg, 2013).
- **Recovery;** disturbance recovery is a critical and particular capability of companies and their supply chain. Some systems, whether a business network or ecological system can recover quickly from disruption due to their idiosyncratic ability. In line with the research of Wang et al., (2010), Shaffi & Rice, (2005), and Valikangas (2010), such capabilities can be associated with the resilience of a dynamic and vast system. For that reason, resilience can be measured by the scope of cost, time, disruption, absorption, recovery, and ability that reduce the influence of the loss.

2.2 Supply Chain Design Quality

Supply chain design quality is gestated in terms of SC nodes, criticality, disruption, and complexity

- **Node density** a large number of nodes remain limited in a terrestrial area while node density is high in a supply chain (Craighead et al., 2007; Falasca et al., 2008). When the sources of distribution or supply markets are comprehensive in a particular area the supply chain nodes exit in high-density groups (Chowdhury and Quaddus, 2017). When sources of supply or distribution markets are abundant in a particular area. The supply chain nodes survive in a high-density group.
- **Complexity** is connected by a number of nodes and the interrelation with those nodes (Craighead et al.,2007). When there is a large number of forward and backward flows in the supply chain the supply chain becomes more composite for which we required or need parts and components of products and there is a relationship between different branches in the supply chain network (Choi & Krause, 2006).
- **Node criticality** depends on the importance of a given node or set of nodes within the supply chain (Craighead et al., 2007). An important supplier or distributor on which others in the supply chain are highly rigorous makes the supply chain vulnerable and evaluative. An important transportation center makes a supply chain also important during sourcing and distribution also makes supply chain criticality (Craighead et al., 2007).

3. Methodology

This current study is a structured exploratory study, and structured interviews were used by already developed instruments while the research design is qualitative. Information was gathered from the goods transport people involved in the wheat supply chain (wheat logistic peoples, wheat transportation-related peoples, wheat distributors, and flour mills wheat supply chain involved peoples). The nonprobability sampling technique was used and collected the data using the purposive sampling technique and the sample size is comprised of 50.

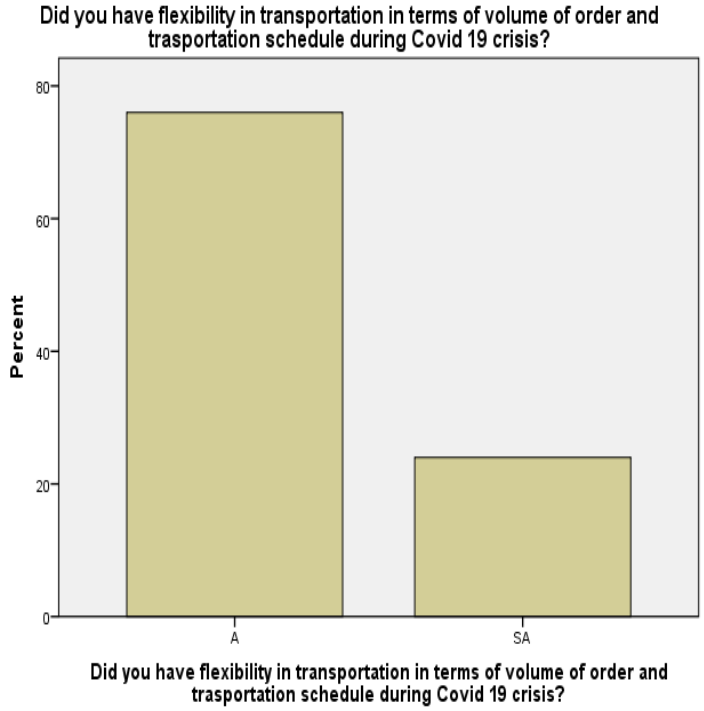
Structured exploratory study and structured interviews method were applied as research tools for the collection of data from the targeted sample. For briefing about the purpose and scope of the study being conducted an attached cover letter will be provided along with the questionnaire. The questionnaires distributed be self-administered without the involvement of the researcher. The questionnaire was in English language and Urdu of the existing validated instruments. In this study were used supply chain resilience scale SCRE. All variables have been measured through a 5 Likert scale where one is strongly disagree, 2nd disagree, third one is neither disagree nor agree, 4th one is agree, and last one is strongly agree. For analysis analyzed descriptive statistics are done with the help of SPSS.

4. Analysis and Results

This study is about the wheat supply chain during the covid-19 crisis. It was structured interviews collected from 50 people from truck drivers, dealers, suppliers, and food providers. The results of different questionnaires through interviews are as follows.

4.1 Question # Flexibility (Pro-activeness)

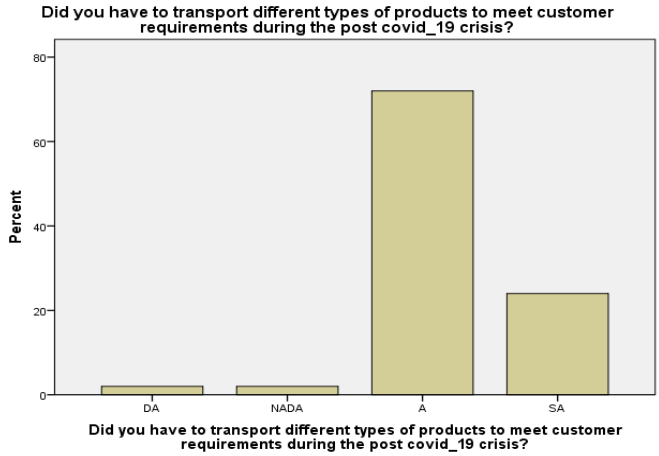
Figure No 1: Flexibility (Pro-activeness)



The first question asked in the interview was about flexibility in transportation schedules during COVID-19. About 76% of the interviewed agreed that they did have flexibility 76 % in this regard. Further 24% of the sample interviewed had a stronger opinion in terms of their agreement with the availability of flexible transportation schedules. What is interesting is that there are no disagreements with this notion. This is true as in those days in the country few industries were kept open and transportation was allowed flexibility to operate by the government, particularly goods transportation. Intermittent restrictions were only placed on passenger transport.

4.2 Q#2 Flexibility (Pro-activeness)

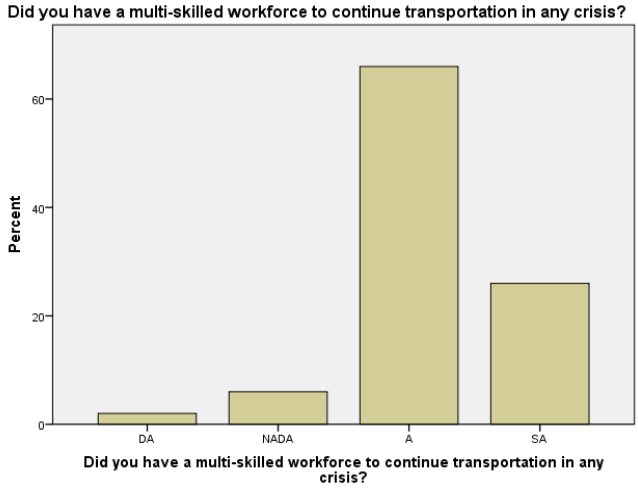
Figure No 2: Flexibility (Pro-activeness)



The second question asked in the interview was about flexibility in different types of transportation to meet customer requirements during the post-covid-19 crisis. about 72% of the interviewees agreed that have different types of customer requirements 72% in this regard. and 24% strongly agreed about this notation. Further, 2% disagreed, and 2% of others neither agreed nor disagreed interestingly there is no one strongly disagreed about this.

4.3 Q#3 Flexibility (Pro-activeness)

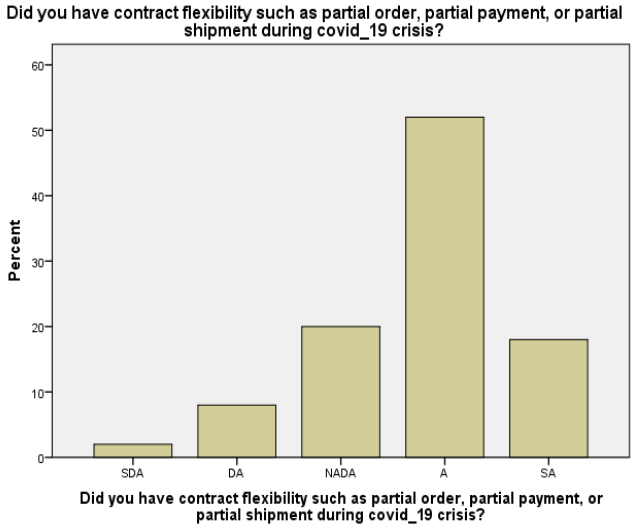
Figure No 3: Flexibility (Pro-activeness)



The third question was about a multi-skilled workforce to continue transportation in any crisis. About 66% of the interviewed agreed they did have a multi-skilled workforce 66% in this regard. 26%of the sample interviewed had a stronger opinion in terms of their agreement. Further, 2% disagreed about this notation, and the other 6% of that neither agreed nor disagreed. no respondent had completely disagreed.

4.4 Q#4 Flexibility (Pro-activeness)

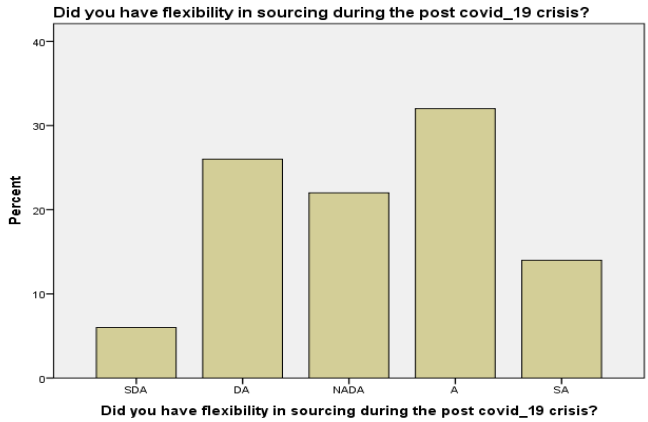
Figure No 3: Flexibility (Pro-activeness)



These questions about contract flexibility such as partial order, partial payment, or partial shipment about transportation during the covid-19 crisis were asked in an interview. 52% of interviewees agreed regarding contract flexibility, 18% strongly agreed in this sample notation, and 20% neither agreed nor disagreed. further 10 % not agreed with this question.

Q# 5 Flexibility (Pro-activeness)

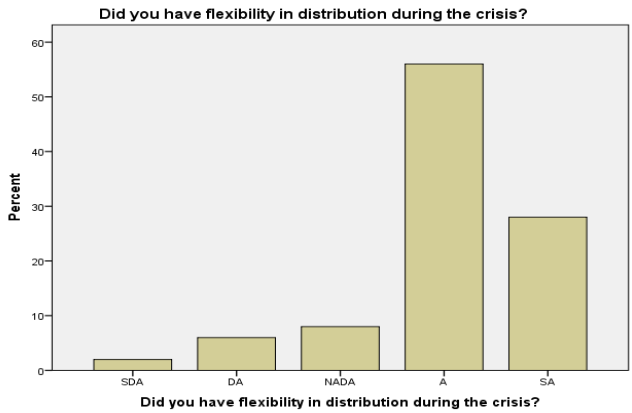
Figure No 5: Flexibility (Pro-activeness)



The fifth question asked in the interview was about the flexibility in sourcing transportation during covid-19. About 32% of the interviewed agreed that they did have flexibility in sourcing 32% in this regard and 14% strongly agreed. The 22% neither agreed nor disagreed further 26% disagreed with this notation. Other remaining sample had 6% completely disagreed. Interestingly, less than 50% were dissatisfied with this question because of sourcing disruption at that time.

Q# 6 Flexibility (Pro-activeness)

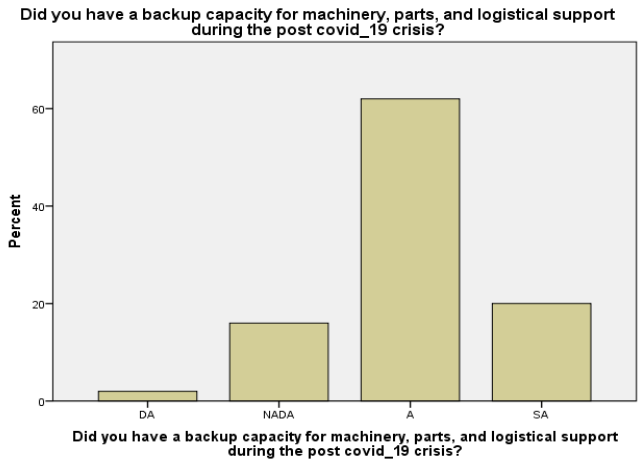
Figure No 6: Flexibility (Pro-activeness)



Flexibility question number 6th was asked during the interview about flexibility in transportation distribution during the resilience. About 56 % of them agreed that they did have resilience/ flexibility in distribution and 28% strongly agreed total of 84% intertwined agreed in this regard. 8% of them neither agreed nor disagreed with this sample and a further 2% strongly disagreed and 6% disagreed interesting is that more of them agreed with this notation.

Q# 7 Redundancy (Pro-activeness)

Figure No 7: Redundancy (Pro-activeness)



Question number 7 was about redundancy asked in the interview about the backup capacity for machinery, parts, and logistical support during the crisis. About 62% of the interviewed agreed that they had the backup capacity and 20% strongly agreed, which means 82% said they had a backup capacity. Further 16% of the respondent neither agreed nor disagreed they had no arguments. Other 2% of respondents disagreed with this notation means during covid-19 they thought that they were no backup capacity. Interesting no, one was ready to strongly disagree.

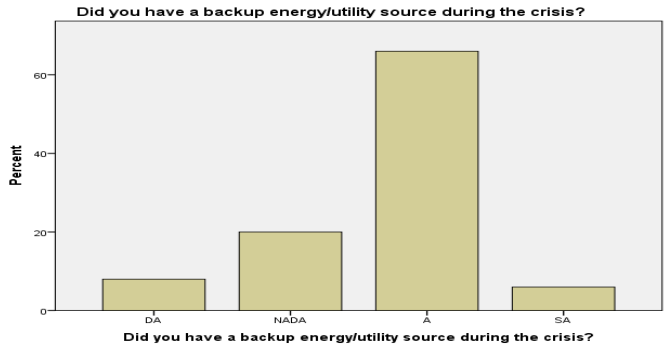
Q#8 Redundancy (Pro-activeness)

Figure No 8: Redundancy (Pro-activeness)

Question number 8th asked in the interview was about the buffer stock in the wheat supply chain during the resilience. About 80% of the interviewed respondents agreed that they had buffer stock for the wheat supply chain 80% in this regard. 12% of respondents completely agreed with that notation. 92% of respondents answered yes. Other remaining 6% were neutral and a further 2% disagreed with this notation. No one completely disagreed. It is true the goods transport operated during the crisis and that they did have buffer stock in the wheat supply chain.

Q# 9 Redundancy (Pro-activeness)

Figure No 9: Redundancy (Pro-activeness)



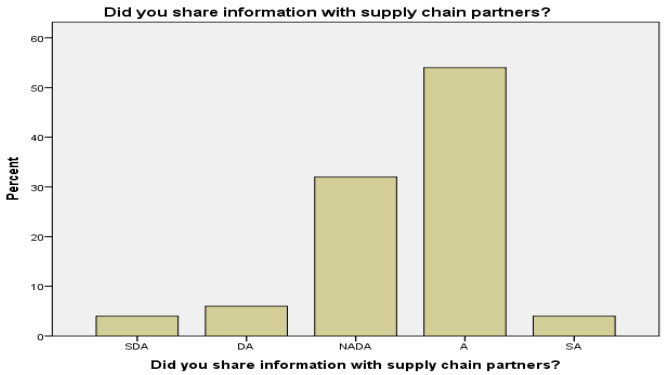
The interview asked this question about the redundancy in wheat backup utility sources during the supply chain. About 66% of the interviewed agreed that they did have backup energy sources and 6% strongly agreed in this regard. Further 20% of the sample had no opinion in terms of their arguments with backup utility sources during the crisis. 8% disagreed about backup sources. What is interesting is that there are no strong disagreements with this notation. It's true in those days the goods transport redundancy wheat had available in backup energy sources. Because there was no restriction for goods transports.

Q# 10 Integration (Pro-activeness)

This question about integration was asked during interviews with the covid-19 transporters who shared information with their supply chain partners. About 54% of

respondents agreed and 4% strongly agreed with the notation total of 58% answered with a yes. Other 6% disagreed.

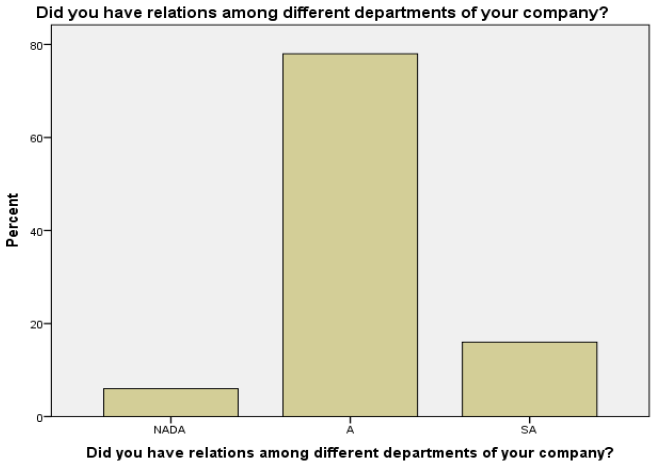
Figure No 10: Integration (Pro-activeness)



And 4% of respondents strongly disagreed in this regard. Interestingly 32% of the respondent had no arguments with this notation. According to these results, most of the transporters shared information with their supply chain partners.

Q#11 Integration (Pro-activeness)

Figure No 11: Integration (Pro-activeness)

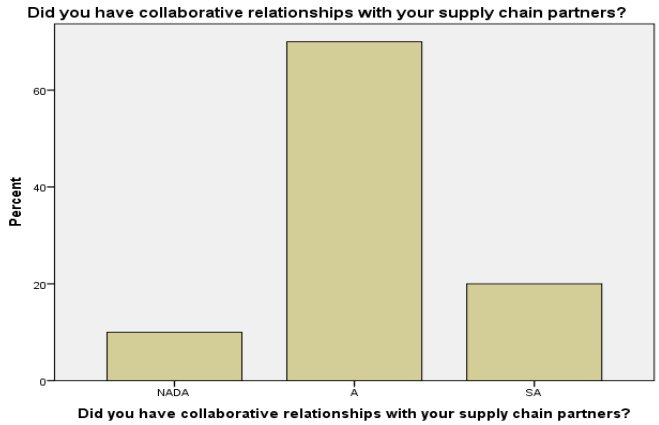


Integration question number two asked in the interview was about the relations among departments of the transport company. About 78% of the interviewed agreed that they did have relations with other departments and 16% strongly agreed with this regard. Further, 6% of the sample interviewed had no arguments with this notation. What is interesting is that there was no disagreement with this notation. this is true as in those days in the country the goods transport company relation with different departments.

Q#12 Integration (Pro-activeness)

Integration question number 3 asked in the interview was about the collaborative relationship between the transport company with its supply chain partners. About 70% of the interviewed agreed that they did have a collaborative relationship with their supply chain partners 70% in this regard.

Figure No 12: Integration (Pro-activeness)

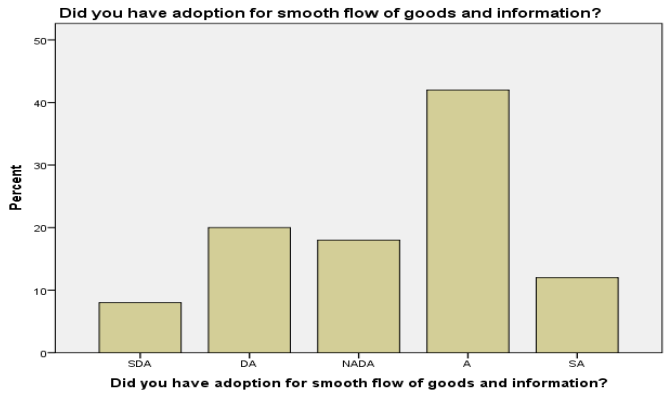


Other 20% of respondents strongly agreed. Further, 10% of respondents have no arguments about this notation. Interestingly there no one has disagreed with this.

Q# 13 Integration (Pro-activeness)

Integration question number 4th asked in the interview was bout the adoption of the smooth flow of goods and information. About 42% of the interviewed agreed and 12% completely

Figure No 13: Integration (Pro-activeness)



agreed that they did have adoption for smooth flow of goods and information in this regard. Further 18% of the sample interviewed had no opinion in terms of their arguments with the adoption of a smooth flow of goods and information. Other 8% of respondents strongly disagreed and 20% disagreed with this notation. According to 54% of respondents, they did have a smooth flow of goods and information.

Q#14 Efficiency (Pro-activeness)

This question was about efficiency the first efficiency question asked in the interview was about efficient employees in transportation. About 8% of the interviewees had no opinion of their arguments in this regard. The total number of disagreed respondents was 36% and only

Figure No 14: Efficiency (Pro-activeness)

48% agreed. The remaining 8% of respondents strongly agreed with this notation. Interestingly transporters did have efficient employees during the covid-19 crisis.

Q#15 Efficiency (Pro-Activeness)

Efficiency question number 2nd asked in the interview was about a strong quality control process in transportation during the post-covid-19. About 32% of the interviewed agreed and 6% strongly agreed that they did have a strong quality control process in this regard. Further 26% of respondents neither agreed nor disagreed they did not argue with this notation. Other 30% of respondents answered disagreed and 6% disagreed. Interestingly there was no proper strong quality control process during the crisis in the transportation company.

Figure No 15: Efficiency (Pro-Activeness)

Q#16 Market strength (Pro-Activeness)

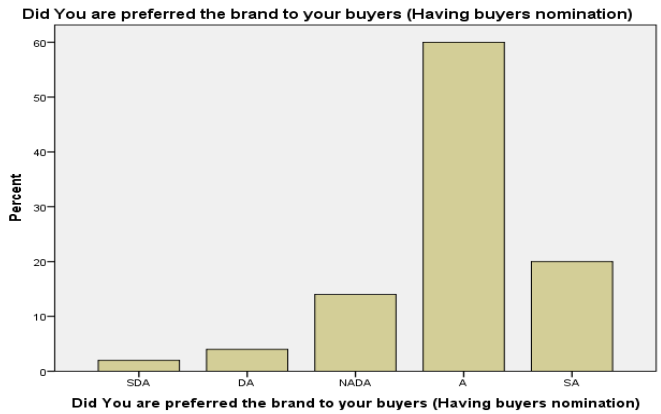
This question was about market strength asked the interview was about the buyers and suppliers satisfied with the transport company. About 64% of the interviewed agreed and 12% strongly agreed that they did have satisfaction with the buyers and suppliers in this regard. Further, 8% have no answers they have not given their argument. Other 4% strongly disagreed and 12% of respondents disagreed with this notation. Interesting most of the transporters were satisfied with the buyers and suppliers during the crisis.

Figure No 16: Market strength (Pro-activeness)

Q#17 Market strength (Pro-Activeness)

Market strength question number 2nd asked in the interview was about transporters who have preferred the brand to their buyers. About 60% of the interviewed agreed and 20% strongly agreed that they did have preferred the brand to their buyers in this regard. further, 14% gave no argument. Other 2% of respondents strongly disagreed and 4% disagreed with this notation. Interestingly is that most of the respondents preferred the brand during those days.

Figure No 17: Market strength (Pro-activeness)



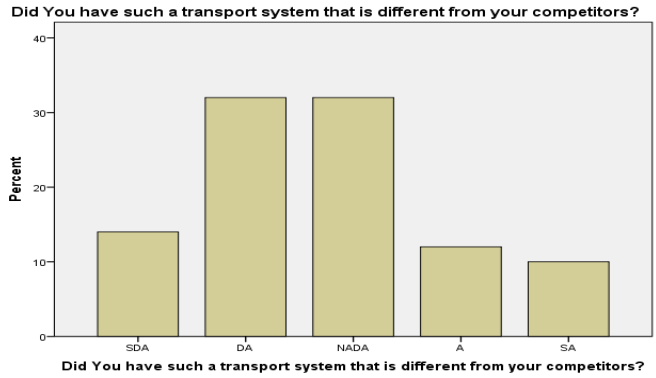
Q#18 Market strength (Pro-activeness)

Question number 3 about market strength was asked in the interview about a good buyer-supplier relationship with the transporters. About 64% of the interviewed agreed and 10% strongly agreed that they had a good buyer-supplier relationship in this regard. Further 14% of the sample interviewed had a neutral. 12% remaining respondents disagreed with this notation. No one strongly disagreed and there was a good relationship with the transporters.

Figure No 18: Market strength (Pro-activeness)

Q#19 Market strength (Pro-Activeness)

Figure No 19: Market strength (Pro-activeness)

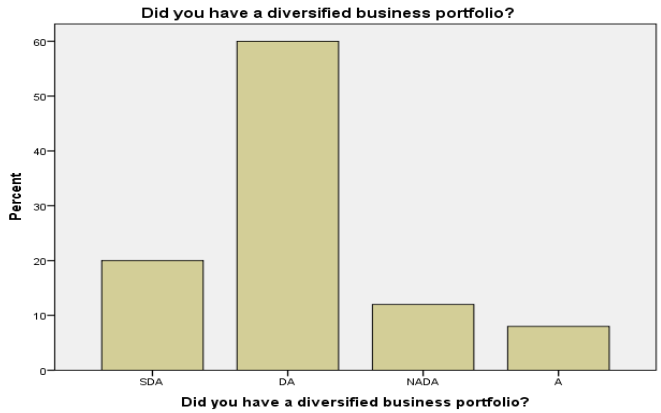


Market strength question number 4 asked in the interview was about the transport system different from your competitors. About 12% of the interviewees agreed and 10% strongly agreed that they did have a different transport system from their competitors in this regard. Further 32% of the sample interviewed had no arguments. Other 14% strongly disagreed and 32% disagreed with this notation. Interestingly most of the respondent was not thought different transport from competitors.

Q#20 Financial Strength (Pro-activeness)

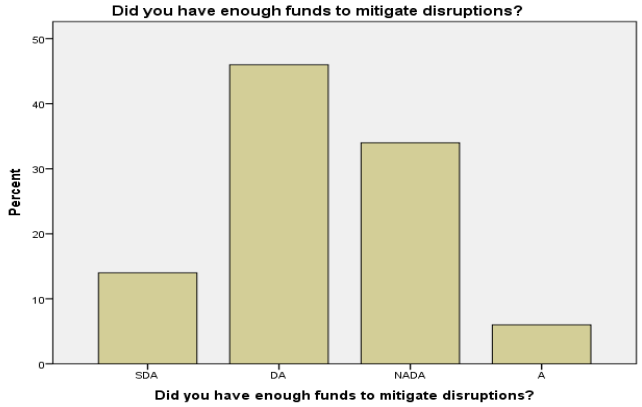
This question was about the financial strength asked in the interview was about the diversified business portfolio in transport management during the covid-19. About 8% of the interviewees agreed that they did have a diversified portfolio in this regard. interestingly 60% of the sample interviewed disagreed and the other 20% strongly disagreed with his opinion or argument. Further 12% had no argument not answered.

Figure No 20: Financial Strength (Pro-activeness)



Q#21 Financial Strength (Pro-activeness)

Figure No 21: Financial Strength (Pro-activeness)



Financial question number two asked in the interview was about transportation management having enough funds to mitigate disruption. Only 6% of the interviewed agreed that they did have enough funds to mitigate disruption in this regard. Further 46% of the sample interviewed disagreed and 14% strongly disagreed. 34% of the respondent neither agreed nor disagreed they did not answer. answer those days the transporter had not enough funds to mitigate the disruption.

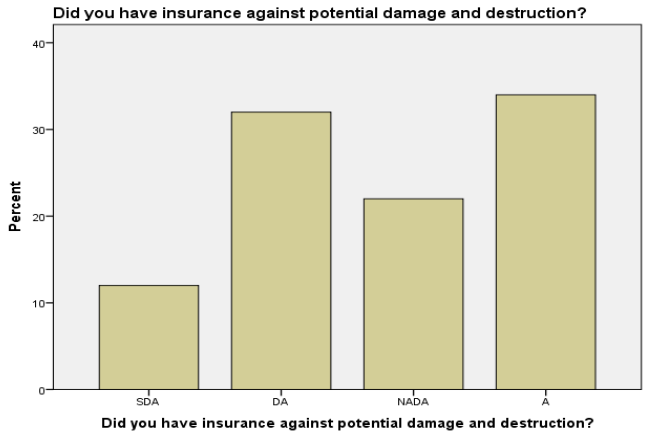
Q#22 Financial Strength (Pro-activeness)

Financial question number 3rd asked in the interview was about the consistent profit over a couple of years. About 2% of the interviewed agreed and only 2% strongly agreed that they did have consistent profit in this regard. 28% of respondents in the sample gave no answers they are neutral. Further 62% interviewed disagreed and 6% strongly disagreed. It's true as in those days the country transport system did not get profit due to covid-19 crisis.

Figure No 22: Financial Strength (Pro-Activeness)

Q#23 Financial Strength (Pro-activeness)

Figure No 23: Financial strength (Pro-activeness)

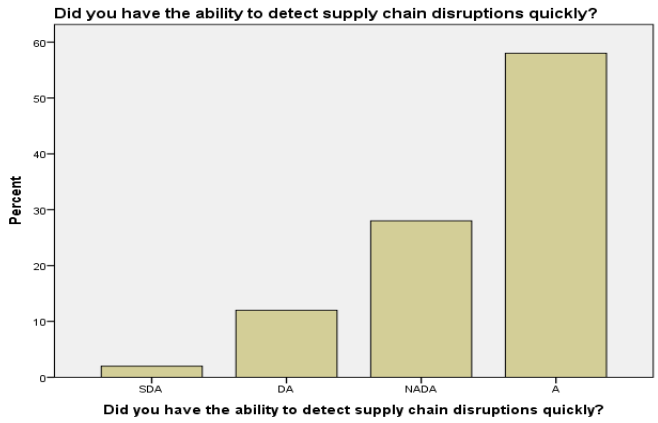


Financial strength question number 4th asked in the interview was about insurance against potential damage and destruction. About 34% of the interviewed agreed that they did have insurance against potential damage and destruction in this regard. 22% neither agreed nor disagreed. Further 31% of the sample interviewed disagreed remaining 12% completely disagreed with this notation. This is not good they had most insurance against those potential damages and destruction.

Q# 24 Readiness (Pro-activeness)

This question was about the readiness asked in the interview about transporters having the ability to detect supply chain disruptions quickly. About 58% of the interviewed agreed that they did have the ability to detect supply chain disruption quickly in this regard. Further28% of respondents had no response to this notation. Other 12% of the sample interviewed had disagreed opinions in terms of their agreement with the ability of disruptions in the supply chain. Only 2% of respondents strongly disagreed. According to this interview, most of the respondents agreed that they did have the ability to detect supply chain disruption quickly.

Figure 24: Readiness (Pro-activeness)



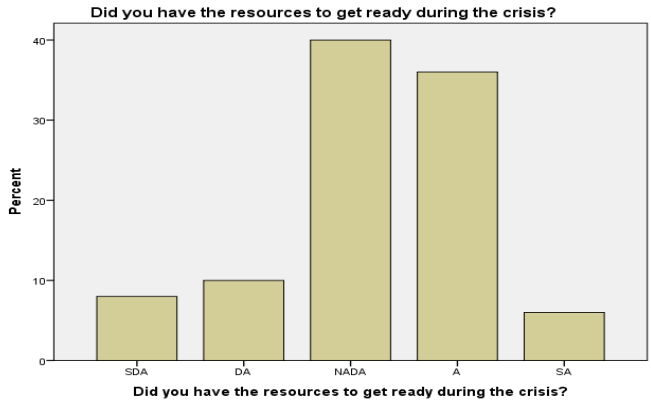
Q# 25 Readiness (Pro-Activeness)

The second question about readiness asked in the interview was about readiness training for overcoming a crisis. About 36% of the interviewed agreed that they had readiness training in this regard and 2% had a stronger opinion about that. Interestingly Further 18% of respondents, not comments they are neutral. Only 2% strongly disagreed and 42% disagreed.

Figure No 25: Readiness (Pro-Activeness)

Q#26 Readiness (Pro-activeness)

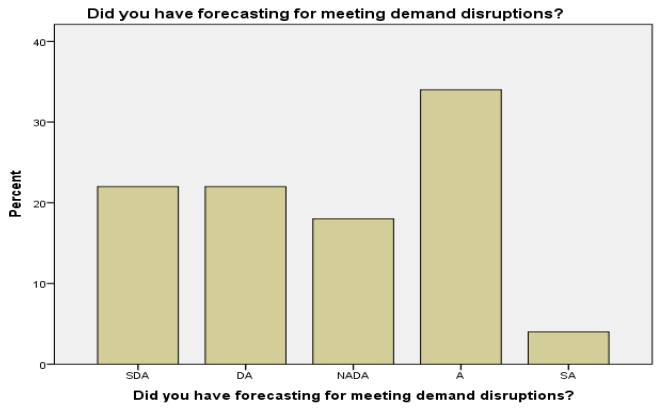
Figure No 26: Readiness (Pro-Activeness)



Readiness question number 3 was asked in the interview about the resources to get ready during the crisis. About 36% of the interviewed agreed and 6% strongly agreed that they did have resources to get ready during the crisis in this regard. Further, 40% had no arguments about this notation. About 10% disagreed and the remaining 8% strongly disagreed with this question. Interestingly there were most of the respondents gave no arguments.

Q#27 Readiness (Pro-Activeness)

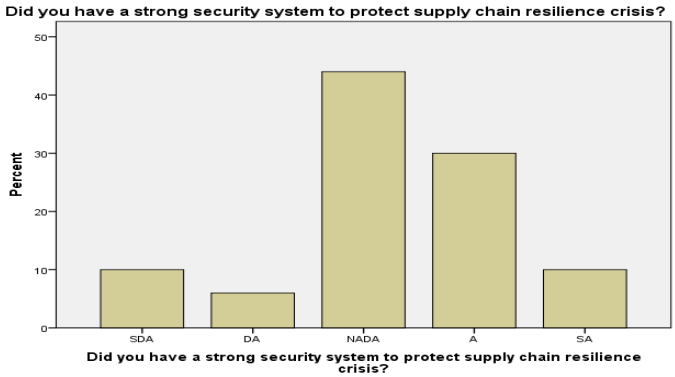
Figure No 27: Readiness (Pro-Activeness)



The readiness question number 4th asked in the interview was about the forecasting for meeting demand disruptions transportation during covid-19. About 34% of the interviewed agreed and 4% had a stronger opinion in terms of their agreement with the forecasting disruption. 22% strongly disagreed and 22% disagreed. Further 18% of respondents had no arguments.

Q#28 Density (Supply Chain Design)

Figure No 28: Density (Supply Chain Design)

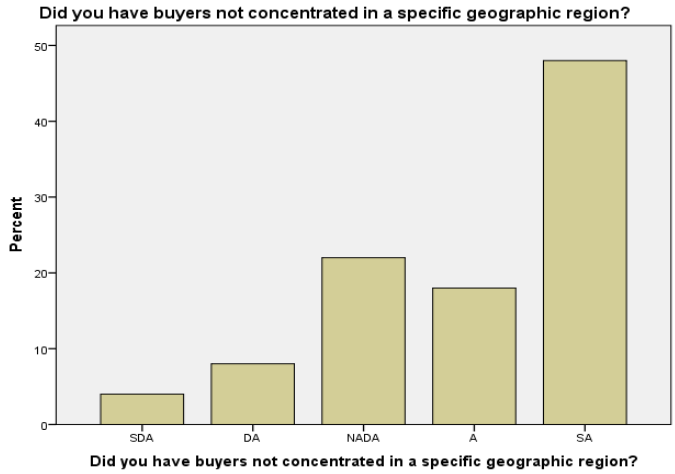


This question about the supply chain asked in the interview was about density and a strong security system to protect supply chain resilience. About 30% of the interviewed greed and 10% of them agreed that they had a strong security system to protect supply chain resilience. 44% of respondents had neutral they had no answers. Further 10% strongly disagreed and the other 6% disagreed about this notation.

Q#29 Density (Supply Chain Design)

Question number 29 about density asked in the interview was about a specific geographic

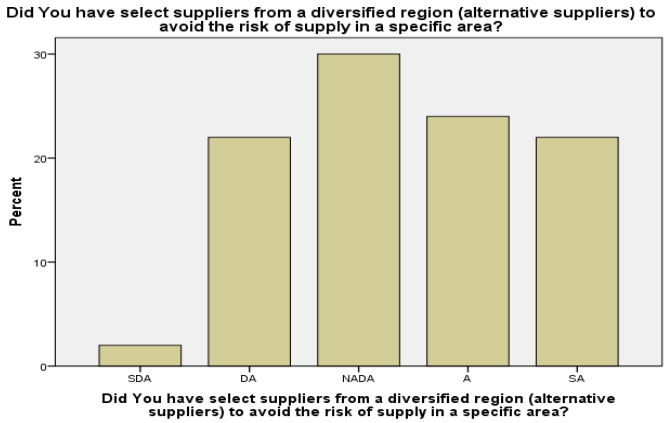
Figure No 29: Density (Supply chain design)



region transportation supply chain during covid-19. About 48% strongly agreed and 18% agreed that they did have buyers not concentrated in a specific geographic region. The remaining 22% neither agreed nor disagreed. further 4% strongly disagreed and 8% disagreed. Interestingly more of the respondent agreed about the supply chain in a specific region.

Q#30 Density (Supply Chain Design)

Figure No 30: Density (Supply chain design)

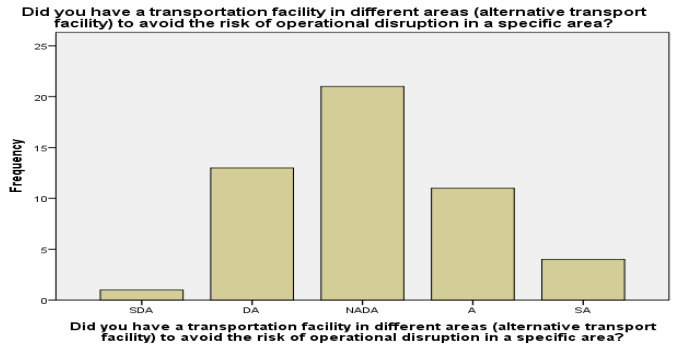


Supply chain design question number 3 about density asked in the interview was about diversified alternative suppliers' regions to avoid the risk of the supply chain in a specific area. About 24% of the interviewed agreed and 22% strongly agreed that they did have a diversified supply chain in a specific area. 30% of interviewers had no argument the had neither agreed nor disagreed. Further 22% disagreed and the remaining 2% completely disagreed with this notation. In those days, supply chain design was affected by covid-19 but the transport management must be restored or they had a strong supply chain design.

Q#31 Complexity (Supply Chain Design)

Question number 31 asked in the interview was about transportation facilities in different areas to avoid the risk of disruption in a specific area. 22% of respondents agreed and 8%

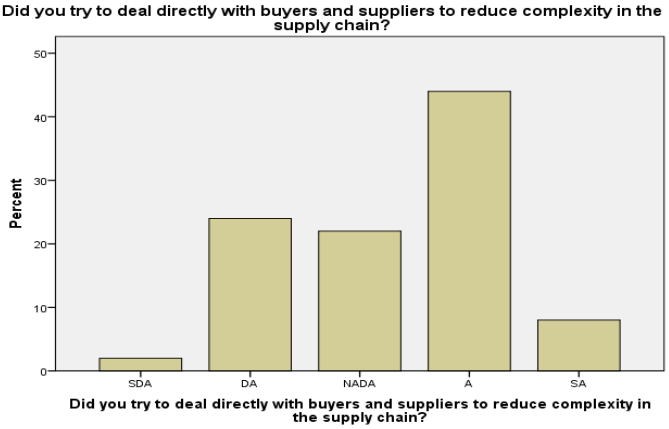
Figure No 31: Complexity (Supply Chain Design)



strongly agreed that they did have transportation facilities to avoid the risk in a specific area. 42% of respondents were neutral. further 26% disagreed and 2% only strongly disagreed with this notation.

Q#32 Complexity (Supply Chain Design)

Figure No 32: Complexity (Supply chain design)

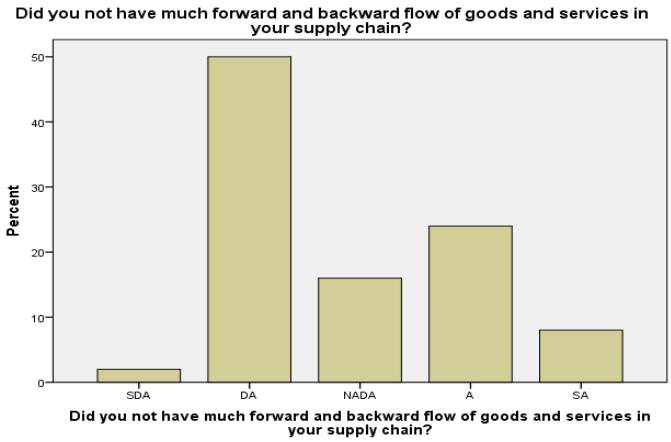


Question number 32 was about the complexity of the transportation supply chain. Asked in the interview about the deal directly with buyers and suppliers to reduce complexity in the supply chain. About 44% of the interviewed agreed and 8% strongly agreed that they did have complexity during the post-covid-19. 22% neither agreed nor disagreed with the notation. Further 24% of respondents strongly disagreed and other there 2% disagreed. Interestingly, more than half of the respondents tried to directly deal with buyers and suppliers in those days.

Q#33 Complexity (Supply Chain Design)

Question number two about the complexity asked in the interview was about the forward and backward flow of goods and services in the supply chain during the crisis. About 50% of the respondents disagreed and 2% completely disagreed that they did not forward and backward flow. 16% were not given the answer they were neutral. further 24% agreed and 8% strongly agreed with the notation. Most of the answers given in disagreed.

Figure No 33: Complexity (Supply Chain Design)



Q#34 Complexity (Supply Chain Design)

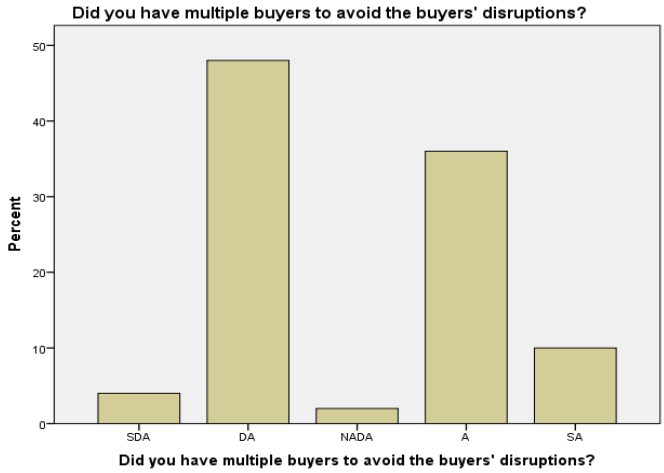
Figure No 34: Complexity (Supply chain design)

The complexity question number 3rd asked in the interview was about the multiple suppliers to avoid the risk of supply. About 48% of the interviewed agreed and the number of stronger opinions about 10% that they did have multiple suppliers to avoid the risk of the supply in this regard. And 30% of the respondent was not agreed with this notation. Further 12% had neutrals. No one strongly disagreed.

Q#35 Complexity (Supply Chain Design)

The complexity in supply chain question number 4 asked in the interview was about the logistic management that has multiple buyers to avoid buyer disruptions. About 36% of the interviewees agreed that they had complexity in the supply chain, and 10% strongly agreed. Interestingly, most did not agree with 48% and 4%strong opinion they disagreed with this notation. Further, 2% didn't want to react to this question.

Figure No 35: Complexity (Supply chain design)



Q#36 Criticality (Supply Chain Design)

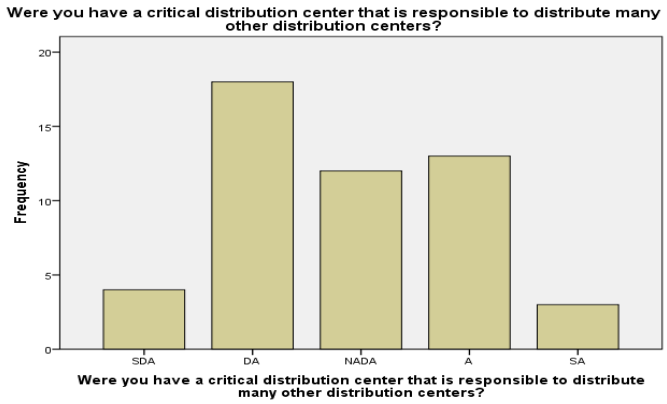
Figure No 36: Criticality (Supply Chain Design)

Question number 36 about criticality the first question about criticality asked in the interview was about whether they did not critically dependent on a specific supplier in supply chain design. About 20% of the interviewed agreed and 2%strongly agreed that they did not critically dependent on a specific supplier in this regard. 48% of interviewees disagreed and 18% strongly disagreed. Further 12% of respondents didn't comment on this notation. Most of the respondents said that they didn't critically dependent on a specific supplier.

Q#37 Criticality (Supply Chain Design)

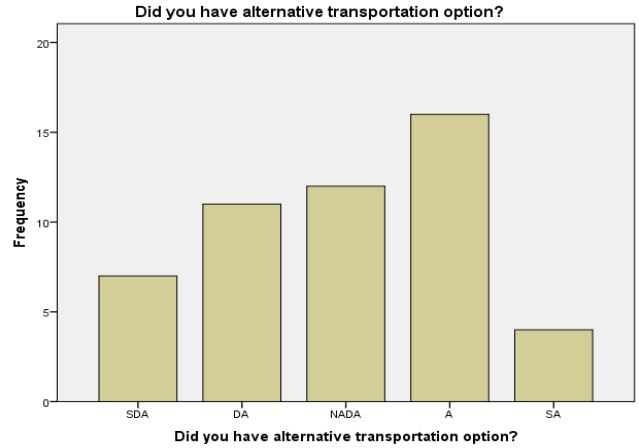
The criticality question 2nd asked in the interview was about the logistic cell having no critical distribution center that is responsible to distribute many other distribution centers. About 26% agreed with the interview and 6% strongly opinion that they did not have many distribution centers. 36% of respondents disagreed and 8% completely disagreed. Further 24% of respondents didn't answer this notation. This means they did have a distribution center that was responsible to distribute many other distribution centers.

Figure No 37: Criticality (Supply Chain Design)



Q#38 Criticality (Supply Chain

Figure No 38: Criticality (Supply Chain Design)

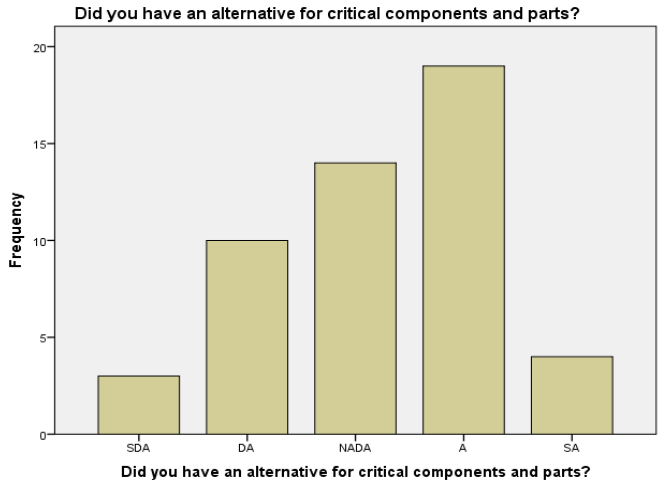


Criticality question number 3rd asked in the interview was about alternative transportation options. About 32 % of the interviewed agreed and 8% strongly agreed that they did have an alternative transportation system. The total number of neutrals was 24% in this regard. Further 22% disagreed and the remaining 14% strongly disagreed with that notation.

Q#39 Criticality (Supply Chain Design)

The criticality question number 4th asked in the interview was about the alternative for critical components and parts of supply chain management. About 38% of the interviewed agreed and 8% strongly agreed that they did have alternative components and parts in this regard. Further 28% were neutral they didn't respond. The remaining 20% disagreed and 6% of them strongly disagreed. According to this question, most of the respondents answered yes more than no.

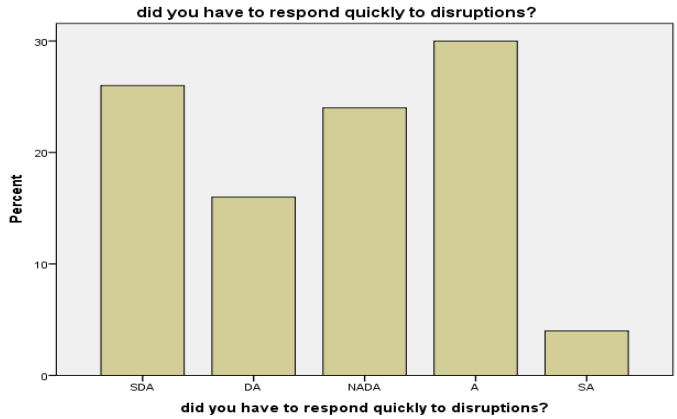
Figure No 39: Criticality (Supply Chain Design)



Q#40 Response (Reactiveness)

Question number 40 about reactive capability response asked in the interview was about to respond quickly to disruptions. About 30% of the interviewed agreed and 4% strongly agreed that they did have the reactive capability. 24% of the respondent was neutral. Further 16% disagreed and 26% strongly disagreed with this notation. More respondents said that they didn't quickly respond to disruption during the covid-19 crisis.

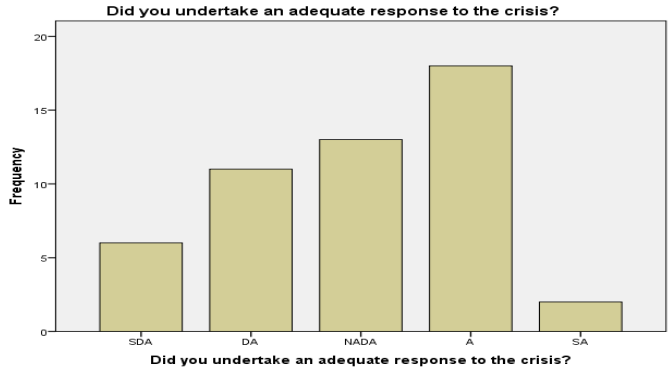
Figure No 40: Response (Reactiveness)



Q#41 Response (Reactiveness)

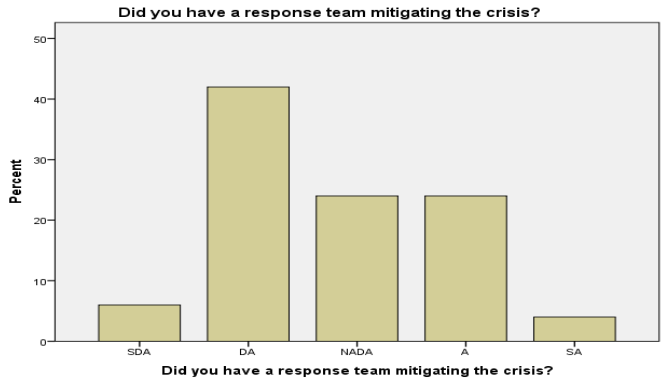
Response question number two asked during the interview was about the undertaking and adequate response to the crisis. The total number of the agreed respondent was 36% and those who strongly agreed was 4%. The number of neutrals was 26% they didn't want to answer. Further 22% disagreed and 12% strongly disagreed with those notations. interestingly most respondents wanted to undertake an adequate response to the crisis.

Figure No 41: Response (Reactiveness)



Q#42 Response (Reactiveness)

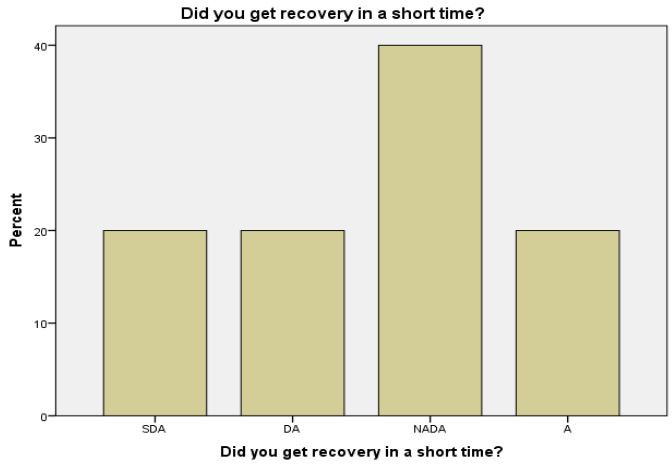
Figure No 42: Response (Reactiveness)



Response question number 3rd asked during the interview was about the response team mitigating the crisis during the crisis. About 24% of the interviewed agreed and 4% strongly agreed that they did have a response team mitigating the crisis. 24% were neutrals which didn't answer this question. Further 42% of respondents disagreed and 6% completely disagreed with this notation. Interestingly most of them didn't have a response team mitigating the crisis.

Q#43 Recovery (Reactiveness)

Figure No 43: Recovery (Reactiveness)



Question number 43 was about recovery asked in the interview was about the transportation to get recovery in a short time. About 20% of the interviewed agreed that they did have got recovery in a short time 20% in this regard. Unfortunately, 40% of respondents were neutral they didn't answer. Further remaining 20% disagreed and 20% of others strongly disagreed with this notation. It was truly more respondents who didn't agree in those days that transportation was impossible to get short time recovery.

Q#44 Recovery (Reactiveness)

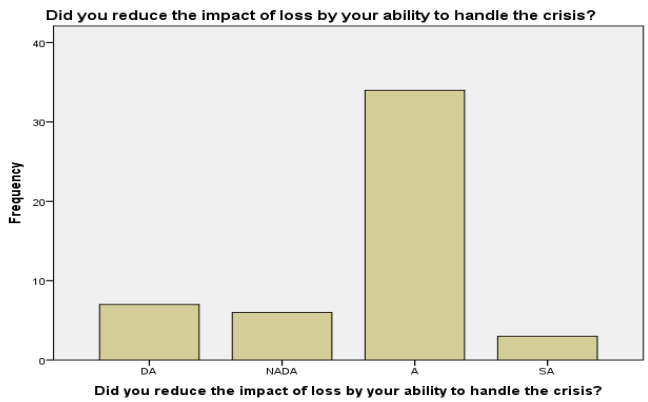
Figure No 44: Recovery (Reactiveness)

Recovery question number two asked in the interview was about the ability to absorb a huge loss. About 38% of the interviewed agreed that they did have the ability to absorb a huge loss 38% in this regard. There were 24% of respondents no response they were neutral. Further 22% disagreed and the other 16% completely disagreed with this notation. Interestingly, according to these results, 38% agreed and 38% didn't agree with the ability to absorb a huge loss during the covid-19 crisis.

Q#45 Recovery (Reactiveness)

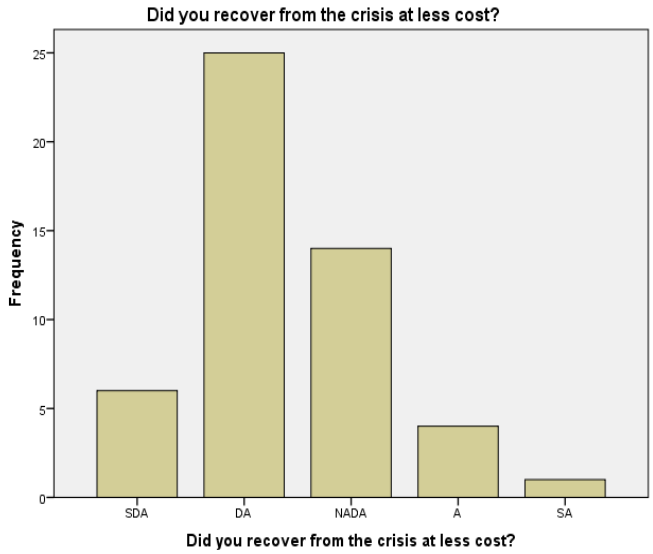
Question number 45 about the recovery asked in the interview was about whether could you reduce the impact of loss by your ability to handle the crisis. About 68% of the interviewed agreed and 6% completely agreed that they did have the ability to handle the crisis. Only 12% didn't respond and the other 14% disagreed with this notation. According to these results, the transporter did have the ability to handle the crisis.

Figure No 45: Recovery (Reactiveness)



Q#46 Recovery (Reactiveness)

Figure No 46: Recovery (Reactiveness)



The last question asked in the interview was about the recovery from the crisis at less cost. About only 8% of the interviewees agreed and 2% completely disagreed that they did have recovered at less cost in this regard. Further 50% disagreed and 12% strongly disagreed with this notation. 28% of respondents neither agreed nor disagreed. According to these results, most of the transporter didn't have recovered with less cost during the post-covid-19 crisis.

4. Discussion and Conclusion

4.1 Flexibility

The result shown that the flexibility of the wheat supply chain in Pakistan based on the opinions of transporters who agreed or strongly agreed with various statements. The results reveal that the transport system was flexible in terms of volume order, transportation schedule, product variety, multi-skilled workforce, partial shipment and order, and distribution. The transporters were able to adapt to the customer needs and market conditions with the support of the government. The only challenge they faced was sourcing, as they had limited options to pick the product from different locations and import-related products were difficult to obtain. The results concludes that the overall flexibility was good, except for sourcing.

4.2 Redundancy

The result shown the redundancy of the wheat supply chain in Pakistan based on the opinions of transporters who agreed or strongly agreed with various statements. The result shown that the transport system had enough backup capacity for machinery, parts, logistic support, and energy source. The transporters also had sufficient buffer stock for wheat and faced no problem with the trucking system. The result concludes that the redundancy was satisfactory, except for sourcing, which was a challenge during the covid-19 crisis.

4.3 Integration

The result shown that the transport system had good integration in terms of relations among different departments of a company and collaborative relations with supply chain partners. However, the result also reveals some challenges in terms of information sharing and smooth flow of goods and information, as around forty percent of transporters disagreed or were neutral about these aspects. The report suggests that there was a problem related to information sharing that came consistently.

4.4 Efficiency

In terms of efficiency, there has an efficient employee problem. When we talk about efficient employees around forty-eight percent agreed and eighteen percent strongly agreed. But the number of negative comments was around forty-five percent. In the strong quality control process, there are around forty percent agreed and the other sixty percent were neutrals or disagreed. If we see in terms of efficiency, there was a shortage of efficient employees, and most of them were agreeing, but if seen collectively, there were more negative comments. Also, there was an issue with the quality control process.

4.5 Market strength

The result shown that the transport system had a strong market position, as most of the suppliers and buyers were satisfied with the company, attached to the brand, and had a good relationship with each other. However, the result also indicates that the transport system lacked diversity, as there was no difference in services from its competitors. The result reveal that the wheat supply chain in Pakistan faces high competition and needs to innovate its services.

4.6 Financial strength

The result shown that the transport system had a weak financial position, as most of the transporters had no diversified business portfolio, no enough funds to mitigate the disruption, no insurance against the potential damage, and no consistent profit. The result show that disruption caused serious financial difficulties for the wheat supply chain in Pakistan, which required better financial planning and execution.

4.7 Readiness

The result finds that the transport system had a weak financial position, as most of the transporters had no diversified business portfolio, no enough funds to mitigate the disruption, no insurance against the potential damage, and no consistent profit. The result suggests that the wheat supply chain in Pakistan faced severe financial challenges due to the disruption and needed to improve its financial management and performance.

4.8 Density

When considering supply chain design, a majority (65-70%) stated that they didn't focus on a specific region for buyers due to wide distribution. Regarding diversified supplier selection, responses were mixed but leaned towards agreement, likely due to wheat's nationwide cultivation. Around 40% didn't comment on transport facilities, with a combined

30% agreeing or disagreeing. Geographic density reflected widespread operations due to Pakistan's seasonal wheat cultivation.

4.9 Complexity

Regarding complexity, opinions diverged when it came to direct dealings with buyers and suppliers, with over 50% agreeing to mitigate risks, around 40% disagreeing, and some offering no comment. Positive responses may stem from anticipated company enhancement. In the forward and backward flow of goods and services within the supply chain, approximately 70% collectively disagreed or remained neutral, while around 30% agreed, indicating limited flexibility. About 60% of respondents favored the use of multiple suppliers to manage supply chain risk, while around 50% agreed on using multi-buyers, signaling varied transporter preferences. In essence, complexity challenges were observed in direct dealings and forward-backward flow, while multi-supplier and multi-buyer approaches found mixed acceptance.

4.10 Criticality

When evaluating critical dependence, around 70-75% disagreed or didn't comment, indicating they had diversified sources and suppliers, reducing reliance on a specific supplier. Concerning distribution centers responsible for other centers, approximately 50% disagreed, 24% didn't respond, and 30% agreed. In terms of alternative components and parts, 25% disagreed, while 28% abstained; a combined 46% agreed, implying availability of alternatives. For alternative transport options, 36% disagreed, 25% were neutral, and 40% agreed, highlighting a lack of backup transport and a predominant reliance on the primary truck system for wheat delivery. Overall, criticality-related perspectives varied, showcasing diversified supplier practices, challenges in distribution center operations, mixed availability of alternative parts, and limitations in transportation alternatives.

4.11 Response

Regarding response capabilities, approximately 65-70% of transporters disagreed, indicating a lack of quick response teams to avoid disruptions, likely due to the absence of sudden disruptions at that time. Around 30% agreed. For undertaking adequate crisis responses, about 40% agreed, signifying existing response strategies, while 60% disagreed, suggesting shortcomings. When considering crisis mitigation response teams, 70% disagreed or remained neutral, and 30% agreed, implying the presence of such teams, albeit not extensively. In essence, while many agreed with response strategies, the combined number of disagreements and neutral responses surpassed agreements, potentially attributed to the context of a smart lockdown during the COVID-19 period in Pakistan, highlighting the need for more comprehensive response teams to tackle crises.

4.12 Recovery

In terms of response and recovery, findings revealed that quick response teams were lacking, with around 65-70% disagreeing, potentially due to the absence of sudden disruptions. Around 40% agreed on undertaking adequate crisis responses, indicating a mixed readiness to manage crises. However, recovery in a short time faced challenges, with 40% disagreeing and 20% agreeing, suggesting limitations. The ability to absorb significant losses also encountered

hurdles, as indicated by mixed responses. While there was confidence in handling crises, recovery at a lower cost yielded negative responses, suggesting difficulties. Criticality analysis highlighted that specific supplier dependence was minimal due to diversified sources, and issues were present in distribution center responsibilities. In terms of complexity, there were challenges in direct dealings and forward-backward flow, but alternative components and parts seemed available. Yet, an alternative transport system was lacking. Reactive capability's response and recovery proved inadequate, as quick response teams and short-time recovery were limited. Well-established companies managed crisis response and recovery better than smaller ones due to financial capabilities. Overall, both proactive and reactive capabilities had limitations, indicating areas requiring enhancement in the wheat supply chain.

5. Conclusion

The study focuses on investigating the resilience of Pakistan's wheat supply chain during the Covid-19 pandemic. The pandemic, declared a global crisis by WHO in 2020, led to widespread disruptions, affecting various sectors. This study conducted structured interviews with 50 individuals involved in the wheat supply chain, using SPSS and bar charts for analysis. The research examines the impact of proactive capability, supply chain design, and reactive capability on the wheat supply chain during the crisis. Proactive capability analysis revealed flexibility in various aspects except for sourcing. Redundancy posed no issues, and integration showed collaboration among departments but challenges in information sharing and efficiency. Market strength was strong due to satisfied buyers and suppliers, while financial constraints affected diversity and insurance. Readiness had detection ability but lacked training and strong security. Supply chain design complexities were seen in direct dealings and lack of flexibility in flow, while alternative components were available, but backup transport systems were absent. Reactive capability indicated challenges in quick response, crisis mitigation, and recovery, where response teams and financial readiness played vital roles. Overall, the study presents a comprehensive analysis of the wheat supply chain's resilience during the Covid-19 pandemic.

5.1 Academic contributions

Viewed through the lens of dynamic capability, the analysis of resilience capability requirements reveals the essence of an institution's adaptability and resource integration (Teece et al., 1997). This approach, an extension of the resource-based view, underscores the need for capabilities that minimize challenges and provide competitive advantages. Dynamic capability involves an institution's intentional modification of its resource base to navigate uncertainties and environmental shifts, creating new value (Teece et al., 1997; Eisenhardt and Martin, 2000). Organizational theory emphasizes dynamic capability as the deliberate alteration of resources to address rapid changes (Teece et al., 1997). Both proactive and reactive supply chain resilience capabilities align with dynamic capability perspectives. Proactivity in identifying environmental changes and cultivating flexibility and adaptability corresponds to supply chain proactive capability, in line with dynamic capability (Teece et al., 1997). However, reactive response and recovery capabilities, as per dynamic capability, should be improved to swiftly restore organizational ability during disruptions. Thus, while proactive flexibility aids dynamic

capability, inadequate response and recovery hinder it, offering insights into the interaction between resilience and dynamic organizational adaptation.

5.2 Managerial implications

The study's findings highlight several areas where supply chain managers should focus on improvement. There's a need to enhance sourcing strategies and information management. Efficiency and employee productivity require attention, along with refining the quality control process. To differentiate from competitors, offering distinct services is essential. Financial support should be prioritized to ensure operational effectiveness. Future efforts should include continuous forecasting and strengthening the security system. The establishment of a robust response team and improved recovery capability is crucial for crisis management. Overall, the study recommends a proactive approach to flexibility, developing reactive capabilities, imparting knowledge on supply chain resilience factors in the transport industry, gaining top management buy-in for proactive and reactive measures, and enhancing supply chain design quality to mitigate vulnerabilities.

5.3 Limitations

Some limitations of this study are worth nothing here. This research adopts a cross-sectional study looking at effectual different disasters and their effect on supply chain resilience (SCRE) would be more beneficial in this regard. This study is qualitative and data was collected in limited specific areas. This study was conducted within a specific goods transport sector (wheat) in one country (Pakistan). Our respondents belong to the limited area from Rawalpindi-Islamabad and northern Pakistan. The total number of respondents was 50. Other things also affected supply but we only took the wheat supply chain perspective. This study had a time-limited and cost limited. This study was self-funded.

5.4 Future research direction

The previous study was conducted in the apparel industry in Bangladesh. The interviewees were submerged in a Bangladeshi culture which was distinguished by high power distance and in-group collectivism (House et al., 2004). Our study was conducted in the wheat industry in o Pakistan. Future research could also be conducted on the overall supply chain avenue. In the future, we can investigate the different sectors and other agricultural products like rice and cotton. The covid-19 duration had been around two years therefore in the future we can also investigate the finished goods and industrial products. The sample size of this study was 50 we can also increase the sample size in the future for further research. We have collected the data from twin cities (Islamabad and Rawalpindi) and northern Pakistan but we can increase it to different areas around Pakistan and other countries.

6. References

Adobor, H., & McMullen, R. S. (2018). Supply chain resilience: a dynamic and multidimensional approach. *The International Journal of Logistics Management, 29*(4), 1451-1471.

Ali, M. G., Ahmad, M. O., & Husain, S. N. (2020). Spread of corona virus disease (COVID-19) from an outbreak to pandemic in the year 2020. *Asian Journal of Research in Infectious Diseases*, *3*(4), 37-51.

Ali, M. H., Suleiman, N., Khalid, N., Tan, K. H., Tseng, M. L., & Kumar, M. (2021). Supply chain resilience reactive strategies for food SMEs in coping to COVID-19 crisis. *Trends in food science & technology*, *109*, 94-102.

Ates, A., & Bititci, U. (2011). Change process: a key enabler for building resilient SMEs. *International Journal of Production Research*, *49*(18), 5601-5618.

Azaron, A., Brown, K. N., Tarim, S. A., & Modarres, M. (2008). A multi-objective stochastic programming approach for supply chain design considering risk. *International Journal of Production Economics*, *116*(1), 129-138.

Bakalis, S., Valdramidis, V. P., Argyropoulos, D., Ahrne, L., Chen, J., Cullen, P. J., ... & Van Impe, J. F. (2020). Perspectives from CO+ RE: How COVID-19 changed our food systems and food security paradigms. *Current Research in Food Science*, *3*, 166.

Bakalis, S., Valdramidis, V. P., Argyropoulos, D., Ahrne, L., Chen, J., Cullen, P. J., ... & Van Impe, J. F. (2020). Perspectives from CO+ RE: How COVID-19 changed our food systems and food security paradigms. *Current Research in Food Science*, *3*, 166.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120.

Bode, C., & Wagner, S. M. (2015). Structural drivers of upstream supply chain complexity and the frequency of supply chain disruptions. *Journal of Operations Management*, *36*, 215-228.

Bozarth, C. C., Warsing, D. P., Flynn, B. B., & Flynn, E. J. (2009). The impact of supply chain complexity on manufacturing plant performance. *Journal of operations management*, *27*(1), 78-93.

Brusset, X., & Teller, C. (2017). Supply chain capabilities, risks, and resilience. *International Journal of Production Economics*, *184*, 59-68.

Cappelli, A., & Cini, E. (2020). Will the COVID-19 pandemic make us reconsider the relevance of short food supply chains and local productions? *Trends in Food Science & Technology*, *99*, 566.

Cappelli, A., & Cini, E. (2020). Will the COVID-19 pandemic make us reconsider the relevance of short food supply chains and local productions? *Trends in Food Science & Technology*, *99*, 566.

Choi, T. Y., & Krause, D. R. (2006). The supply base and its complexity: Implications for transaction costs, risks, responsiveness, and innovation. *Journal of operations management*, *24*(5), 637-652.

Chowdhury, M. M. H., & Quaddus, M. (2017). Supply chain resilience: Conceptualization and scale development using dynamic capability theory. *International Journal of Production Economics*, *188*, 185-204.

Chowdhury, M. M. H., & Quaddus, M. (2017). Supply chain resilience: Conceptualization and scale development using dynamic capability theory. *International Journal of Production Economics*, *188*, 185-204.

Chowdhury, M. M. H., & Quaddus, M. (2017). Supply chain resilience: Conceptualization and scale development using dynamic capability theory. *International Journal of Production Economics*, *188*, 185-204.

Chowdhury, M. M. H., & Quaddus, M. A. (2015). A multiple objective optimization based QFD approach for efficient resilient strategies to mitigate supply chain vulnerabilities: The case of garment industry of Bangladesh. *Omega*, *57*, 5-21.

Chowdhury, M. M. H., & Quaddus, M. A. (2021). Supply chain sustainability practices and governance for mitigating sustainability risk and improving market performance: A dynamic capability perspective. *Journal of Cleaner Production*, *278*, 123521.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain.

Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J., & Handfield, R. B. (2007). The severity of supply chain disruptions: design characteristics and mitigation capabilities. *Decision sciences*, *38*(1), 131-156.

Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J., & Handfield, R. B. (2007). The severity of supply chain disruptions: design characteristics and mitigation capabilities. *Decision sciences*, *38*(1), 131-156.

Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J., & Handfield, R. B. (2007). The severity of supply chain disruptions: design characteristics and mitigation capabilities. *Decision sciences*, *38*(1), 131-156.

Craighead, C. W., Blackhurst, J., Rungtusanatham, M. J., & Handfield, R. B. (2007). The severity of supply chain disruptions: design characteristics and mitigation capabilities. *Decision sciences*, *38*(1), 131-156.

DiMaio, D., & Petti, L. M. (2013). The E5 proteins. *Virology*, *445*(1-2), 99-114.

Durach, C. F., Wieland, A., & Machuca, J. A. (2015). Antecedents and dimensions of supply chain robustness: a systematic literature review. *International Journal of Physical Distribution & Logistics Management*.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic management journal*, *21*(10-11), 1105-1121.

Erol, O., Sauser, B. J., & Mansouri, M. (2010). A framework for investigation into extended enterprise resilience. *Enterprise Information Systems*, *4*(2), 111-136.

Eskola, M., Kos, G., Elliott, C. T., Hajšlová, J., Mayar, S., & Krska, R. (2020). Worldwide contamination of food crops with mycotoxins: Validity of the widely cited 'FAO estimate of 25%. *Critical reviews in food science and nutrition*, *60*(16), 2773-2789.

Falasca, M., Zobel, C. W., & Cook, D. (2008, May). A decision support framework to assess supply chain resilience. In *Proceedings of the 5th International ISCRAM Conference* (pp. 596-605).

Falasca, M., Zobel, C. W., & Cook, D. (2008, May). A decision support framework to assess supply chain resilience. In *Proceedings of the 5th International ISCRAM Conference* (pp. 596-605).

Falasca, M., Zobel, C. W., & Cook, D. (2008, May). A decision support framework to assess supply chain resilience. In *Proceedings of the 5th International ISCRAM Conference* (pp. 596-605).

Falkowski, A., & Riva, F. (2015). Model-independent precision constraints on dimension-6 operators. *Journal of High Energy Physics*, *2015*(2), 1-22.

Falkowski, J. (2015). Resilience of farmer-processor relationships to adverse shocks: the case of dairy sector in Poland. *British Food Journal*, *117*(10), 2465-2483.

Fiksel, J. (2006). Sustainability and resilience: toward a systems approach. *Sustainability: Science, Practice and Policy*, *2*(2), 14-21.

Fiksel, J. (2006). Sustainability and resilience: toward a systems approach. *Sustainability: Science, Practice and Policy*, *2*(2), 14-21.

García-Gozalbo, B., & Cabañas-Alite, L. (2021). A Narrative Review about Nutritional Management and Prevention of Oral Mucositis in Haematology and Oncology Cancer Patients Undergoing Antineoplastic Treatments. *Nutrients*, *13*(11), 4075.

Grindley, P. C., & Teece, D. J. (1997). Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics. *California management review*, *39*(2), 8-41.

Harland, C., Brenchley, R., & Walker, H. (2003). Risk in supply networks. *Journal of Purchasing and Supply management*, *9*(2), 51-62.

Hohenstein, N. O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: a systematic review and paths for further investigation. *International Journal of Physical Distribution & Logistics Management*.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics*, 1-23.

Hollnagel, E., Woods, D. D., & Leveson, N. (Eds.). (2006). *Resilience engineering: Concepts and precepts*. Ashgate Publishing, Ltd.

House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). *Culture, leadership, and organizations: The GLOBE study of 62 societies*. Sage publications.

House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). *Culture, leadership, and organizations: The GLOBE study of 62 societies*. Sage publications.

Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by the COVID-19 outbreak. *International Journal of Production Research*, *58*(10), 2904-2915.

Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, *58*(10), 2904-2915.

Jüttner, U., & Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. *Supply chain management: An international journal*, *16*(4), 246-259.

Jüttner, U., & Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. *Supply chain management: An international journal*, *16*(4), 246-259.

Jüttner, U., & Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. *Supply chain management: An international journal*, *16*(4), 246-259.

Jüttner, U., & Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. *Supply chain management: An international journal*, *16*(4), 246-259.

Khachatryan, V., Sirunyan, A. M., Tumasyan, A., Adam, W., Bergauer, T., Dragicevic, M., ... & Zang, J. (2010). CMS tracking performance results from early LHC operation. *The European Physical Journal C*, *70*(4), 1165-1192.

Kim, Y., Chen, Y. S., & Linderman, K. (2015). Supply network disruption and resilience: A network structural perspective. *Journal of operations Management*, *33*, 43-59.

Kumar, S., & Managi, S. (2020). Does stringency of lockdown affect air quality? Evidence from Indian cities. *Economics of Disasters and Climate Change*, *4*(3), 481-502.

Lai, C. C., Shih, T. P., Ko, W. C., Tang, H. J., & Hsueh, P. R. (2020). Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *International journal of antimicrobial agents*, *55*(3), 105924.

Lam, J. S. L., & Bai, X. (2016). A quality function deployment approach to improve maritime supply chain resilience. *Transportation Research Part E: Logistics and Transportation Review*, *92*, 16-27.

Li, Y., Zobel, C. W., Seref, O., & Chatfield, D. (2020). Network characteristics and supply chain resilience under conditions of risk propagation. *International Journal of Production Economics*, *223*, 107529.

Lu, W., Wang, H., Lin, Y., & Li, L. (2020). Psychological status of medical workforce during the COVID-19 pandemic: A cross-sectional study. *Psychiatry research*, *288*, 112936.

Manning, L., & Soon, J. M. (2016). Building strategic resilience in the food supply chain. *British Food Journal*.

Manning, L., & Soon, J. M. (2016). Building strategic resilience in the food supply chain. *British Food Journal*.

Martin, S. (2004). The cost of restoration as a way of defining resilience: a viability approach applied to a model of lake eutrophication. *Ecology and society*, *9*(2).

Mitroff, I. I., Alpaslan, M. C., & Green, S. E. (2004). Crises as ill-structured messes. *International Studies Review*, *6*(1), 175-182.

Morlighem, M., Williams, C. N., Rignot, E., An, L., Arndt, J. E., Bamber, J. L., ... & Zinglersen, K. B. (2017). BedMachine v3: Complete bed topography and ocean bathymetry mapping of Greenland from multibeam echo sounding combined with mass conservation. *Geophysical research letters*, *44*(21), 11-051.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., ... & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International journal of surgery*, *78*, 185-193.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., ... & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International journal of surgery*, *78*, 185-193.

Ozdemir, D., Sharma, M., Dhir, A., & Daim, T. (2022). Supply chain resilience during the COVID-19 pandemic. *Technology in Society*, *68*, 101847.

Pal, R., Torstensson, H., & Mattila, H. (2014). Antecedents of organizational resilience in economic crises—an empirical study of Swedish textile and clothing SMEs. *International Journal of Production Economics*, *147*, 410-428.

Pal, R., Torstensson, H., & Mattila, H. (2014). Antecedents of organizational resilience in economic crises—an empirical study of Swedish textile and clothing SMEs. *International Journal of Production Economics*, *147*, 410-428.
Pal, R., Torstensson, H., & Mattila, H. (2014). Antecedents of organizational resilience in economic crises—an empirical study of Swedish textile and clothing SMEs. *International Journal of Production Economics*, *147*, 410-428.
Perona, M., & Miragliotta, G. (2004). Complexity management and supply chain performance assessment. A field study and a conceptual framework. *International journal of production economics*, *90*(1), 103-115.
Pettit, T. J., Croxton, K. L., & Fiksel, J. (2013). Ensuring supply chain resilience: development and implementation of an assessment tool. *Journal of business logistics*, *34*(1), 46-76.
Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). Ensuring supply chain resilience: development of a conceptual framework. *Journal of business logistics*, *31*(1), 1-21.
Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). Ensuring supply chain resilience: development of a conceptual framework. *Journal of business logistics*, *31*(1), 1-21.
Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The international journal of logistics management*.
Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The international journal of logistics management*.
Rezapour, S., Farahani, R. Z., & Pourakbar, M. (2017). Resilient supply chain network design under competition: A case study. *European Journal of Operational Research*, *259*(3), 1017-1035.
Sheffi, Y., & Rice Jr, J. B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan management review*, *47*(1), 41.
Sheffi, Y., & Rice Jr, J. B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan management review*, *47*(1), 41.
Smith, K., Lawrence, G., MacMahon, A., Muller, J., & Brady, M. (2016). The resilience of long and short food chains: a case study of flooding in Queensland, Australia. *Agriculture and Human Values*, *33*(1), 45-60.
Smith, M. R., Zeuwts, L., Lenoir, M., Hens, N., De Jong, L. M., & Coutts, A. J. (2016). Mental fatigue impairs soccer-specific decision-making skill. *Journal of sports sciences*, *34*(14), 1297-1304.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, *18*(7), 509-533.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, *18*(7), 509-533.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, *18*(7), 509-533.
Tenhiälä, A., & Salvador, F. (2014). Looking inside glitch mitigation capability: The effect of intraorganizational communication channels. *Decision Sciences*, *45*(3), 437-466.
Välikangas, L. (2010). *The resilient organization: How adaptive cultures thrive even when strategy fails*.

Vonderembse, M. A., Uppal, M., Huang, S. H., & Dismukes, J. P. (2006). Designing supply chains: Towards theory development. *International Journal of production economics*, *100*(2), 223-238.

Vugrin, E. D., Warren, D. E., & Ehlen, M. A. (2011). A resilience assessment framework for infrastructure and economic systems: Quantitative and qualitative resilience analysis of petrochemical supply chains to a hurricane. *Process Safety Progress*, *30*(3), 280-290.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and society*, *9*(2).

Wang, J. W., Gao, F., & Ip, W. H. (2010). Measurement of resilience and its application to enterprise information systems. *Enterprise information systems*, *4*(2), 215-223.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic management journal*, *5*(2), 171-180.

Wieland, A., & Wallenburg, C. M. (2012). Dealing with supply chain risks: Linking risk management practices and strategies to performance. *International journal of physical distribution & logistics management*.

Wieland, A., & Wallenburg, C. M. (2013). The influence of relational competencies on supply chain resilience: a relational view. *International journal of physical distribution & logistics management*.

Wieland, A., & Wallenburg, C. M. (2013). The influence of relational competencies on supply chain resilience: a relational view. *International journal of physical distribution & logistics management*.

Williams, T. A., Gruber, D. A., Sutcliffe, K. M., Shepherd, D. A., & Zhao, E. Y. (2017). Organizational response to adversity: Fusing crisis management and resilience research streams. *Academy of Management Annals*, *11*(2), 733-769.

Williams, T. A., Gruber, D. A., Sutcliffe, K. M., Shepherd, D. A., & Zhao, E. Y. (2017). Organizational response to adversity: Fusing crisis management and resilience research streams. *Academy of Management Annals*, *11*(2), 733-769.

World Health Organization. (2020). Toxicological evaluation of certain veterinary drug residues in food: prepared by the eighty-fifth meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

World Health Organization. (2020). *COVID-19 and food safety: guidance for food businesses: interim guidance, 07 April 2020* (No. WHO/2019-nCoV/Food_Safety/2020.1). World Health Organization.