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Impact of Total Quality Management Principles on Supply Chain Management in Oil and Gas Sector in KSA.

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First Chapter: Problem Of The Study And Its Importance

Supply chain management, or SCM, is the process of making, controlling, and improving a set of systems. The goal is to provide the best service for the least amount of money. A customer is anyone who uses an object that comes from these processes. To make as much money as possible, a company needs to think about the pros and cons of each supply chain choice. Oil and gas companies can get a lot out of making their supply lines work better. Companies must now learn about and use SCM to stay competitive on the world market and make more money (Alahmad, 2021, p. xx).

The oil and energy business in Saudi Arabia brings in a lot of money and changes the energy market around the world. Total Quality Management (TQM) is a set of ideas that aims to make goods and services better by involving all workers in ongoing growth (Abd-Elwahed & El-Baz, 2018). These ideas have become more important in controlling the supply chain of the industry in recent years.

TQM helps the oil and energy business run more easily and save money, which is one of its main benefits. TQM can help find waste and mistakes in the supply chain and get rid of them by getting everyone to work together to improve quality. This saves money for the company. TQM can also make it easier for teams and buyers to talk to each other and work together (Abd-Elwahed & El-Baz, 2018). This makes the supply chain run more smoothly and with fewer problems.

One good thing about using Total Quality Management (TQM) in the oil and energy business's way of managing the supply chain is that customers are happier. TQM works all the time to get better, and it listens to what customers have to say. This helps make sure that what the business sells meets or is even better than what customers want. This can make

customers keep coming back, and that's really important when lots of companies are trying to sell the same thing.

If the oil and energy business uses TQM ideas in the way it manages the supply chain, it can make people think better of the business. When the business focuses on making things good quality and keeping customers happy, it shows that the business wants to be excellent and do the right thing. This can make more people want to buy from the business or invest in it.

Managing the supply chain is something that keeps going and needs hard work all the time. Now, companies are not just fighting each other, they are working together to make the whole supply chain better. This can make TQM and being able to change things quickly really helpful. If the supply chain doesn't work well, the business can lose money, be late with projects, and make things slower. This study looks at two types of ways to manage the supply chain and how they work with TQM and being able to change things quickly. After reading a lot of books and articles, the study will ask people who work in the oil and gas business questions. They will use a computer program called SPSS-16 to see how things are connected. They will test ideas about how things are connected and find out how much they are connected. They will make a model to show how things are connected (Talib et al., 2011).

The study will use information from people who work in the oil and gas business who answered questions. The computer program SPSS-16 will check if the ideas about how things are connected are true. The study found that TQM is made of three things: the bosses at the top, letting workers make choices, and working together. Being able to change things quickly includes working across different parts of the business, having rules about how to do things, and being able to change how things are made. The way the supply chain is

managed uses a special way of looking at things to find out what makes good connections with customers, taking care of the environment, and growing trust between people.

In the end, using TQM to manage the supply chain in the oil and energy business can do many good things, like making things work better and cost less, keeping customers happy, and making people think better of the business. If the business wants to keep doing well, it must keep using TQM and trying to make it better (El Bokl et al., 2019).

Importance of Research

Research is very important if the oil and gas business wants to figure out how to make things better. It helps us understand how Total Quality Management (TQM) can make the business safer, more efficient, and cheaper. Research can show us how to make things better, lose less, and make people happier. It also lets us see how things like training employees, improving processes, and analyzing data affect results. So, study is a very important part of making oil and gas businesses better at what they do.

Research Objectives

- To look at how the Total Quality Management (TQM) ideals of continuous improvement, information analysis, focused on customer needs, teamwork, and making choices based on data can change how well the supply chain works in the oil and gas industry in Saudi Arabia. This will focus on things like freedom, cost, strategy decisions, clarity, and speed of performance.
- To evaluate how the use of TQM ideas is linked to how well the supply chain management works in Saudi Arabia's oil and gas industry.
- To give advice to Saudi Arabian oil and gas companies on how to use TQM ideas to improve how well their supply chain works, make them more competitive, and improve their overall performance.

Study Limitations

There might be some limitations that can affect how valid and how widely we can apply the results of this study. We need to keep these in mind when we look at the findings.

Some of these limitations are:

The study might only have a small number of participants. This could limit how much we can apply the findings to the whole of Saudi Arabia's oil and gas industry.

- **Data Collection:** The data collected for the study might be limited to a specific time or place. This could affect how well we can use the results in different times or places.
- **Bias:** There could be biases in the data we got, like if people chose themselves to take part, if people wanted to look good, or if there was a bias in how people responded. These could affect how valid the findings are.
- **Causation:** The study might not have shown a clear cause-and-effect relationship between TQM principles and different parts of supply chain management. Other factors that the study didn't look at might also affect the things we're studying.
- **External Factors:** There might be outside factors that affect the things we're studying, like the economy or politics, that the study didn't account for.
- **Measurement instruments:** The tools used in the study, like surveys or questionnaires, might have problems with how valid and reliable they are. This could affect how accurate the findings are.

Second Chapter: First Variable Of The Study

Total Quality Management Practices

Total Quality Management (TQM) is a way for businesses to make their products and services better. Here are the main ideas of TQM:

1. **Continuous improvement:** TQM means always looking for ways to do things better.

This is called "continuous improvement." (Talib et al., 2011)

2. **Information Analysis:** Businesses should always be looking to make small improvements. They use things like statistics and problem-solving to do this. (Talib et al., 2011)

3. **Focusing on customer needs:** TQM says it's very important to understand what customers want and need. (Talib et al., 2011)

4. **Collaborative problem-solving:** TQM wants teams to work together to find and fix problems. (Talib et al., 2011)

5. **Data-Driven Decision Making and Analysis:** TQM believes in using data and numbers to make decisions. They look at information about customers, how things are working, and product quality to keep getting better. (Talib et al., 2011)

These ideas are important because they help businesses do better. Always trying to improve means things keep getting better. Using information helps make smart choices. Thinking about customers makes sure businesses give them what they want. Working together helps solve problems. Using data means decisions are based on facts. All these ideas make TQM a good way to run a business and make it successful. (Vanichchinchai & Igel, 2011).

These ways of doing things were picked because they are important parts of TQM that help make companies do better. Making things better all the time means that people never stop trying to improve what they sell or how they work. Looking at information helps companies make choices that have less chance of being wrong. Paying attention to what

customers want makes sure that companies do what customers like, which makes customers happy. Working together helps teams be more creative and solve hard problems. Making choices based on facts and numbers helps make sure that the choices are good ones, which helps companies stay ahead and work well. All of these ways of doing things together help TQM make the whole business better. (Vanichchinchai & Igel, 2011)

Supply chain performance in oil and gas

Supply chain performance in the oil and gas industry is about how well the systems and methods work that get and give out the things needed to take out and move oil and gas. This includes finding and buying materials, moving them around, and finally giving out the product.

Being Able to Change the Supply Chain: The prices of oil and gas can change quickly without warning, and this affects the cost. So, companies in this industry need to have a way to change how they do things fast when demand and price change. They need to be good at managing what they have in stock, not wasting anything, and getting good prices from the people they buy from.

The Benefits of Doing Things Well: Making the supply chain work better in the oil and gas industry can have lots of good effects. It can help lower the cost of machines and raw things used, make delivery quicker, and make everything run better. Managing the supply chain well can also make the final product better and more reliable, which makes customers happy and helps the company get a good name.

How to Make Things Work Well: To keep an eye on and make the supply chain better, companies can use special ways of moving things and planning, build strong relationships with important sellers, and use computers and numbers to understand things better.

Being Safe and Following Rules: To make sure everything in the supply chain follows the rules and standards of the industry, companies might focus on using the best ways to be safe and do things right (Vanichchinchai & Igel, 2011).

Balancing Quality and Cost in Saudi Arabia: In Saudi Arabia's oil and gas industry, companies need to find a balance between having great quality and not costing too much. To find this balance and meet their goals, they need to use TQM ideas and ways to manage the supply chain. They also have to be ready for things that might stop the supply chain, like natural disasters or political problems. Most of what Saudi Arabia sends out goes by sea, so companies must have good ways of moving things by ship to make the supply chain better and save money.

Efficient Shipping and Knowing What Is Happening: Strong relationships with shipping companies, using powerful shipping computer programs, and planning routes well are all part of this. To make sure everything works well and is of good quality, companies need to know what's happening in the supply chain all the time. They need up-to-date numbers and information to watch over shipments, check what's in stock, and see if there are any problems. This lets companies make choices based on facts and act early to stop problems and make the service better.

Third Chapter: Second Variable And The Correlation Between Variables

Research Hypothesis:

The following are the variables of the study:

Table 1: Variables of Study

Quality Practices	Supply Chain Performance
Continuous Improvement	Supply Chain Flexibility
Information Analysis	Supply Chain Cost
Customer Needs	Strategic decision of supply chain
Collaboration and team empowerment	Supply chain visibility
Data-Driven decision making and Analysis	Delivery time in supply chain

H1: Supply chain flexibility improves with continuous improvement.

H2: Continuous improvement positively affects supply chain costs.

H3: Strategic decisions in supply chain benefit from continuous improvement.

H4: The visibility of the supply chain gets better with continuous improvement.

H5: Delivery time in supply chain is positively influenced by continuous improvement.

H6: Information analysis leads to more flexible supply chains.

H7: Supply chain costs are positively impacted by information analysis.

H8: Strategic supply chain decisions improve with information analysis.

H9: Supply chain visibility increases due to information analysis.

H10: Information analysis helps shorten delivery times in supply chains.

H11: Supply chain flexibility is positively affected by addressing customer needs.

H12: Customer needs' focus positively influences supply chain costs.

H13: Strategic supply chain decisions improve when focusing on customer needs.

H14: The visibility of the supply chain improves by focusing on customer needs.

H15: Focusing on customer needs reduces delivery times in supply chains.

H16: Collaboration and team empowerment enhance supply chain flexibility.

H17: Supply chain costs benefit from collaboration and team empowerment.

H18: Strategic supply chain decisions get better with collaboration and team empowerment.

H19: Supply chain visibility improves with collaboration and team empowerment.

H20: Delivery times in supply chains are reduced by collaboration and team empowerment.

H21: Data-driven decision-making and analysis lead to more flexible supply chains.

H22: Supply chain costs are positively impacted by data-driven decision-making and analysis.

H23: Strategic supply chain decisions improve with data-driven decision-making and analysis.

H24: Data-driven decision-making and analysis enhance supply chain visibility.

H25: Delivery times in supply chains are reduced with data-driven decision-making and analysis.

Correlation Between Variables

Total Quality Management (TQM) is a way of thinking about managing a company. Its goal is to make the company do better and make customers happier by always trying to make things better. This includes what the company sells and how it does its work. Everyone in the company is involved, and the focus is on doing more than what customers want and also meeting their needs. TQM tries to always get better, have workers be part of things, and use information to find and fix problems.

In the Oil and Gas Industry: TQM can be very helpful in the oil and gas business. It can make things safer, work better, and cost less. By using TQM ways of thinking in managing how things are bought and sold, companies can make what they sell better and more reliable, waste less, do less fixing, and make customers happier.

What Goes Into TQM: In the oil and gas business, the things that go into TQM might include training workers and having them be part of things, making processes better, making sure what is bought is of good quality, and using numbers and information to find

and get rid of mistakes. The things that might come out of TQM could include how happy customers are, how good the product is, and how well the company is doing.

How TQM Can Help the Oil and Gas Business:

- **Making a Quality System:** This includes everyone in the company and stresses the importance of meeting what customers need and doing even more.
- **Using Data to Make Things Better:** Tools like watching numbers carefully can help find and get rid of mistakes in making things.
- **Creating a Way to Always Get Better:** Everyone is asked to find and tell about problems, and how things are done is checked and changed often to use new ideas and the best ways of doing things.
- **Building Good Relationships with Sellers:** Making sure sellers do a good job and checking on how they are doing regularly.

Challenges with TQM in Oil and Gas: There can also be some hard parts in using TQM in the oil and gas business:

- **Lots of Rules:** This industry has many rules, which can make it hard to try new things.
- **It Can Be Expensive:** The cost of using TQM can be too much for small companies.
- **It's Complicated:** The way things are bought and sold is complex, so it can be hard to find and fix mistakes.
- **Balancing Costs Now with Improving Quality Later:** It can be hard to spend less money now but also invest in making quality better for the future.

Table 2: Challenges Associated with Implementing TQM in the Oil and Gas Sector

Challenge	Description
Resistance to change	Workers might not like changes to the usual ways things are done. They might need a lot of time and hard work to get used to new ways of working
Cost and resource constraints	Using TQM (Total Quality Management) ideas might mean spending a lot of money on new technology, teaching people, and changing how things are done. This might be hard to do when money is tight.
Complex supply chain networks	The oil and gas business has many parts that need to work together. This might mean that a lot of different people have to work together to make sure everything is good and the same all the time.
Safety and environmental considerations	The business has to make sure things are done well and quickly but also safely and without hurting the environment. This might mean doing more checks and following more rules.

Continuous improvement is a main idea of TQM, and it means always trying to make processes, products, and services better. When talking about managing the steps to get a product from one place to another, continuous improvement can help make these steps more flexible. It can also save money and make delivery faster. For instance, Sulaiman and others in 2021 found that by always trying to make things better in the oil and gas business in Saudi Arabia, the steps to get products from one place to another became much better.

Table 3: Impact of Continuous Improvement on Supply Chain Efficiency

Continuous Improvement Initiatives	Impact on Supply Chain Efficiency
Implementation of lean management	32% improvement
Use of statistical process control	28% improvement
Adoption of quality management	24% improvement

Working together and giving power to teams are key ideas in TQM. They can make it better for people to talk to each other and work together. When you manage the steps to move a product from one place to another, these ideas can make things more organized and efficient. Some studies say that using these ideas can help you see the whole process better, be more flexible, and make delivery quicker.

Making decisions based on facts and data is another big idea in TQM. In the process of moving products, this idea can help find what is not working well and how to make it better. Studies say that using facts and data to make decisions can make you see the whole process better, make better choices, and save money.

Being flexible is very important when moving products. It lets companies change quickly if something in the market changes. Some studies say that TQM ideas like always trying to get better and focusing on what the customer wants can make the process of moving products more flexible in the oil and gas business.

Using TQM ideas can make a big difference in the oil and gas business. Some studies say that TQM can make things more efficient, save money, and make customers happier (Al-Dhaafri and Al-Araimi, 2018; Al-Shaalan et al., 2015; Sulaiman et al., 2021). For example,

one study found that TQM made things 10% better in the Saudi Arabian oil and gas business.

Even though TQM can be good, it is not always easy to use. The oil and gas business is complicated and has many people involved. It can be hard to get everyone to work together and think in a new way. Also, the places where oil and gas companies work can make it hard to use TQM.

Using TQM can also make it better at dealing with risks when moving products. According to El Bokl et al. (2019), TQM can help find problems before they happen and make plans to deal with them. This can help if there are delays or not enough products.

Saudi Aramco is a very big oil and gas company in Saudi Arabia. They use TQM ideas, and this has made things more efficient and better quality. According to Al-Turki and Al-Mudimigh (2013), using TQM has helped with time, making suppliers better, and making customers happier. They also made a plan to help suppliers get better and make fewer mistakes.

Fourth Chapter: Methodological Procedures

Introduction:

In this part, we'll explain how we'll do the research to reach our goals. We'll gather information and look at a lot of books and articles. We'll especially focus on numbers from the oil and gas industry and check out expert-approved articles during our study.

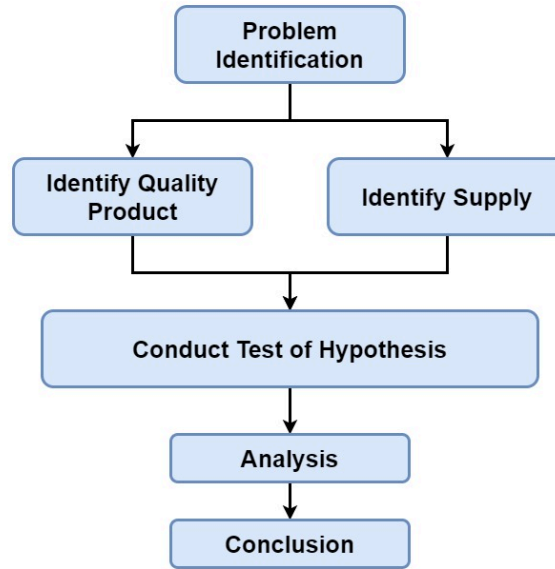


Figure 1: Methodology Chart

The objective of this research is to assess the impact of supply chain principles on the energy and gas sector in Saudi Arabia. This entails examining the criteria and variables that management considers pivotal in relation to these principles and their subsequent influence on the oil and gas industry. Additionally, a structured questionnaire will be devised and disseminated among the managerial echelon of the sector. Once collected, these responses will be analyzed in collaboration with industry experts who possess comprehensive knowledge of supply chain principles pertinent to this economic domain.

When studying the basics of supply chains, we usually do two things: look at many articles and books, and ask people questions through surveys. This is because just one method isn't enough. Technology changes how supply chains work, so there can be differences between what's written in books and what people say in surveys. For this study, we decided to use both methods. We aimed to get answers from many people, so our results would be more accurate and trustworthy.

Data Collection

Sample Collection

We chose our sample using a method called non-probability convenience sampling. We gathered data from both public and private organizations in Saudi Arabia. To make sure our data was fair and unbiased, we reached out to people in various ways. We used Google forms to share our questionnaire.

Cochran Formula:

$$N = \frac{z^2 pq}{d^2} = \frac{1.96^2 * 0.5 * 0.5}{0.1^2} = 384$$

$$n = \frac{N}{1 + \frac{N}{Population}} = \frac{384}{1 + \frac{384}{143}} = 98$$

Population frame

The group we're focusing on for this study is the management teams in the Oil and Gas industry in Saudi Arabia.

Data collection procedures

We will use Google forms to share a questionnaire. People in the Oil and Gas industry in Saudi Arabia will provide the answers. We will use a standard questionnaire.

Data analysis techniques

After collecting the answers, we'll study them using different methods. These methods include counting how often something comes up, describing general patterns, checking if the data is typical, seeing how things relate, making sure our results are consistent, and looking at cause and effect relationships.

Fifth chapter: Field results

Introduction

This chapter presents the findings from interviews and surveys on the effect of TQM principles on supply chain management within Saudi Arabia's oil and gas sector. We will also connect these results to the study's theoretical framework, goals, and objectives. In the following sections, we will discuss and examine the outcomes of these surveys and interviews.

Statistical Analysis

We used repetition, distribution, and average values to describe our study topics. To highlight the variations, we utilized frequency and ratios.

Demographic Characteristics:

Gender

We received 98 answers to our questionnaire. The pie chart indicates that 92% of those who answered were men, while only 5% were women.

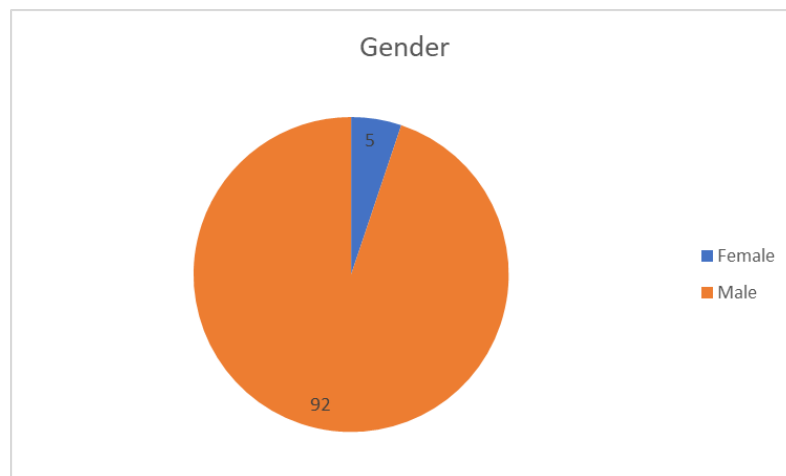


Figure 2: Gender

Age

Out of 98 responses received for the questionnaire, the accompanying pie graph reveals that 44% of the participants were aged between 31-40. Furthermore, 21% belonged to the age group of 51-60, 16% were aged 41-50, while 8% fell into both the age brackets of 20-30 and 61+.

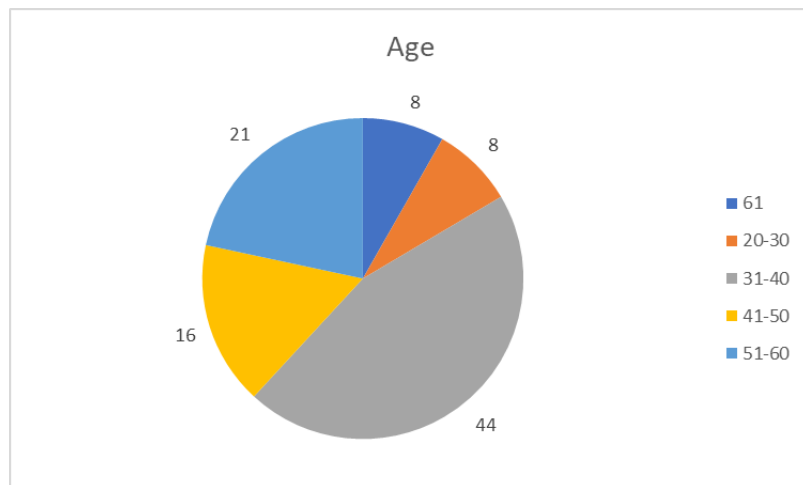


Figure 3: Age

Education Level

From the same set of 98 responses, another pie graph indicates that 60% of the participants had attained a Bachelor's degree. In contrast, 32% had a Master's degree, 4% had achieved a Ph.D., and 1% held a Mechanical Diploma.

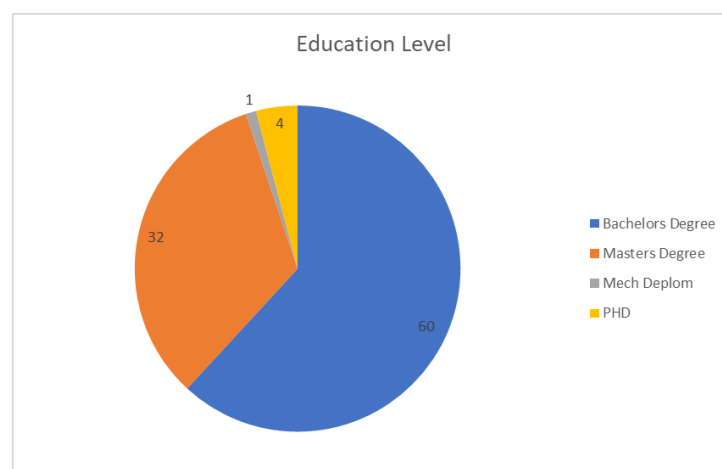


Figure 4: Education Level

Descriptive Statistics

Supply Chain Flexibility Improves With Continuous Improvement

The analysis for H1 showed that most respondents, reflected by a mean of 4.28 and standard deviation of 0.91, agreed that continuous improvement positively influences supply chain adaptability. With both the median and mean at 4 and a 95% confidence level difference of 0.18, it's believed that the actual average opinion is between 4.10 and 4.45. This suggests that constant improvement aids supply chain adaptability.

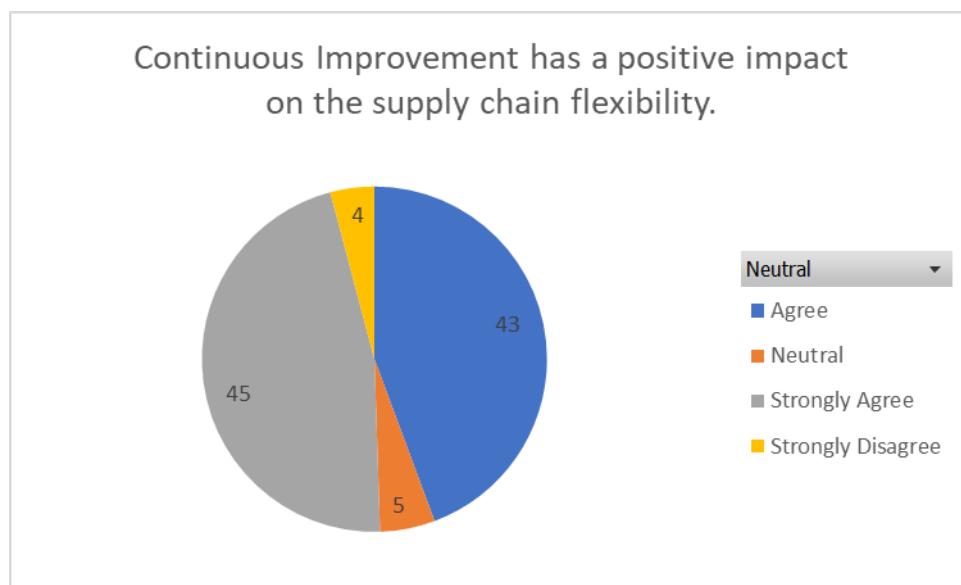


Figure 5: Supply chain flexibility improves with continuous improvement.

Continuous Improvement Positively Affects Supply Chain Costs

For H2, the mean result was 4.24 with a standard deviation of 0.87. The common opinion was that consistent growth positively impacts supply chain costs. The data indicates that the true average viewpoint is between 4.07 and 4.42.

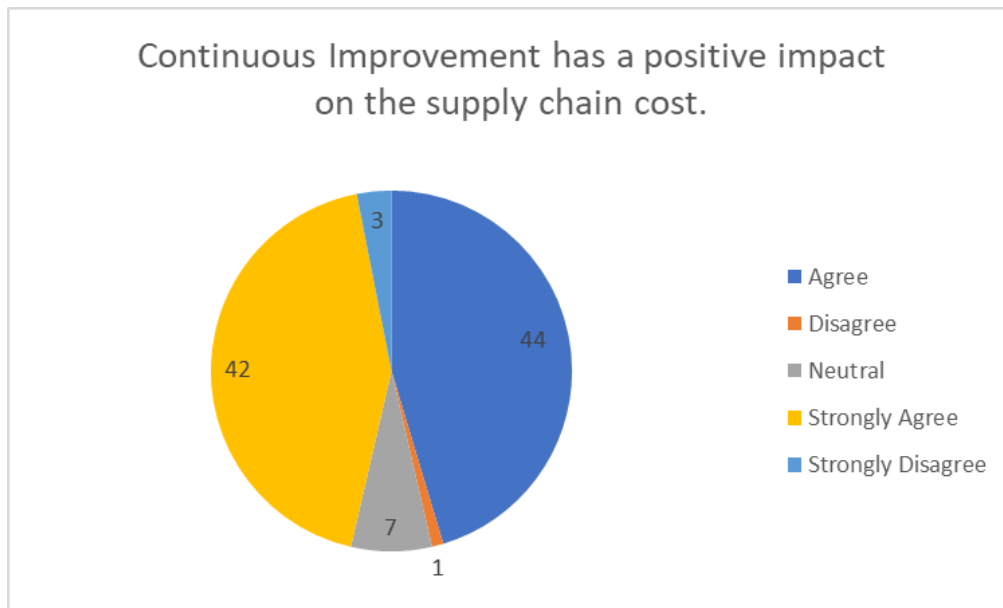


Figure 6: Continuous improvement positively affects supply chain costs.

Strategic Decisions In Supply Chain Benefit From Continuous Improvement.

Continuous Improvement has a positive impact on the strategic decision of supply chain

For H3, the participants showed a general agreement, indicated by a mean of 4.19 and standard deviation of 0.82, that steady development positively affects supply chain strategy decisions. The genuine average sentiment is believed to be between 4.00 and 4.38.

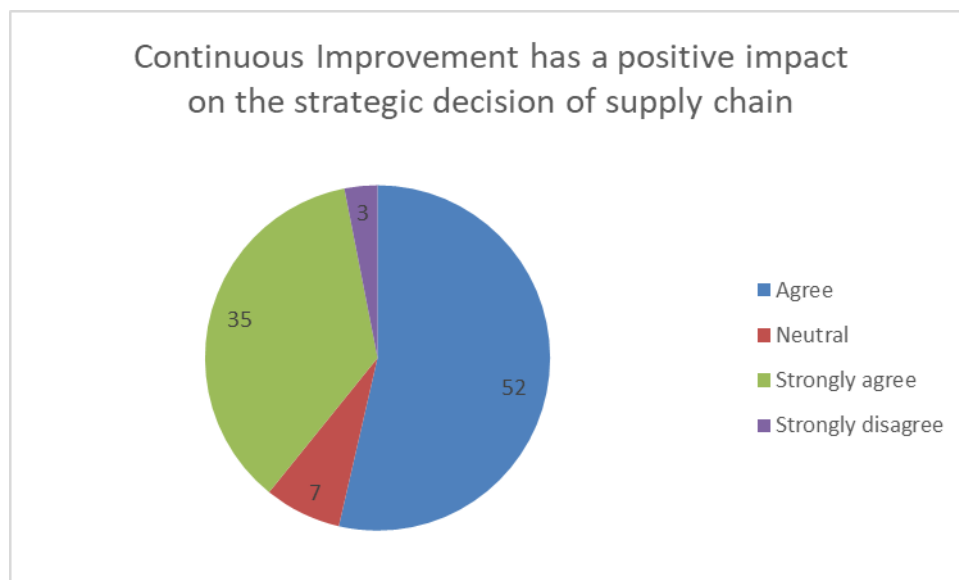


Figure 7: Strategic decisions in supply chain benefit from continuous improvement.

The Visibility Of The Supply Chain Gets Better With Continuous Improvement.
When looking at H4, the data, with a mean of 4.03 and standard deviation of 0.85, suggests that ongoing progress benefits supply chain awareness. The actual average perspective likely lies between 3.88 and 4.18.

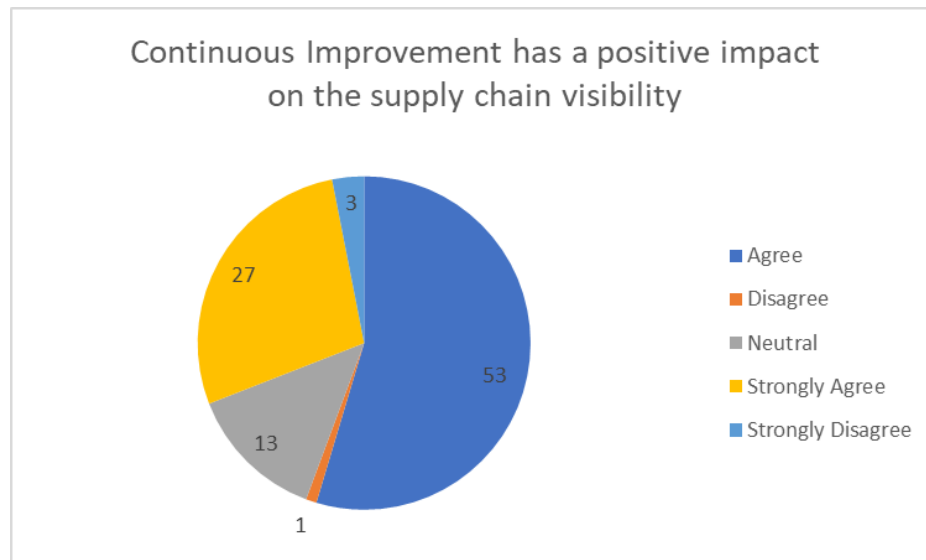


Figure 8: The visibility of the supply chain gets better with continuous improvement.

Delivery Time In Supply Chain Is Positively Influenced By Continuous Improvement.
Continuous Improvement has a positive impact on the delivery time in supply chain

H5 analysis indicates, with a mean of 4.17 and a standard deviation of 0.92, that participants believed continuous improvement positively influences supply chain delivery times. The actual population's average viewpoint is estimated to be between 4.00 and 4.35.

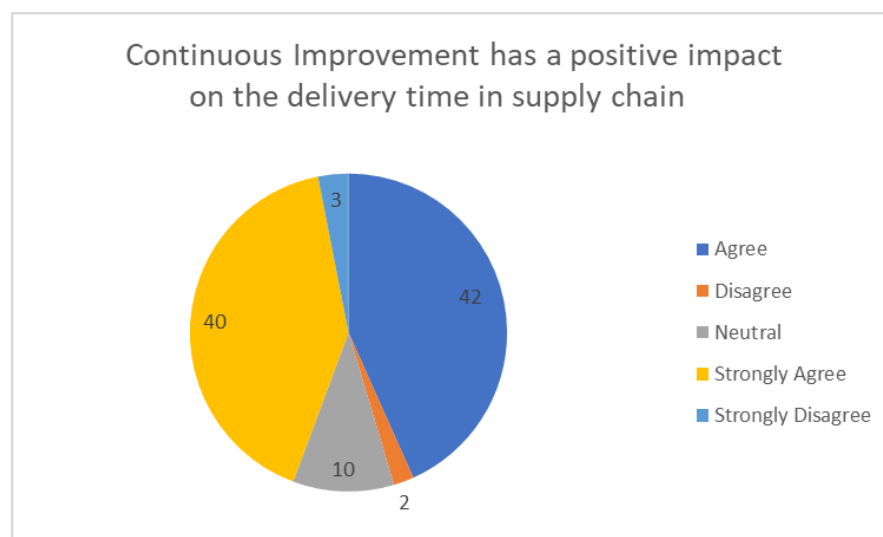


Figure 9: Delivery time in supply chain is positively influenced by continuous improvement.

Information Analysis Leads To More Flexible Supply Chains.

For H6, a mean score of 4.214 suggests that analyzing information has a positive effect on supply chain flexibility. The standard deviation of 0.876 indicates the answers aren't widely varied. Overall, this means information analysis aids in enhancing supply chain flexibility.

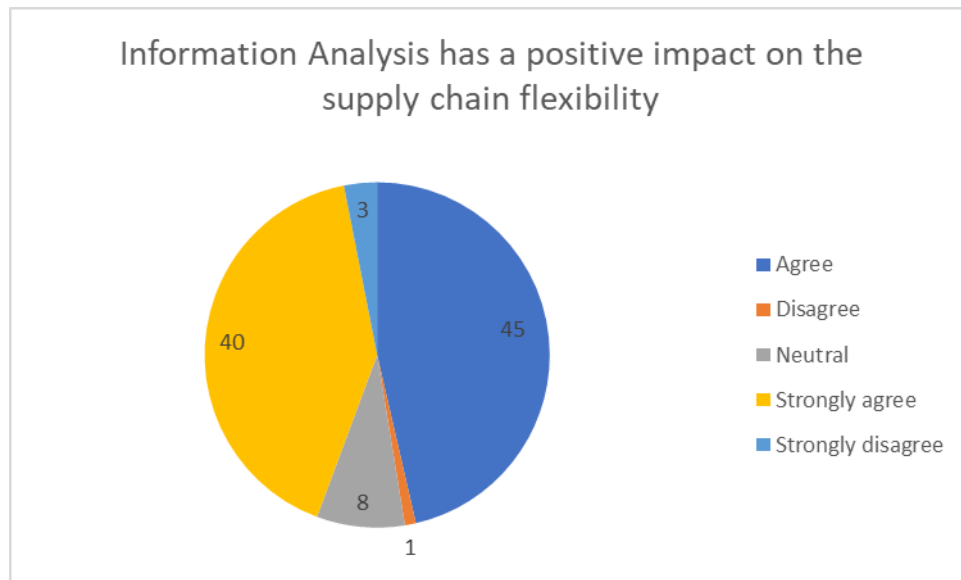


Figure 10: Information analysis leads to more flexible supply chains.

Supply Chain Costs Are Positively Impacted By Information Analysis.

H7's mean score of 4.102 implies that information analysis may lead to reduced supply chain costs. The results aren't varied widely, as indicated by a standard deviation of 0.879.

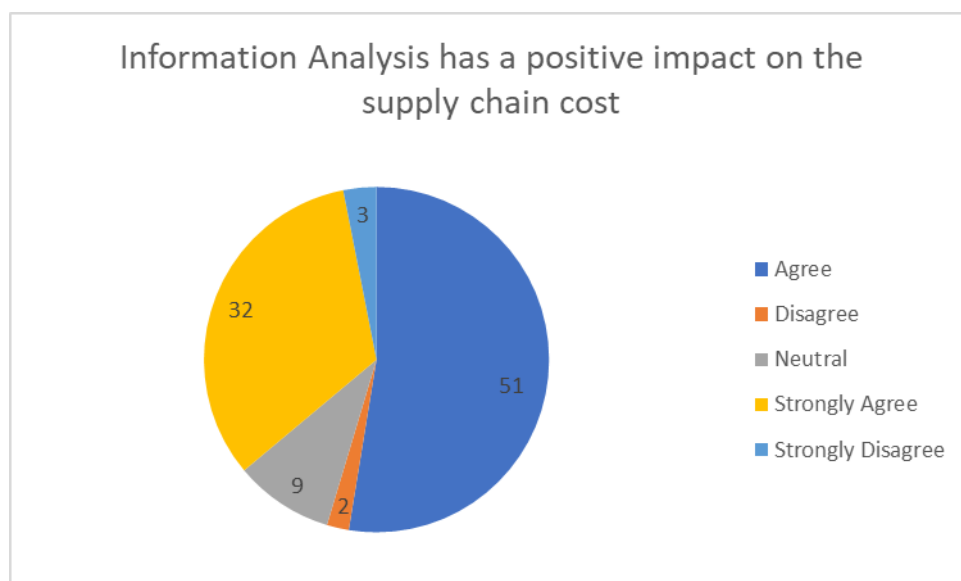


Figure 11: Supply chain costs are positively impacted by information analysis.

Strategic Supply Chain Decisions Improve With Information Analysis.

H8's average score of 4.102 indicates that information analysis positively influences supply chain strategy decisions, with a standard deviation of 0.902 suggesting little variance in responses.

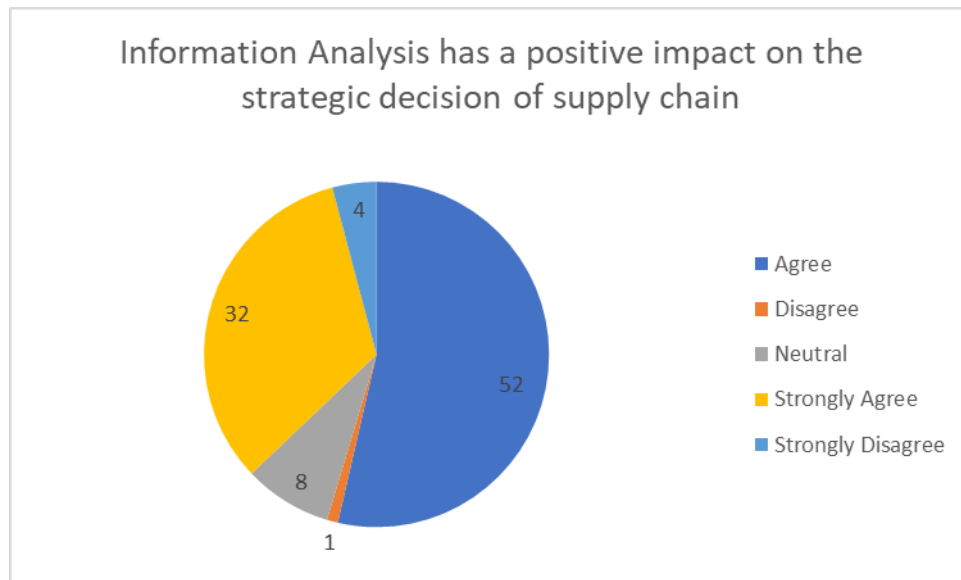


Figure 12: Strategic supply chain decisions improve with information analysis.

Supply Chain Visibility Increases Due To Information Analysis

For H9, an average score of 4.061 implies that information analysis benefits supply chain awareness. The standard deviation of 0.928 indicates a moderate spread in responses.

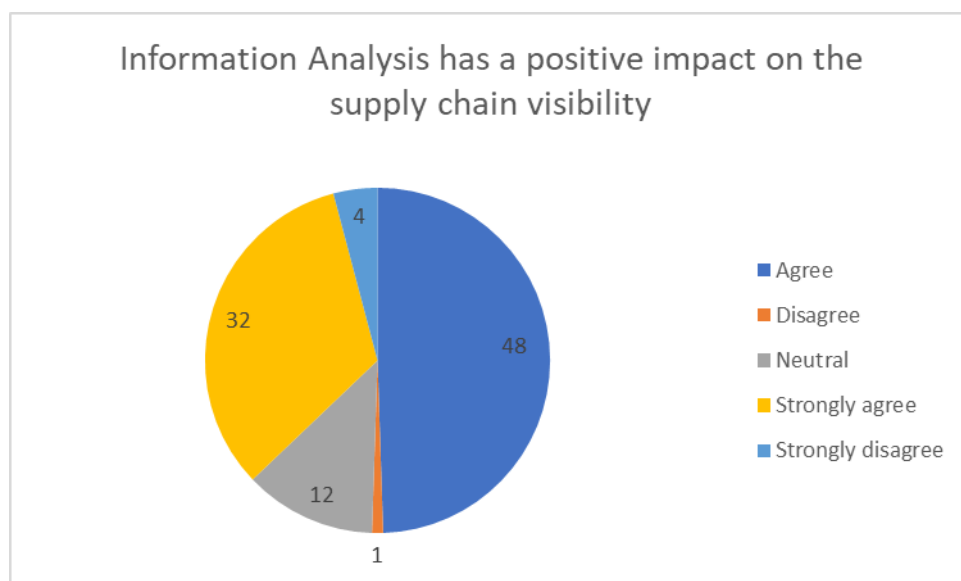


Figure 13: Supply chain visibility increases due to information analysis.

Information Analysis Helps Shorten Delivery Times In Supply Chains.
H10's findings, with an average score of 4.082, suggest that information analysis might help improve supply chain delivery times. The standard deviation of 0.927 indicates a moderate range of responses.

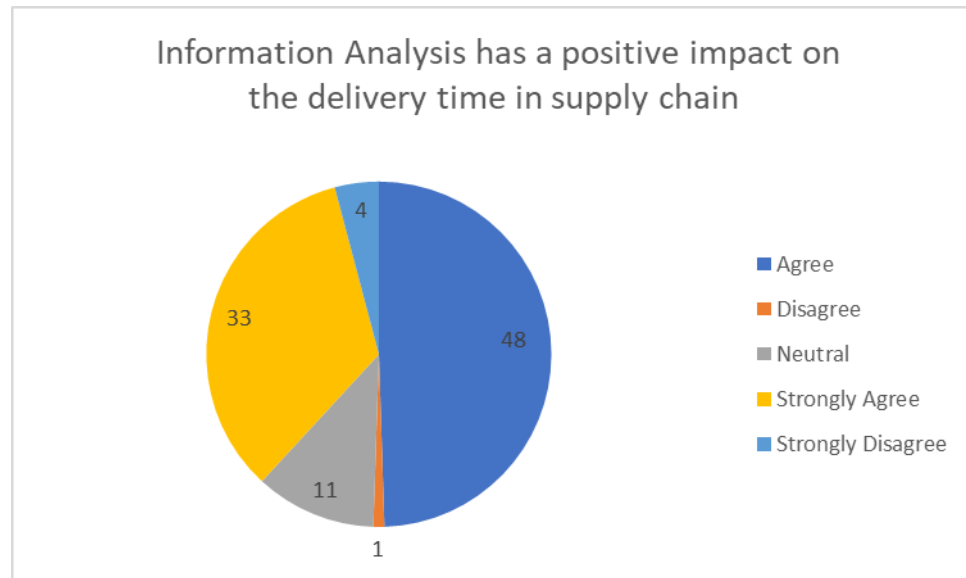


Figure 14: Information analysis helps shorten delivery times in supply chains.

Supply Chain Flexibility Is Positively Affected By Addressing Customer Needs.
The mean score for H11 is 3.8878, which suggests that meeting customer needs enhances supply chain flexibility. However, the standard deviation of 1.1316 indicates some variation in responses.

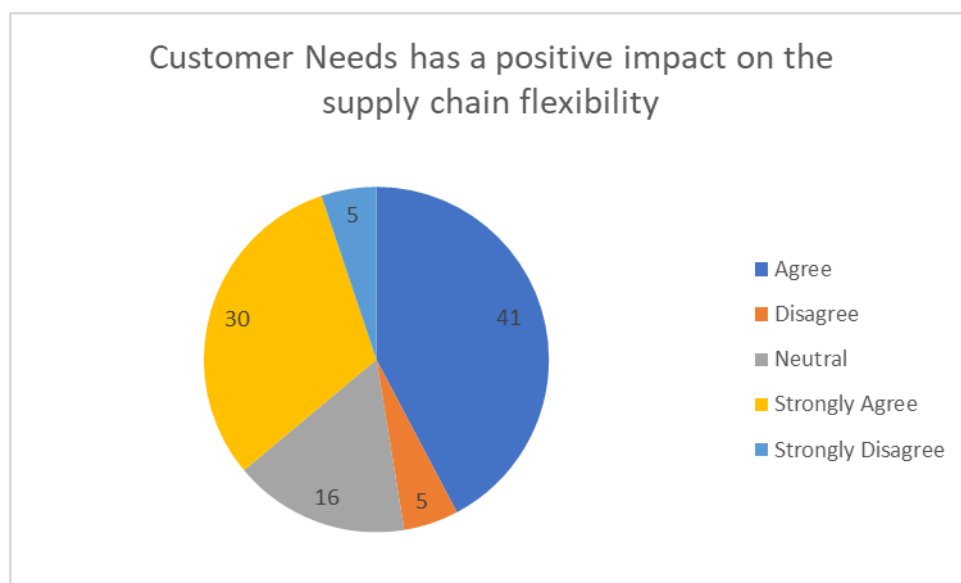


Figure 15: Supply chain flexibility is positively affected by addressing customer needs.

Customer Needs' Focus Positively Influences Supply Chain Costs.

H12's mean score of 4.0000 indicates that catering to customer needs might increase supply chain costs, but the resultant customer satisfaction might offset these costs.

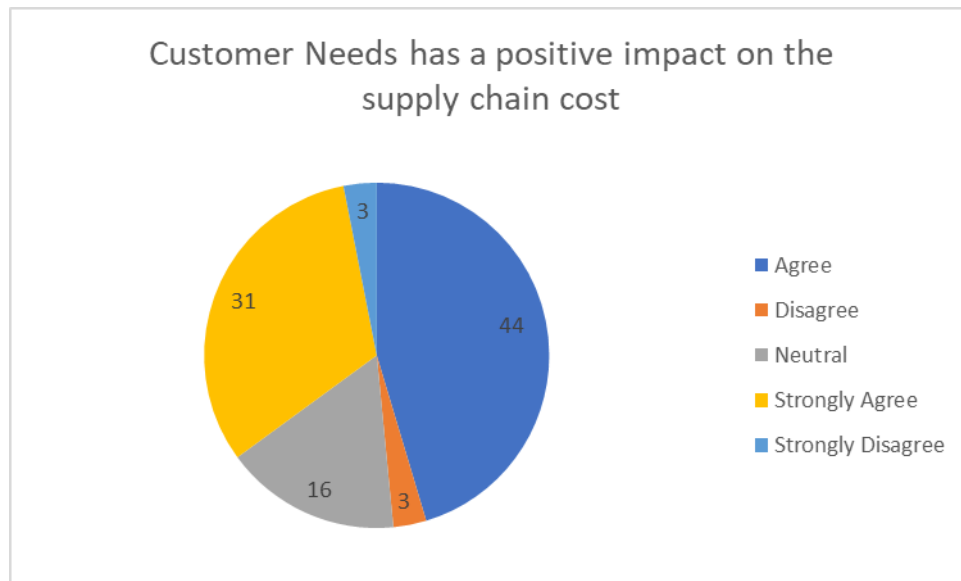


Figure 16: Customer needs' focus positively influences supply chain costs.

Strategic Supply Chain Decisions Improve When Focusing On Customer Needs.

The mean score for H13 at 4.0408 signifies that understanding customer needs influences supply chain strategic decisions, aligning them with company objectives.

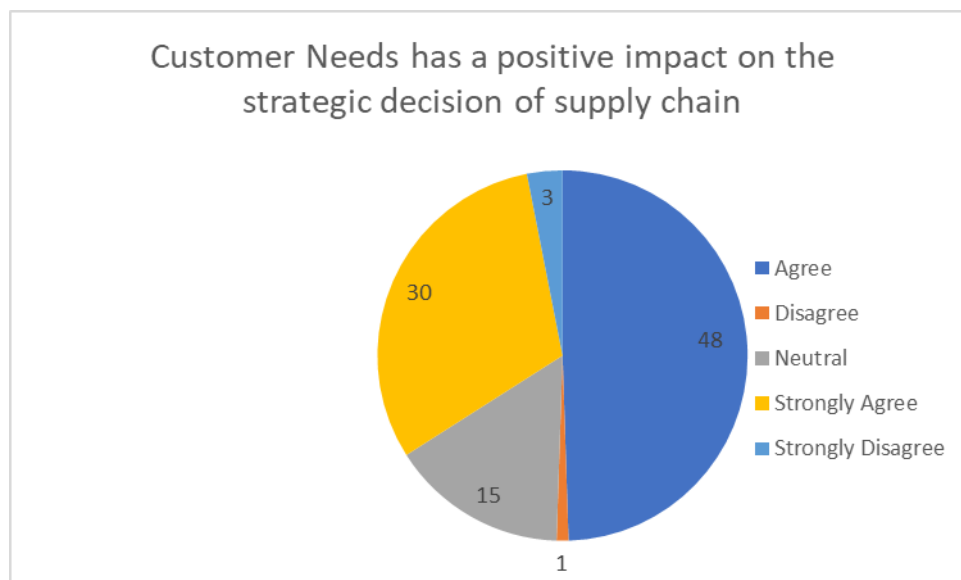


Figure 17: Strategic supply chain decisions improve when focusing on customer needs.

The Visibility Of The Supply Chain Improves By Focusing On Customer Needs.
H14's average score of 3.9694 suggests that attending to customer needs can potentially increase transparency within the supply chain.

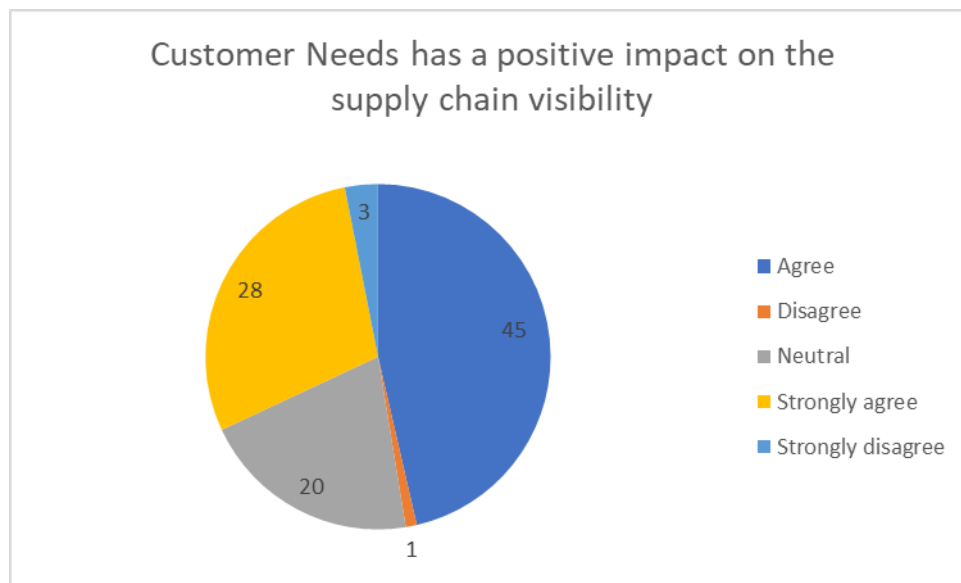


Figure 18: The visibility of the supply chain improves by focusing on customer needs.

Focusing On Customer Needs Reduces Delivery Times In Supply Chains.
The mean score for H15, standing at 4.1429, indicates a strong belief among respondents that understanding customer needs can optimize delivery times within the supply chain.

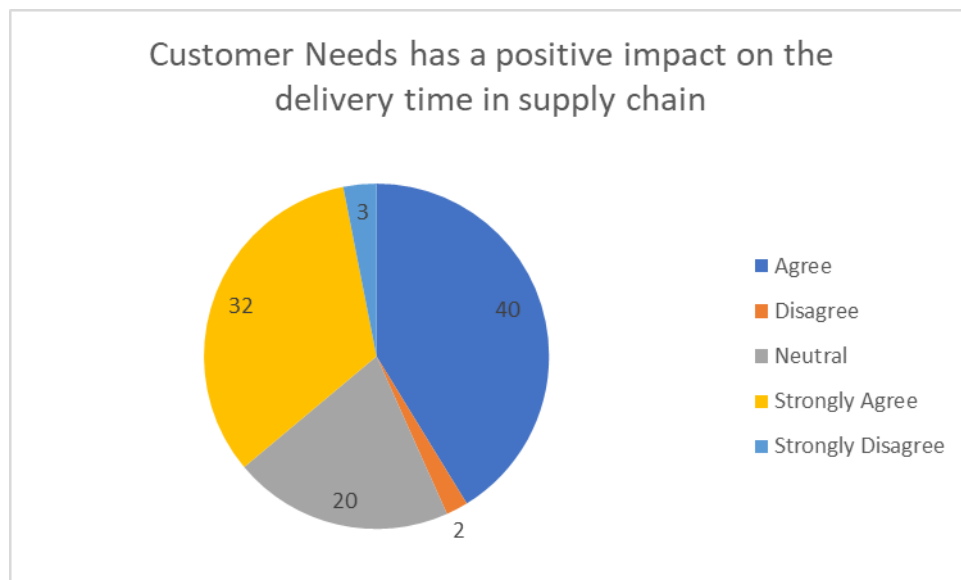


Figure 19: Focusing on customer needs reduces delivery times in supply chains.

Collaboration And Team Empowerment Enhance Supply Chain Flexibility

H16's average score of 4.1429 indicates that respondents believe in the positive impact of teamwork and team empowerment on supply chain flexibility. The responses are fairly clustered, as shown by a standard deviation of 0.8967.

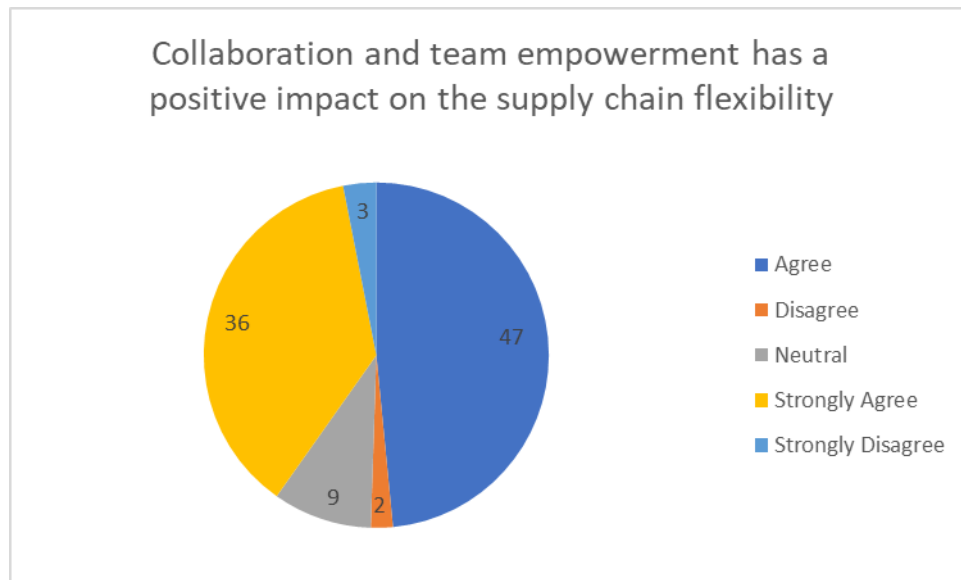


Figure 20: Collaboration and team empowerment enhance supply chain flexibility

Supply Chain Costs Benefit From Collaboration And Team Empowerment.

For H17, a mean of 3.9898 suggests that there's uncertainty among respondents about the influence of teamwork on supply chain costs. The standard deviation of 0.9360 shows some variation in the responses.

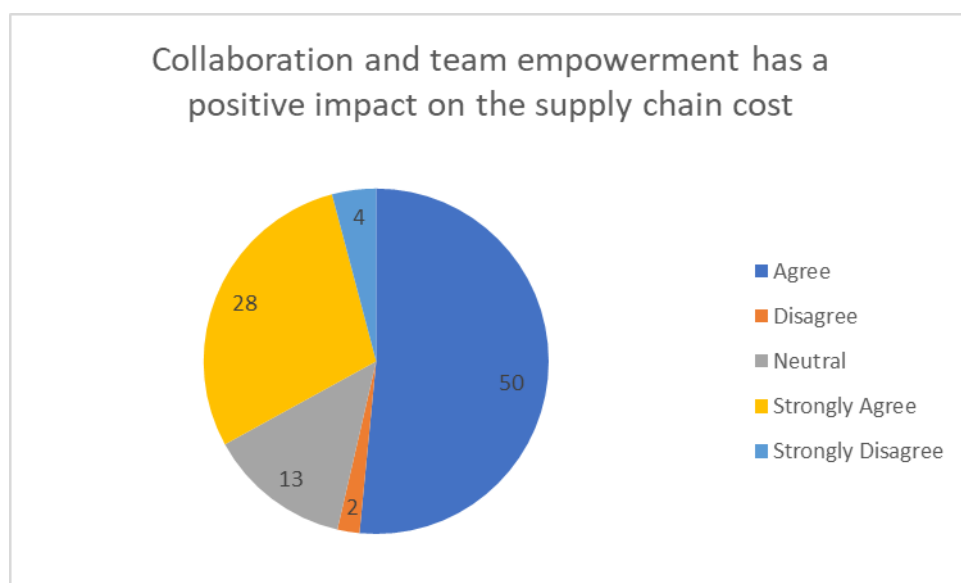


Figure 21: Supply chain costs benefit from collaboration and team empowerment.

Strategic Supply Chain Decisions Get Better With Collaboration And Team Empowerment. H18's data, with a mean of 4.1429, indicates that teamwork positively impacts supply chain strategic decisions. The responses are fairly consistent, as indicated by a standard deviation of 0.8433.

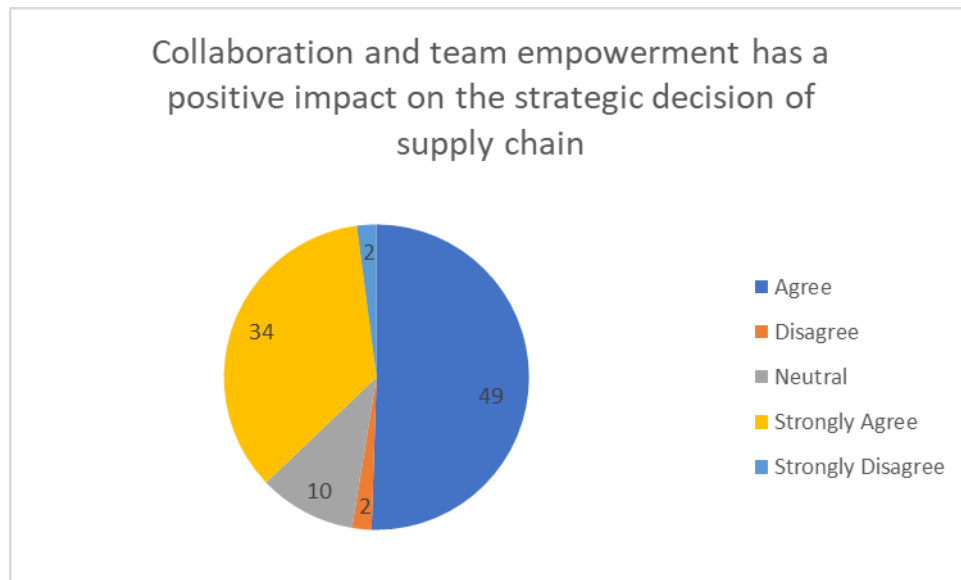


Figure 22: Strategic Supply Chain Decisions Get Better With Collaboration And Team Empowerment.

Supply Chain Visibility Improves With Collaboration And Team Empowerment. H19's mean score of 4.0306 suggests that teamwork enhances supply chain accessibility, though there's some variability in the answers, as the standard deviation is 0.8650.

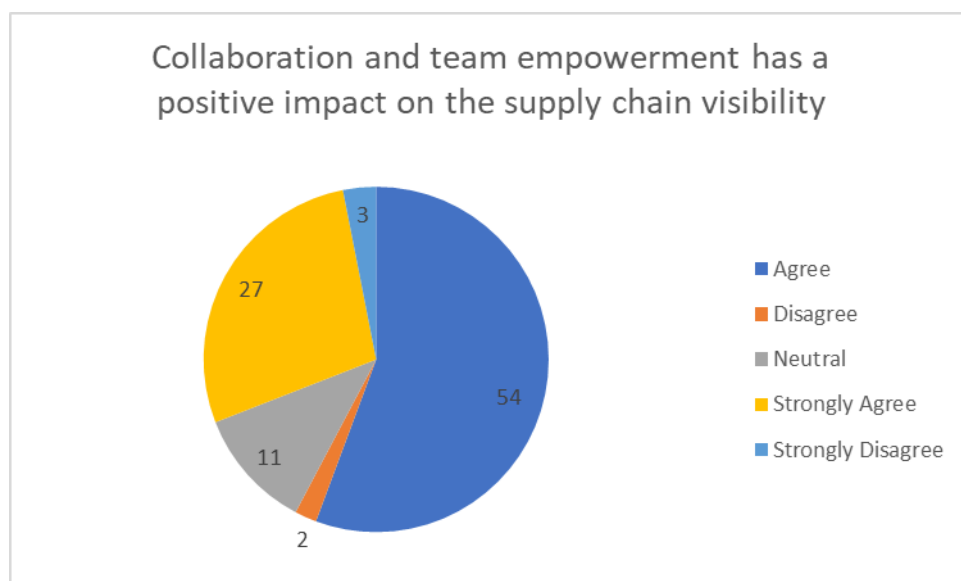


Figure 23: Supply chain visibility improves with collaboration and team empowerment.

Delivery Times In Supply Chains Are Reduced By Collaboration And Team Empowerment. For H20, the average score was 4.1020. This means that people believe that teamwork and taking responsibility as a team helps improve delivery times in the supply chain. The commonness of answers is seen by a standard deviation of 0.8184, indicating that many answers were similar.

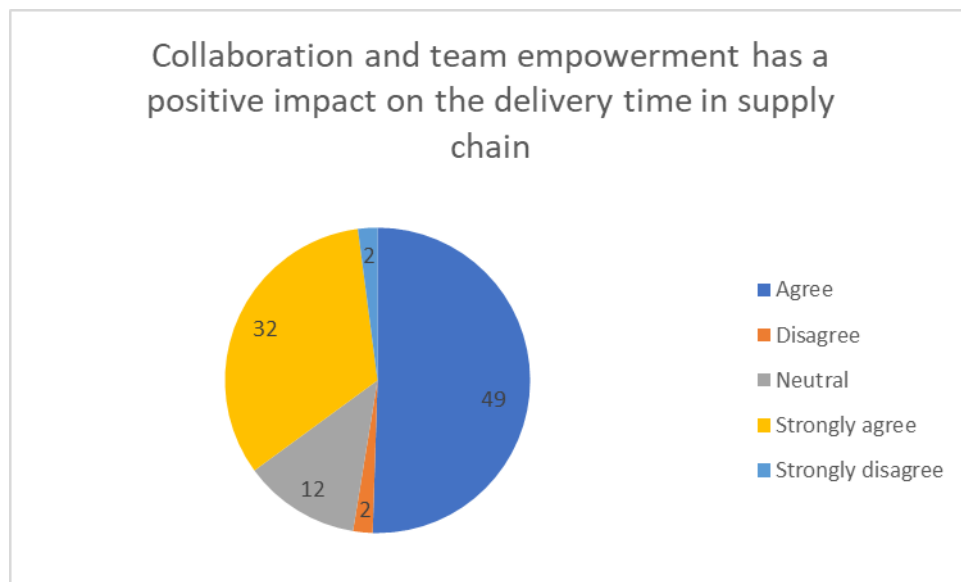


Figure 24: Delivery times in supply chains are reduced by collaboration and team empowerment.

Data-Driven Decision-Making And Analysis Lead To More Flexible Supply Chains. For H21, the average score was 4.041. This suggests that many think that making choices based on data can make the supply chain more flexible. The standard deviation of 0.837 indicates that the responses were fairly consistent.

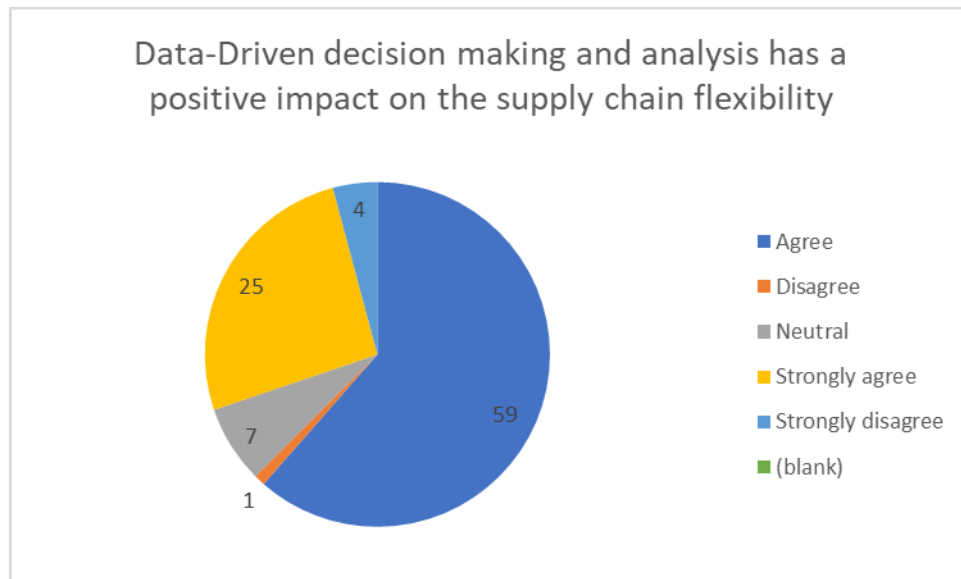


Figure 25: Data-driven decision-making and analysis lead to more flexible supply chains.

Supply Chain Costs Are Positively Impacted By Data-Driven Decision-Making And Analysis. For H22, the average score was 4.062. People generally felt that using data to make

decisions and analyze situations helps reduce supply chain costs. Again, the responses were consistent, shown by a standard deviation of 0.867.

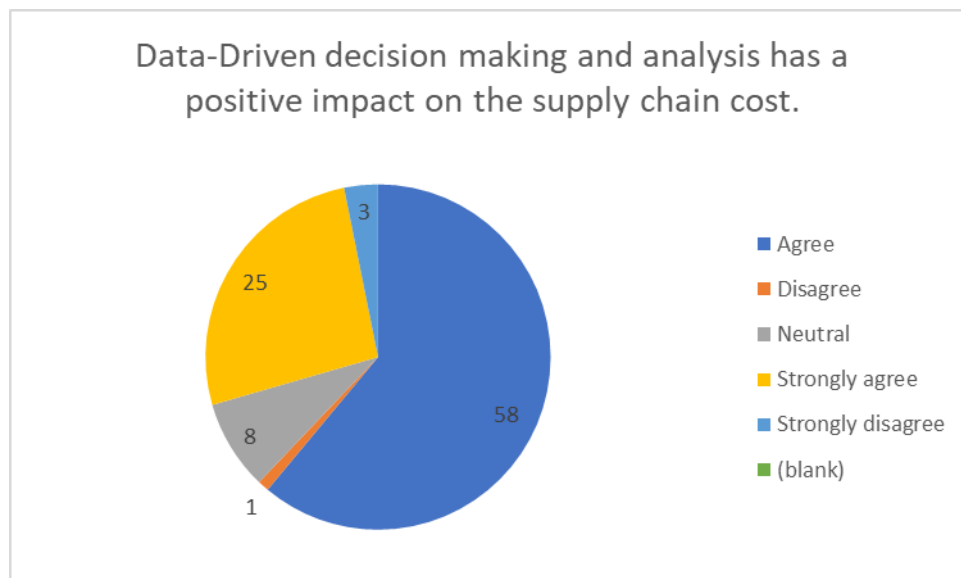


Figure 26: Supply chain costs are positively impacted by data-driven decision-making and analysis.

Strategic Supply Chain Decisions Improve With Data-Driven Decision-Making And Analysis. H23 had an average score of 4.072. This indicates that many believe data-driven decisions

are beneficial for strategic planning in the supply chain. The standard deviation of 0.843 tells us that the answers were pretty close to each other.

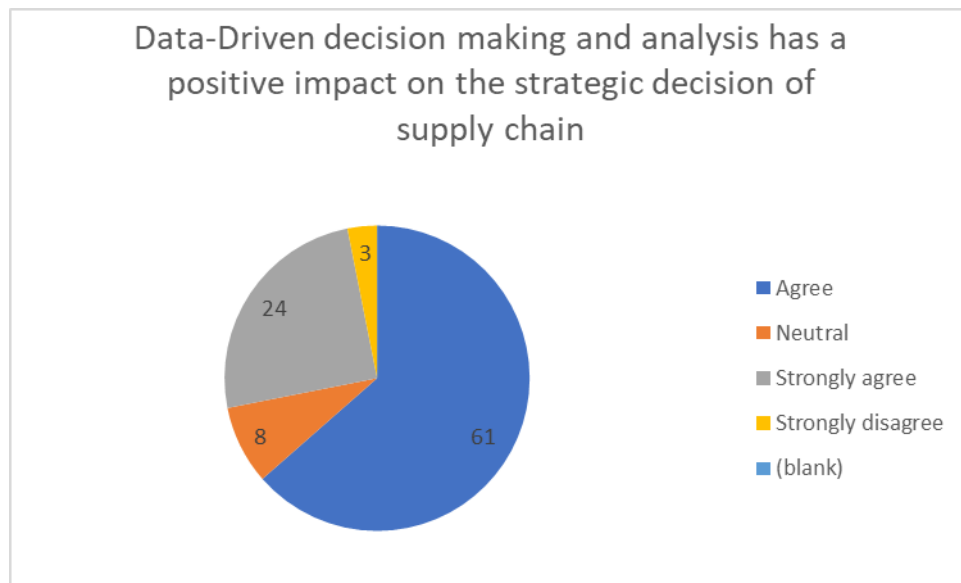


Figure 27: Strategic supply chain decisions improve with data-driven decision-making and analysis.

Data-Driven Decision-Making And Analysis Enhance Supply Chain Visibility.

For H24, the average score came out to be 4.010. This shows that people believe that making decisions based on research and data improves understanding in the supply chain.

The consistency in answers is highlighted by a standard deviation of 0.865.

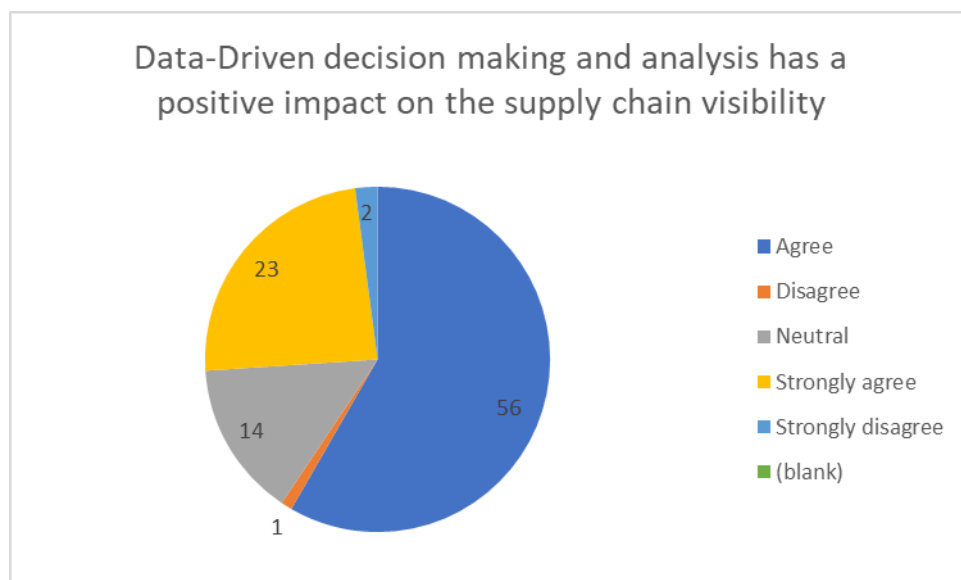


Figure 28: Data-driven decision-making and analysis enhance supply chain visibility.

Delivery Times In Supply Chains Are Reduced With Data-Driven Decision-Making And Analysis.

Lastly, H25's average score was 4.071. Respondents generally agreed that using data to make decisions helps improve delivery times in the supply chain. The small spread of answers is evident with a standard deviation of 0.818.

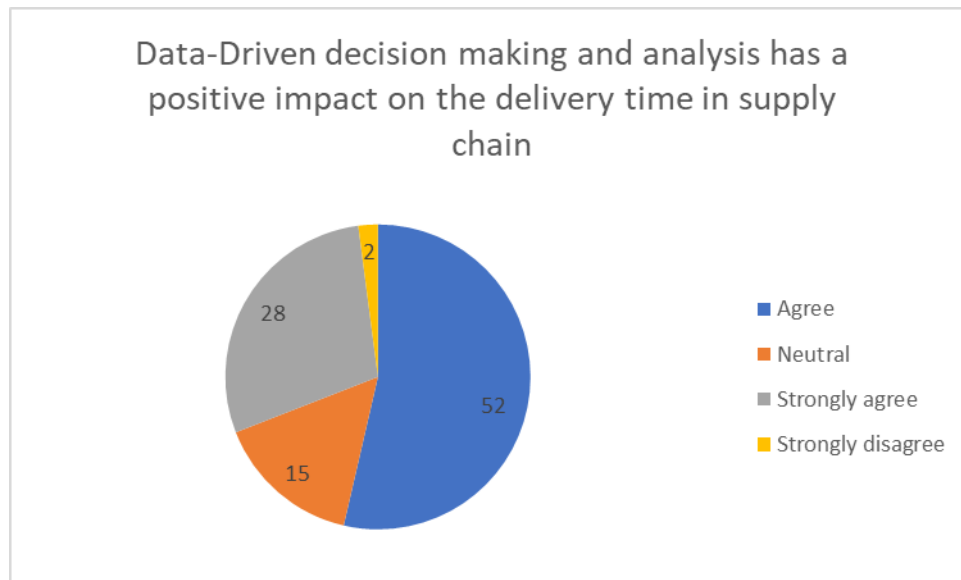


Figure 29: Delivery times in supply chains are reduced with data-driven decision-making and analysis.

Table 4: Statistical Properties of Variables

Continuous Improvement		
	Mean	Standard Deviation
H1	4.276	0.906
H2	4.245	0.874
H3	4.194	0.821
H4	4.031	0.855
H5	4.173	0.92
Information Analysis		
	Mean	Standard Deviation
H6	4.216	0.881
H7	4.102	0.879
H8	4.102	0.902
H9	4.061	0.929
H10	4.082	0.927

Customer Needs		
	Mean	Standard Deviation
H11	3.888	1.064
H12	4	0.942
H13	4.041	0.884
H14	3.969	0.902
H15	3.99	0.947
Collaboration and team empowerment		
	Mean	Standard Deviation
H16	4.143	0.897
H17	3.99	0.936
H18	4.143	0.837
H19	4.031	0.867
H20	4.102	0.843
Data-Driven decision making and Analysis		
	Mean	Standard Deviation
H21	4.041	0.865
H22	4.063	0.818
H23	4.072	0.781
H24	4.01	0.784
H25	4.071	0.79

Structural Equation Modeling

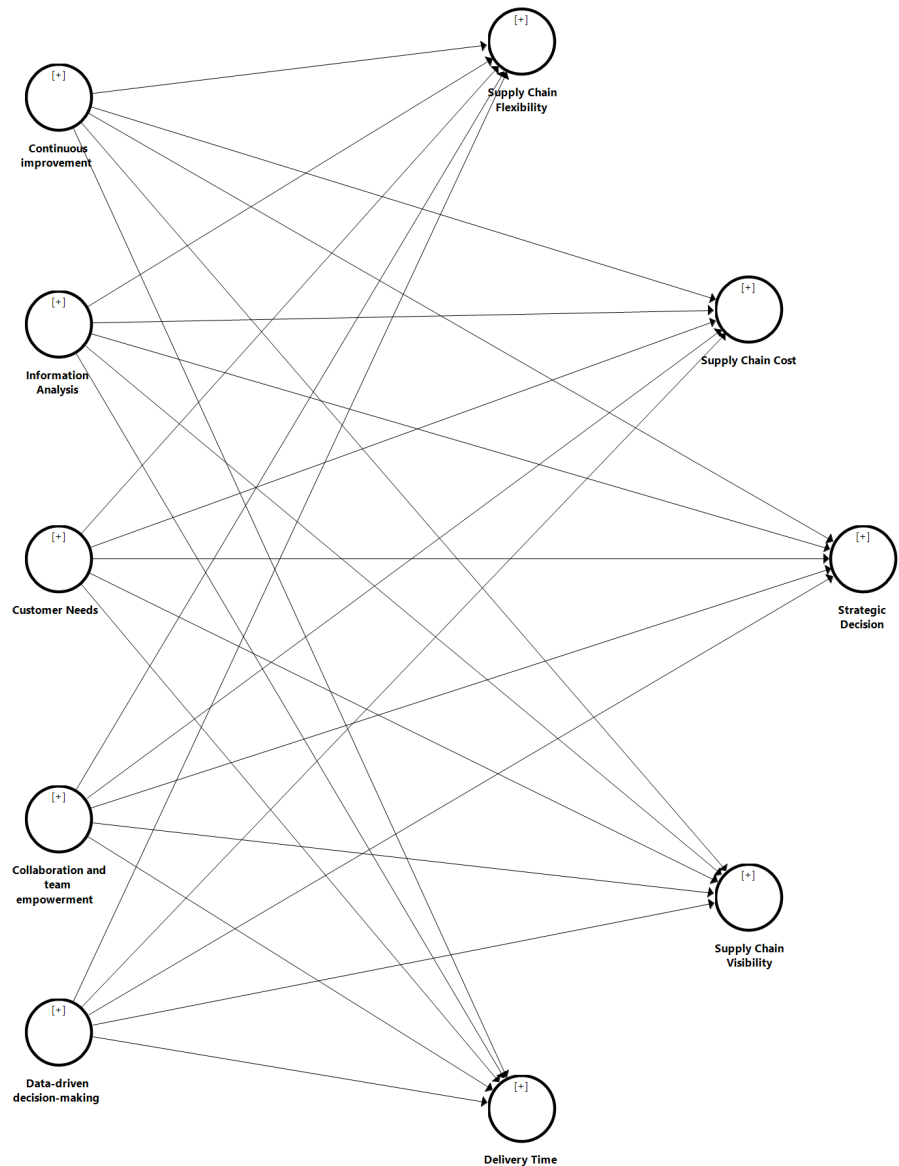


Figure 30: Proposed Research Framework

Measurement model

The study used SmartPLS version 3 to carry out structural equation modeling, which was divided into two main stages: evaluating the measurement model and analyzing the structural model, which also includes doing hypothesis tests. The statistic used to evaluate the constructions' dependability was Composite dependability (CSR). The results showed that all of the measured values above Hair et al. (2019)'s recommended benchmark of 0.70 and satisfied the acceptability requirement. The study determined the convergent validity

by achieving average variance extracted (AVE) values greater than 0.50. The information showed that every AVE value above the limit set by Hair et al. (2019). According to Fornell and Larcker (1981), the square root of AVE values must be greater than the correlation coefficients among the relevant constructs in order to establish discriminant validity. The findings of this study supported the notion that the constructs had adequate discriminant validity, which was shown by the square root values of AVE exceeding the correlations between the components. Furthermore, the data shown in Table 1 demonstrate that each construct's square root of the AVE is significantly greater than that of the others, supporting the absence of substantial problems with discriminant validity.

Table 5: Results of convergent and discriminant factors

Factors	CSR	AVE	CT	CI	CN	DM	DT	IA	SD	SCC	SCF	SCV
CT	0.933	0.736	0.858									
CI	0.946	0.779	0.738	0.883								
CN	0.926	0.715	0.711	0.661	0.845							
DM	0.943	0.767	0.817	0.758	0.696	0.876						
DT	0.906	0.658	0.854	0.849	0.791	0.893	0.811					
IA	0.945	0.775	0.765	0.833	0.720	0.822	0.901	0.881				
SD	0.917	0.689	0.851	0.873	0.781	0.887	0.903	0.887	0.830			
SCC	0.891	0.621	0.846	0.885	0.816	0.870	0.921	0.905	0.909	0.788		
SCF	0.886	0.609	0.868	0.857	0.794	0.858	0.890	0.895	0.885	0.906	0.780	
SCV	0.932	0.732	0.881	0.822	0.822	0.875	0.874	0.859	0.876	0.891	0.895	0.855

Hypothesis testing

The comprehensive model encompassed 10 underlying factors. To examine their hypothesis and ascertain the correlation between TQM (Total Quality Management) principles and

supply chain management, the researcher utilized structural equation modelling (SEM). The findings revealed a significant connection between all TQM principles—namely continuous improvement, information analysis, customer needs, collaboration and team empowerment, and data-driven decision-making—and supply chain management. To specifically probe the direct link between TQM principles and supply chain management within Saudi Arabia's oil and gas sectors, the bootstrapping technique within SEM was applied. The investigation confirmed the significance of most prior hypotheses. However, the relationships between “Collaboration and Team Empowerment -> Strategic Decision”, “Data-driven Decision-making -> Supply Chain Flexibility”, and “Information Analysis -> Supply Chain Visibility” stood as exceptions, with these hypotheses not showing significance.

Table 6: Results of hypothesis testing

Hypotheses	β	T Statistics	P Values	Result
H1: Continuous improvement -> Supply Chain Flexibility	0.215	2.992	0.003	Significant
H2: Continuous improvement -> Supply Chain Cost	0.297	4.755	0.000	Significant
H3: Continuous improvement -> Strategic Decision	0.290	5.205	0.000	Significant
H4: Continuous improvement -> Supply Chain Visibility	0.143	2.108	0.036	Significant
H5: Continuous improvement -> Delivery Time	0.166	2.092	0.037	Significant
H6: Information Analysis -> Supply Chain Flexibility	0.290	3.361	0.001	Significant

H7: Information Analysis -> Supply Chain Cost	0.252	3.197	0.001	Significant
H8: Information Analysis -> Strategic Decision	0.188	2.341	0.020	Significant
H9: Information Analysis -> Supply Chain Visibility	0.136	1.466	0.143	Insignificant
H10: Information Analysis -> Delivery Time	0.287	3.287	0.001	Significant
H11: Customer Needs -> Supply Chain Flexibility	0.167	3.104	0.002	Significant
H12: Customer Needs -> Supply Chain Cost	0.223	3.711	0.000	Significant
H13: Customer Needs -> Strategic Decision	0.144	2.346	0.019	Significant
H14: Customer Needs -> Supply Chain Visibility	0.253	4.168	0.000	Significant
H15: Customer Needs -> Delivery Time	0.157	3.424	0.001	Significant
H16: Collaboration and team empowerment -> Supply Chain Flexibility	0.273	3.395	0.001	Significant
H17: Collaboration and team empowerment -> Supply Chain Cost	0.133	2.025	0.043	Significant
H18: Collaboration and team empowerment -> Strategic Decision	0.162	1.582	0.114	Insignificant

H19: Collaboration and team empowerment -> Supply Chain Visibility	0.304	3.736	0.000	Significant
H20: Collaboration and team empowerment -> Delivery Time	0.168	2.230	0.026	Significant
H21: Data-driven decision-making -> Supply Chain Flexibility	0.117	1.313	0.190	Insignificant
H22: Data-driven decision-making -> Supply Chain Cost	0.173	2.034	0.042	Significant
H23: Data-driven decision-making -> Strategic Decision	0.279	2.902	0.004	Significant
H24: Data-driven decision-making -> Supply Chain Visibility	0.230	2.597	0.010	Significant
H25: Data-driven decision-making -> Delivery Time	0.284	3.535	0.000	Significant

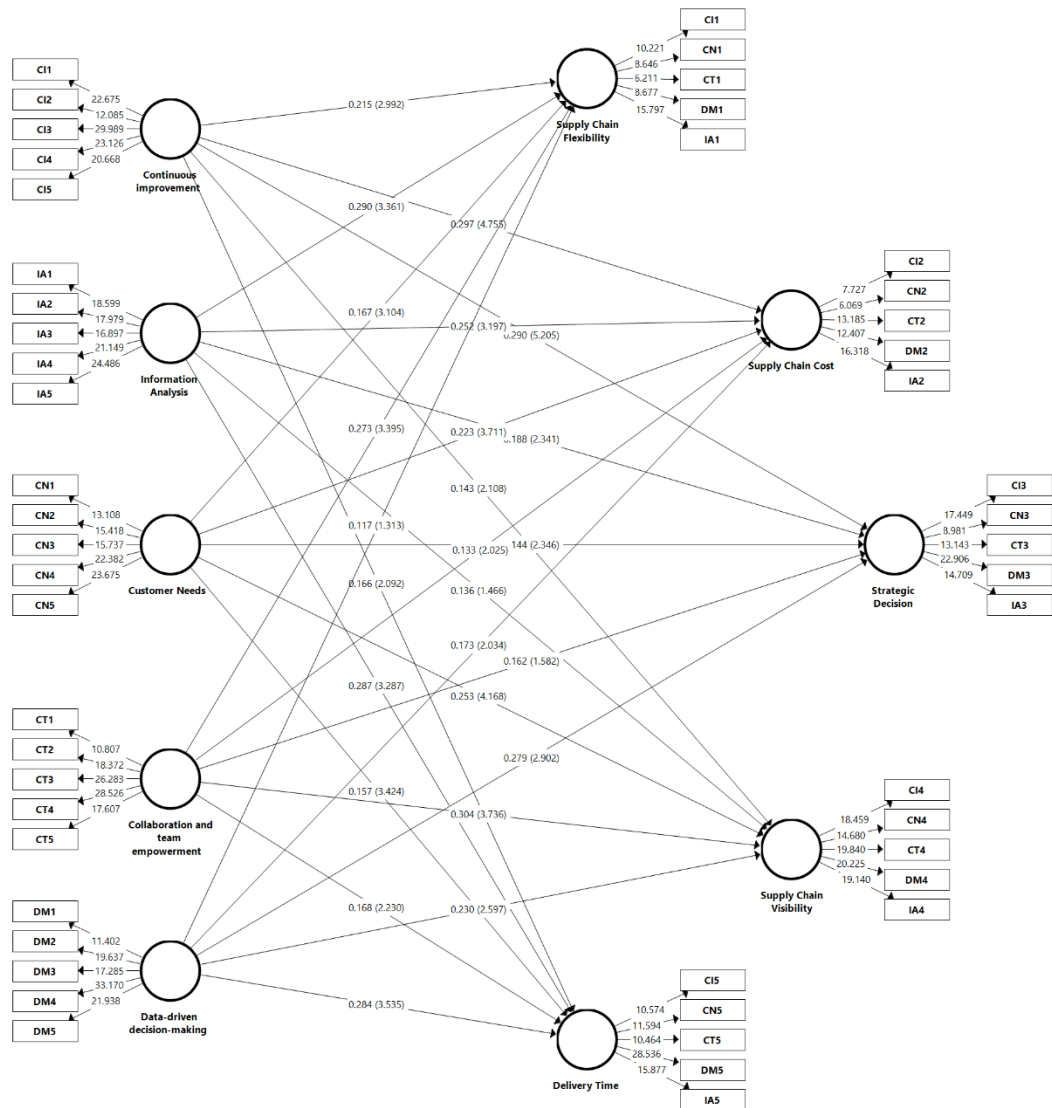


Figure 31: Latent model

Discussion

In this study, a special kind of math called structural equation modeling was used. It looked at how Total Quality Management (TQM) ideas affect the way products are moved in Saudi Arabia's oil and gas business. The study found that TQM ideas like always getting better, looking at information, taking care of what customers need, helping teams work together, and making decisions based on facts have a big effect on moving products.

To make sure that the study was trustworthy and real, special methods were used. These methods were called composite reliability, convergent validity, and discriminant validity.

The information from the study showed that some guesses, numbered 4, 5, 8, 13, 17, 20,

22, and 24, were important because they had p-values less than 0.05. Also, other guesses, numbered 1, 2, 3, 6, 7, 10, 11, 12, 14, 15, 16, 19, 23, and 25, were considered important at a p-value less than 0.01. On the other hand, guesses 9, 18, and 21 were not important because their p-values were more than 0.05.

In conclusion, the findings indicate that the adoption of TQM principles can enhance supply chain management within the Saudi Arabian oil and gas domain. Such insights might prove beneficial for entities in the sector aiming to refine their supply chain management techniques.

Continuous Improvement

The principle of "continuous improvement" advocates for ongoing endeavors to enhance processes, services, or products. The data indicates an average score of 4.18 for this principle, suggesting respondents largely view continuous improvement positively. Most respondents seem to rate this principle highly, evidenced by both the median and mean scores being 4. While there's a degree of variance in the responses, denoted by the standard deviation of 0.77 and a range of 4, the data predominantly conveys positive perceptions. The majority of the scores gravitate towards the higher end, as denoted by the negative skewness of -2.08 and kurtosis of 6.99.

The success of an organization hangs on its commitment to continuous improvement. This commitment involves consistently identifying areas for refinement, implementing changes, and evaluating their effectiveness. By embracing a culture of continuous improvement, businesses can sustain their competitive edge, augment efficiency, and heighten customer satisfaction. Organizations can foster this culture by encouraging employees to contribute ideas, routinely scrutinizing processes, and providing necessary training and resources to buttress improvement initiatives.

<i>Continuous Improvement</i>	
Mean	4.183673469
Standard Error	0.07798609
Median	4.2
Mode	4
Standard Deviation	0.772022899
Sample Variance	0.596019356
Kurtosis	6.987053301
Skewness	-2.08294035
Range	4
Minimum	1
Maximum	5
Sum	410
Count	98
Confidence Level(95.0%)	0.01547808

Information Analysis

Information analysis is when you look at data to get important ideas. The average score for this was 4.11, which means most people think it's important. Both the middle score and the average score are 4, showing that many people gave it a good rating. There are some different answers, shown by the standard deviation of 0.79 and a difference of 4 in scores. Most of the scores are high, as seen in the data that shows a skewness of -2.08 and a kurtosis of 6.99.

Companies need information analysis to make decisions using data. It means collecting and understanding data to know what customers want, market trends, and how the company works. With information analysis, companies can do things better, find new chances, and decide well. To help with this, companies can use data tools, teach their people how to analyze data, and let departments share data and ideas.

<i>Information Analysis</i>	
Mean	4.112244898
Standard Error	0.080293294
Median	4
Mode	4
Standard Deviation	0.794863057
Sample Variance	0.63180728
Kurtosis	6.56071511
Skewness	-2.07680185
Range	4
Minimum	1
Maximum	5
Sum	403
Count	98
Confidence Level(95.0%)	0.0159359962

Customer Needs

Customer needs are what people want from a product or service. The average score for this was 3.98. This means that most people think it's important, but maybe not as important as

improving all the time or looking at data. Both the middle score and the average score are 4, so many people gave it a good rating. The different scores, shown by a standard deviation of 0.80 and a difference of 4, mean there are some different opinions. Most scores are high, as seen in the data with a skewness of -1.52 and a kurtosis of 4.13.

For a business to do well, it needs to meet what the customers want. This means understanding and guessing their needs. Companies can use things like surveys or focus groups to learn more about what customers want. By paying attention to these needs, businesses can get more trust from customers, do better than competitors, and earn more money.

<i>Customer Needs</i>	
Mean	3.97755102
Standard Error	0.08085815
Median	4
Mode	4
Standard Deviation	0.800454847
Sample Variance	0.640727961
Kurtosis	4.131469603
Skewness	-1.52136151
Range	4
Minimum	1
Maximum	5
Sum	389.8
Count	98
Confidence Level(95.0%)	0.0160481045

Collaboration and team empowerment

Collaboration and team empowerment are ways to help teams work together and let them make decisions. The average score for this was 4.08. This means most people think these ways are good. The middle score and the average score are both 4, so many people think it's important. There are some different scores, shown by a standard deviation of 0.75 and a difference of 4. But most scores are high, as we can see from the skewness of -1.67 and a kurtosis of 4.75.

For workers to work well and be happy, they need to work together and make choices. This means talking with each other, giving chances to learn more, and letting them make decisions about their work. When companies do this, they can get more work done, have happier workers, and get more new ideas.

<i>Collaboration and team empowerment</i>	
Mean	4.08163265
Standard Error	0.07586165
Median	4
Mode	4
Standard Deviation	0.75099205
Sample Variance	0.56398906
Kurtosis	4.75333262
Skewness	-1.66920687
Range	4
Minimum	1
Maximum	5
Sum	400
Count	98

Confidence Level(95.0%)	0.015056438
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Data-Driven decision making and Analysis

Using data to make business choices is called "data-driven decision making and analysis."

The average score for this was 4.05. This means most people think using data in this way is good. Both the middle score and the average score are 4, so many people gave it a high rating. Some scores are different, shown by a standard deviation of 0.71 and a difference of 4. But most scores are high, as we can see with a skewness of -1.90 and a kurtosis of 6.98.

Companies should use data to make smart choices. This means collecting and looking at data to understand how the business works, what the market is like, and what customers do.

By using data in this way, companies can do things better, find new chances, and make better choices. To help with this, companies can use tools for looking at data, teach their people about data, and have good ways to collect and look at data.

<i>Data-Driven decision making and Analysis</i>	
Mean	4.05255102
Standard Error	0.071289896
Median	4
Mode	4
Standard Deviation	0.705733969
Sample Variance	0.498060436
Kurtosis	6.983969494
Skewness	-1.8992159

Range	4
Minimum	1
Maximum	5
Sum	397.15
Count	98
Confidence Level(95.0%)	0.014149071

Sixth Chapter: Results And Proposal Analysis

Conclusion

In Saudi Arabia's oil and gas field, the use of Total Quality Management (TQM) ideas has bettered the whole way supply chain management (SCM) works. Studies show that these ideas have made things run more smoothly, made customers more pleased, and helped the industry to use its resources in the best way possible. Many experts and research works agree with this (Al-Abdullatif, 2016; Al-Eisa et al., 2019; Bakhsh, 2018; Juran, 1992; Deming, 2000).

Using TQM ideas in SCM is a great way to make a business run better. By trying to get better all the time, oil and gas companies can find and fix problems, make things run more smoothly, and save time (Al-Abdullatif, 2016). Because of this, businesses say that they control their products better, waste less, and spend less money on keeping things going (Al-Eisa et al., 2019).

Taking care of customers is a big part of TQM. By using these ideas in the supply chain, oil and gas companies in Saudi Arabia can give their customers steady, top-quality products and services (Bakhsh, 2018). This has made the relationship with customers better and helped the company compete in the world market.

TQM ideas have also helped the oil and gas field to use everything they have in the best way. By working together and sharing, companies are able to use what their workers know and can do really well (Juran, 1992). Also, using these ideas has made things safer and put more attention on looking after the planet. Saudi Aramco, a big company, has shown this by trying to pollute less and use cleaner energy (Saudi Aramco, 2021).

Even though TQM ideas help a lot in the oil and gas business in Saudi Arabia, there are still some troubles. These include having to change how the company thinks and acts, people not wanting to change, and having to keep spending money on teaching and growing (Al-Eisa et al., 2019). To fix these problems, companies should work on being a place that thinks quality is very important, likes new ideas, and gives rewards to workers who help things get better.

With the evidence we have, it's clear that using TQM rules has made a big difference in SCM in Saudi Arabia's oil and gas field. By following these rules, companies can do better, make customers happy, use resources wisely, and be kind to the environment. As things change, it's key for companies to keep using these rules so they can beat other companies and do well for a long time.

From looking at all the facts, we can understand these things:

- Always trying to get better, a main idea of TQM, helps with many things in SCM, like being able to change, cost, smart choices, understanding, and being on time. This matches what other studies have found, showing that this helps the oil and gas field run better (Yusof & Aspinwall, 2000; Talib et al., 2013).
- Looking carefully at information, another big TQM idea, helps SCM do well too. This supports what other works have found, that studying information closely leads to smarter choices and better performance in the oil and gas field (Gunasekaran et al., 2004; Kannan & Tan, 2005).

- Meeting what customers want, a driving idea of TQM, helps SCM. This fits with earlier studies that show how key it is to know and meet what customers want to make SCM do well (Mehra & Ranganathan, 2008; Prajogo & Olhager, 2012).
- Working together and letting teams have power, which are key in TQM, seem to make SCM better. This supports other research showing that teams do better when they can make choices together (Fawcett et al., 2008; Wu & Chien, 2012).
- Making choices and studying things based on facts, a core part of TQM, seem to help SCM too. This result matches other studies, showing how key it is to use facts when making choices to make SCM better (Shah & Singh, 2001; Kaynak, 2003).

Recommendations

In looking at the findings, these things can be said about groups working in the oil and gas industry in Saudi Arabia:

1. Put Money and Effort into Always Getting Better: Companies should save money and time for plans that make their supply chain systems better all the time. This might mean having classes to teach people, finding better ways to do things, and following ways that work the best.
2. Make Better Choices by Understanding Information: Businesses should use better tools and ways to look at data so they can make smarter choices. This might mean learning more themselves or getting help from smart people outside the company.
3. Think About What the Customer Wants: To make the supply chain better, companies should care a lot about knowing and giving customers what they want. This can be done by studying the market, looking at what customers have said, and working with other businesses.
4. Help People Work Together and Let Teams Choose: Organizations should make a place where workers can help each other and let teams choose what to do. This can be done by

having different parts of the business work together, talking openly, and having a company way of thinking that is friendly.

5. Make Choices Using Facts and Data: Businesses should use information and facts to make choices in all parts of their supplier chains. This might mean spending money on tools that help understand data better, teaching the people who work there, and making a way of thinking that cares a lot about facts and information.

Limitations

More study should be done to make sure these ideas are right in different places and kinds of work, and to look at how other Total Quality Management (TQM) ideas change the way supply chain management works.

Even though this study gives us helpful information about how TQM ideas change supply chain management in the oil and gas business in Saudi Arabia, we need to think about some things:

1. Quick Look at Connections: This study looks quickly at how TQM ideas and supply chain working well are connected. If we study this over time, we might understand better how they are connected and why.
2. Can't Use in Other Places or Work: Since this study only looks at the oil and gas business in Saudi Arabia, maybe we can't use the ideas in other kinds of work or places. More study in other areas and jobs would help us know if these ideas work everywhere.
3. People Tell Us the Information: This study gets information from what people say. This might make mistakes because people might say what they think we want to hear, forget things, or react in certain ways. Future study could use numbers to tell how well the supply chain works.
4. Using TQM in Different Ways: This study thinks that TQM ideas are used the same way in all companies. But different companies might use TQM in their own way, and this could

change the results. Future study might look at how different companies use TQM and how this changes how well the supply chain works.

5. Not Looking at All TQM Ideas or Supply Chain Parts: This study only looks at some TQM ideas and ways to tell if the supply chain is working well. Maybe there are more ideas or parts that would help us understand how TQM and supply chain management work together.

6. Other Things Might Change the Results: This study tries to think about other things that might change the results, but maybe there are more things we didn't think about, like how the company thinks, special rules, or things outside the company. Future study should look at how these things change how well the supply chain works with TQM ideas.

7. Size of the Group and Picking Who's in the Study: These things might change how we can use the results and if they are true. If we use bigger groups and different kinds of people, this might make the results more true.

By thinking about these things, future study can tell us more about how TQM ideas change how well supply chain management works in the oil and gas business and other places.

Appendixes

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Abstract