

Application of process improvement tools and methodologies in supply chain logistic management in pharmaceutical industry

Research dissertation presented in partial fulfillment of the requirements for the degree on MSc
in Pharmaceutical Business and Technology (QQI)

Inopharma Faculty of Pharmaceutical Science
Griffith College Dublin

Dissertation Supervisor: Dr. Munira Derby

Snowitta Anaston
3085163

15th May 2023

Candidate Declaration

I, Snowitta Anaston, certify that this project is my own work, based on my personal study and/or research and that I have acknowledged all material and sources used in its preparation, whether they be books, articles, reports, lecture notes, and any other kind of document, electronic or personal communication.

I also certify that this project has not previously been submitted for assessment in any academic capacity, and that I have not copied in part or whole or otherwise plagiarised the work of other persons.

I confirm that I have identified and declared all possible conflicts that I may have.

A handwritten signature in black ink, appearing to read 'Snowitta', with a horizontal line extending to the right.

Snowitta Anaston

Student Number: 3085163

Date: 15/ 05/ 2023

Dedication & Acknowledgement

I would like to extend my gratitude to my supervisor Dr. Munira Derby. Her unwavering support, guidance, and encouragement she has given me throughout this journey has been greatly appreciated. It is my pleasure to say thank you to Griffith College and Inopharma for giving me the opportunity to pursue a Master's degree.

I would like to extend a sincere thank you to my family and my friends, their unending support and patience they provided me enabled me to complete my thesis.

Lastly, I dedicate my Master's thesis to my parents Thevathasan Charlton Anaston and Amali Maria Fareena Anaston, who were the inspiration for all the goals I've set for myself.

Abstract

To improve a process, tools and techniques are used to identify and analyze problems and implement changes so that it is more efficient and effective. From data collection to problem-solving to monitoring and evaluation, they can be used at any stage of the improvement process. It is crucial to identify inefficiencies, bottlenecks, and quality issues in pharmaceutical supply chain logistics management with process improvement tools as they help organizations reduce waste, increase productivity, and enhance the quality of their products and services. Using these tools, organizations are able to analyze and improve their supply chain processes, resulting in an increase in efficiency, a decrease in lead times, and an improvement in inventory control. It is possible for pharmaceutical companies to improve customer satisfaction, reduce waste, and improve product quality by making use of these tools. A limitation in the research on pharmaceutical supply chain logistics management processes is the lack of understanding about the effectiveness and applicability of these tools in different settings and contexts. Furthermore, empirical evidence on the impact of process improvement tools on performance outcomes such as cost, quality, and customer satisfaction is lacking. This study aims to evaluate whether Lean and Six Sigma are the best process improvement tools for all logistics management or whether there are specific tools for improving specific logistics processes. There were 58 participants in the logistics industry, who were logistic managers, the logistic coordinators, and the logistics engineers, who were surveyed using Microsoft forms with a deductive approach. In supply chain logistics management, Lean and Six Sigma are popular tools for improving workplace productivity and reducing waste. As a result of implementing these tools, reverse logistics, compliance delays, and fines have been significantly improved. More than half of respondents agreed to using third-party logistics as a method of process improvement, including reverse logistics. Adapting to emerging trends can be enhanced by outsourcing supply chain logistics internationally. Future researchers will be able to use this study to determine what will be the most efficient and cost-effective tools to use to improve your processes.

Table of Contents

List of Tables	7
List of Figures	8
List of Abbreviation	1
Chapter 1	3
Introduction	3
1.1 Purpose of the study	3
1.2 Context of the study	3
1.3 Significance of the study	5
1.4.1 Research objectives	8
1.4.2 Research Questions.....	8
1.5 Overview of the dissertation	9
Chapter 2	10
Literature review	10
2.1 Supply chain logistics management	10
2.1.3 Third party and Fourth Party Logistics	16
2.2.1 Lean Principle.....	17
2.2.2 Six Sigma	19
2.2.5 Value Stream Mapping	24
2.2.6 5S Methodology	25
Chapter 3	28
Research Methodology.....	28
3.1 Research Methodology	28
3.1.1 Research Philosophy.....	30
3.1.2 Research Approach.....	30
3.1.3 Research Strategy	31
3.1.4 Research Choice	32
3.1.5 Time Horizon.....	33
3.1.6 Research Techniques and Procedures	33
3.1.7 Ethical Consideration	34
Chapter 4	35
Finding and Analysis.....	35
4.1 Demographic.....	35
4.1.1 Participants Occupations in the Logistics sector in pharmaceutical Supply Chain Management.....	36
4.1.2: Distribution of Participants by gender.....	37

4.1.3 Distribution of Participants' by age	38
4.1.4 Distribution of participants' the Level of Education	40
4.1.5 Distribution of participants' by the years of work experience in the pharmaceutical industry	41
4.1.6 Global Distribution of Participants	43
4.2 Analysis of Objective 1	45
Assessment of the process improvement tools in supply chain logistic management and their performance in pharmaceutical companies.....	45
4.3 Analysis of Objective 2.....	52
Identify pharmaceutical company's experience with the use of process improvement tools in their supply chain logistics management.....	52
4.4 Analysis of Objective 3.....	57
Analyze the use of reverse logistics management in pharmaceutical supply chains during withdrawals.....	57
4.5 Analysis of Objective 4.....	63
Investigate the outsourcing supply chain logistics from other external services. Use of third parties and fourth parties.....	63
4.6 Analysis of Objective 5.....	68
Identify Pharmaceutical companies that do supply chain distribution domestically and internationally: Comparison of tools.	68
Chapter 5	83
Discussion and Conclusion	83
5.1 Discussion.....	83
5.2 Conclusion	89
5.2.1 Limitations.....	90
5.2.2 Recommendation	91
Reference	92
Appendix.....	97
Survey.....	97

List of Tables

1	Table 2.1: Stakeholder perceptions of factors affecting Pakistan's pharmaceutical supply chain (Malik et al., 2022).....	12
2	Table 2.2.4: frequency distribution of Hard and Soft TQM (Modgil and Sharma, 2017).....	22
3	Table 4.1.1: Occupational distribution of supply chain logistics management participants	36
4	Table 4.1.2: Gender distribution by participants	37
5	Table 4.1.3: Distribution of the participants' by age range	39
6	Table 4.1.4: The distribution of participants' educational levels	40
7	Table 4.1.5: Statistical distribution of participants' by the years of work experience	41
8	Table 4.1.6: Global distribution of survey respondents	43
9	Table 4.2.1: Participant-response in the use of Process Improvement Tools for Pharmaceutical Supply Chain Logistics	45
10	Table (a) 4.2.2: Participants report regarding the use of process improvement tools across different logistics management in pharmaceutical supply chains logistics management.....	49
11	Table (b) 4.2.2: Percentage distribution of Participants report regarding the use of process improvement tools across different logistics management in pharmaceutical supply chains logistics management	50
12	Table 4.3.1: participants response to the reasons for implementation of the Process Improvement Tools in the Supply Chain Logistics Management	53
13	Table 4.3.2: Distribution of the participants response regarding observed improvements in their workplace after the adoption of the Process Improvement Tools.....	56
14	Table 4.4.1: participants response regarding the use of the reverse logistics in their Supply Chain Management	58
15	Table 4.4.2: The participants' response regarding the use of the different process improvement tools in reverse logistics.....	60
16	Table 4.5.1: A report of the participants' responses to outsourcing logistics services to external provider in the pharmaceutical industry	63

17	Table 4.5.2: Participants' response regarding the use of External Supply Chain Logistics Service Providers	65
18	Table 4.6.1: The report of the participants' responses on international outsourcing for process improvement	68
19	Table 4.6.2: participants' opinions regarding correlation between outsourcing supply chain logistics internationally and improved performance.....	70
20	Table 4.6.3: participants' responses regarding the reasons for outsourcing supply chain logistics internationally	73

List of Figures

1	Figure 2.1.2: Structure of the reverse logistics network (FLEISCHMANN, 2001)	15
---	---	----

2	Figure 2.1.3: Comparison of 3PL vs 4PL in a warehouse (Ciemcioch, 2018)	17
3	Table 2.2.2: The phases of the DMAIC tool in Six Sigma (De Mast and Lokkerbol, 2012)	20
4	Figure 2.2.3: TQM process flow (Anre, 2018)	22
5	Figure 2.2.4: Fishbone diagrams are used to determine both the main cause and its root cause of a problem (Poncotoyo et al., 2022).....	24
6	Figure 2.2: Case studies and papers based on LSS tools and techniques (De Mast and Lokkerbol, 2012)	27
7	Figur 3.1: Research Onion (Saunders et al., 2012).....	29
8	Figure 4.1.1: A funnel bar chart showing the distribution of participants' occupations in supply chain logistics management	37
9	Figure 4.1.2: Distribution of participants in a bar graph.....	38
10	Figure 4.1.3: cluster column graph distribution of participants by age	39
11	Figure 4.1.4: The distribution of participants' educational levels.....	40
12	Figure 4.1.5: Chart distribution of participants by the years of experience in the pharmaceutical industry	42
13	Figure 4.1.6: Global distribution map of survey respondents.....	44
14	Figure 4.2.1: Graph representation of distribution of the pharmaceutical supply chain logistics system tools according to participants response	46
15	Figure 4.2.2: Cluster column graphs comparing logistics management tools across different pharmaceutical supply chains	51
16	Figure 4.3.1: Graph representation of participants response to the reasons for implementation of the Process Improvement Tools in the Supply Chain Logistics Management.....	54
17	Figure 4.3.2: The bar chart representing the distribution of the participants response regarding observed improvements in their workplace after the adoption of the Process Improvement Tools	56
18	Figure 4.4.1: A pie chart representation of the distribution of the participants response regarding the use of reverse logistics in their Supply Chain Managements	59

19	Figure 4.4.2: Funnel chart representation of the participant’s response regarding the use of the different process improvement tools in reverse logistics.....	61
20	Figure 4.5.1: Pie chart representations of the participants’ responses regarding on the outsourcing supply chain logistics services to external providers in the pharmaceutical industry	64
21	Figure 4.5.2: Graph representations of the participants’ response regarding the use of the External Logistics Service Providers	66
22	Figure 4.6.1: A pie chart of participants' responses to improving processes through international outsourcing.....	69
23	Figure 4.6.2: Distribution of participants' opinions on regarding correlation between outsourcing supply chain logistics internationally and improvement in process performance	71
24	Figure 4.6.3: Distribution of participants' responses regarding the reasons for outsourcing supply chain logistics internationally.....	73
25	Figure (a) 4.6.4: 2-D column graph of the Lean distribution around the world	75
26	Figure (b) 4.6.4: 2-D column graph of the Six Sigma distribution around the world	76
27	Figure (c) 4.6.4: 2-D column graph of the TQM distribution around the world	77
28	Figure (d) 4.6.4: 2-D column graph of the VMS distribution around the world	78
29	Figure (d) 4.6.4: 2-D column graph of the Ishikawa Diagram distribution around the world.	79
30	Figure (e) 4.6.4: 2-D column graph of the 5S distribution around the world.....	80
31	Figure (f) 4.6.4: 2-D column graph of the Others distribution around the world	81

List of Abbreviation

TQM- Total Quality Management
AI- Artificial Intelligence
3PL- Third Party Logistics
4PL- fourth Party Logistics
5PL- Fifth Party Logistics
DMAIC- Define, Measure, Analyze, Improve, and Control
TOC- Theory of Constraints
CTQ- Critical To Quality
SCM- Supply Chain Management
TMS- Top Management Support
CF- Customer Focus
T&D- Training and Development
EE- Employee Empowerment
R&D- Research and Development
PQ- Product Quality
TPM- Total Productive Maintenance
QDR- Quality data and reporting
BBNs- Bayesian Belief Networks
VSM- Value Stream Mapping
GMVSM- Green-Modified Value Stream Mapping
5S- Sort, Straighten, Shine, Standardize, and Sustain
SMEs- Small and Medium-sized Enterprises
LSS- Lean Six Sigma
APO- Asian Productivity Organization
AGILE- Adaptive Global Innovative Learning Environment
D365- Microsoft Dynamics 365
SCS-CARGOWISE- Supply Chain Solutions Cargowise

SAP- System Analysis Program

ERP- Enterprise Resource Planning

SMED- Single-Minute Exchange of Die

JIT- Just-In Time

TPM- Total Productive Maintenance

QMS- Quality Management Software

Chapter 1

Introduction

1.1 Purpose of the study

The focus of the study is to evaluate if Lean and Six Sigma is the best process improvement tool, for all logistics management or, whether there are specific process improvement tools for specific logistics management.

1.2 Context of the study

Pharmaceutical supply chain logistics is critical to the success of the pharmaceutical industry since it involves a complex process of planning, implementing, and controlling the flow of products and materials (Moons *et al.*, 2019). There are many aspects to logistics, such as transportation, warehousing, inventory management, quality control, regulatory compliance, and so on. To ensure the safety and efficacy of pharmaceutical products and materials, it is important to carefully manage their movement and storage. It is equally important to minimize costs and meet delivery deadlines at the same time (Urciuoli and Hintsä, 2017). The complexity and sensitivity of pharmaceutical products require specific knowledge, expertise, and attention to detail when managing supply chain logistics in the pharmaceutical industry due to the fact that the products must arrive on time, in good condition, and meet regulatory requirements (O'Mahony *et al.*, 2021). In order to ensure the timely delivery of high-quality medicines to patients, pharmaceutical supply chain logistics management includes a variety of activities. Purchasing raw materials, executing production processes, managing inventories, transporting finished products, and distributing them to customers are some of the activities that are involved in this process (Moosivand *et al.*, 2019). Pharmaceutical companies must ensure that their supply chains are managed effectively in order to meet regulatory requirements and maintain product quality, safety, and efficacy (Ding, 2018). The reverse logistics in the supply chain should also be taken into account when the medicinal drugs are being returned.

According to where in the supply chain the drug is returned to, it is important to analyze and decide whether it can be remanufactured or discarded (Jayaraman *et al.*, 2008). It is especially important to ensure the integrity of pharmaceutical products that are sensitive to temperature changes and require special handling and packaging in order to maintain their reliability (Carter *et al.*, 2019). Their operations are optimized, costs are reduced, and they are able to be more competitive on the market due to the tools. Through the identification of inefficiencies and opportunities to improve supply chain logistics management, these tools can improve productivity and profitability by streamlining operations and reducing waste (Javaid *et al.*, 2021). In the highly regulated and competitive pharmaceutical industry, process improvement can also result in enhanced product quality and improved customer satisfaction. As a result, pharmaceutical companies can save money in the short term through process improvement tools, while also improving their long-term viability (Rajabion *et al.*, 2019).

Pharmaceutical supply chains entail an intricate network of companies, to ensure efficient product flow from manufacturer to end-user. A manufacturer, a distributor, a wholesaler, and a retailer fall into this category (Lee and Whang, 2004). It is vital to effectively manage these entities in order to deliver the right product at the right time and place. Pharmaceutical supply chain logistics management faces a major challenge maintaining the integrity and quality of pharmaceutical products during transportation and storage. The importance of this is particularly great for products like vaccines, insulin, and many biologics that are sensitive to temperature (Masood and Nasir, 2015). These products' effectiveness and safety can be significantly affected by temperature fluctuations. In order to overcome this challenge, pharmaceutical companies use specialized packaging and temperature monitoring systems throughout the supply chain in order to maintain the correct temperature of products (Mercier *et al.*, 2017). Furthermore, logistics providers with experience handling pharmaceutical products ensure that products are transported and stored safely. In addition to reducing costs, optimizing operations, and competing more effectively, effective supply chain management ensures the timely delivery of safe and high-quality medicines to patients (Duijzer *et al.*, 2018). In addition to that, pharmaceutical companies must comply with strict quality control standards to ensure the safety and effectiveness of their products. Regulatory requirements must be followed and regular audits conducted to ensure compliance (Kulkarni and Chandra Vemuri,

2014). In order to maintain the safety and efficacy of pharmaceutical products, these quality control measures are critical. A quality control program is an effective means of maintaining the quality of pharmaceutical products, improving operational efficiency, reducing costs, and gaining a competitive advantage (Modgil and Sharma, 2016). It is also vital for the growth and sustainability of the pharmaceutical sector as a whole to manage pharmaceutical companies effectively. This promotes innovation, new drug discoveries, and the availability of lifesaving medicines everywhere (Veleva *et al.*, 2018).

1.3 Significance of the study

In the pharmaceutical industry, process improvement tools play a key role in supply chain logistics management because they help identify inefficiencies and opportunities for optimization in the process in order to optimize it (Moons *et al.*, 2019). The process improvement tools used in supply chain logistics management are significant and justified for several reasons. Process improvement tools are a series of methods and techniques used to design and optimize pharmaceutical manufacturing processes. These tools assist in identifying, analyzing, and eliminating process inefficiencies, reducing variability, and improving product quality (Yu, 2008). There are several tools commonly used in the pharmaceutical industry to improve processes, including Six Sigma, Lean Manufacturing, Kaizen, and Value Stream Mapping (Tripathi *et al.*, 2021). Through the use of these tools, process efficiency is improved, lead times are reduced, productivity is increased, and ultimately product quality and customer satisfaction are improved (Grangeia *et al.*, 2020). Essentially, the Lean Six Sigma methodology combines two separate methodologies for improving processes - Lean Manufacturing and Six Sigma. Lean Manufacturing aims to identify and eliminate waste in a process, while Six Sigma reduces variability and defects (Ikumapayi *et al.*, 2020). The goal of Lean Six Sigma is to minimize waste and increase efficiency in processes through the combination of the two methodologies. Through identifying non-value-added activities, improving processes, and streamlining processes, Lean Six Sigma helps organizations achieve these goals. Utilizing process flow analysis, value stream mapping, and root cause analysis, the methodology involves a variety of tools and techniques for identifying and eliminating waste (Ahmad and

Khan, 2022). Additionally, data-driven decision making and statistical analysis are employed to reduce variability and improve quality (Clancy *et al.*, 2021). The implementation of Lean Six Sigma can significantly improve quality, efficiency, and cost efficiency in pharmaceutical supply chain logistics management. Companies that identify and eliminate waste, streamline processes, and reduce variability are able to deliver safe and high-quality medicines to patients while reducing costs and improving efficiency (Yaduvanshi and Sharma, 2017). In addition, pharmaceutical companies can maintain the safety and quality of their products by following rigorous quality control measures and conducting regular audits to ensure compliance with regulatory requirements, supporting the pharmaceutical industry's growth and sustainability (Alkunsol *et al.*, 2019). The value stream mapping method allows organizations to visualize the flow of materials and information within a process. Pharmaceutical manufacturers use it to identify waste and improve process efficiency through lean manufacturing techniques (Suarez-Barraza *et al.*, 2016). An important part of the value stream mapping process is the creation of a visual representation of the entire process from start to finish. With the help of this visual representation, each step of the process is identified and analyzed as well as the amount of time and resources required for each step (Noto and Cosenz, 2020). The analysis of a process allows inefficiencies or waste to be identified and then eliminated or reduced to improve the process as a whole (Garza-Reyes *et al.*, 2018). Pharmaceutical companies can use value stream mapping to improve their manufacturing processes, increase efficiency, and reduce costs while ensuring the quality of their products (Abideen and Mohamad, 2021). In total quality management (TQM), customer satisfaction is a priority in all aspects of an organization's operations. This approach emphasizes teamwork and collaboration among all employees and is customer-focused. As a result of TQM, quality is prioritized, continuous improvement is prioritized, customers are focused, employees are empowered, and processes are emphasized (Issac *et al.*, 2004). To identify and eliminate inefficiencies and improve processes, it involves the use of a variety of tools and techniques. Creating a culture of continuous improvement in the organization entails the involvement of people from all levels of the organization in the efforts towards improving quality and customer satisfaction as a whole (Bhuiyan *et al.*, 2006). The TQM process includes training and education, employee engagement, customer feedback, process improvements, and data analysis. The philosophy of TQM focuses on everyone having a responsibility for quality. As a result, every employee in the organization is

responsible for maintaining quality standards and continuously improving processes (Ngambi and Nkemkiafu, 2015). In addition to teamwork and collaboration, TQM emphasizes the importance of involving stakeholders, including suppliers and customers, in quality improvement (Sriyakul *et al.*, 2019). The purpose of this system is to identify and eliminate waste, to improve quality, and to decrease costs by taking a systematic approach to the process. These tools can help pharmaceutical companies identify inefficiencies in their supply chain logistics management processes, reduce waste, improve quality, and increase their efficiency. As a result, customer satisfaction can increase, competitiveness can increase, and overall performance can improve.

The process improvement tools used in supply chain logistics management are significant and justified for a number of reasons. Despite its high level of competition, the pharmaceutical industry boasts narrow profit margins. The implementation of process improvement tools can help reduce the costs associated with logistics, inventory management, and transportation by using the tools to improve processes. Pharmaceuticals are regulated and quality controlled, so quality assurance must be improved. The use of process improvement tools can play a major role in ensuring that projects are completed on time and meet the quality standards needed. The improvement of the supply chain logistics management process can lead to an improvement in delivery times, a reduction in lead times, and a greater accuracy in order fulfillment, thereby increasing customer satisfaction levels. As a result of using the tools, the pharmaceutical industry is able to optimize the logistics management process of its supply chain, thereby improving its efficiency and productivity. There are multiple stakeholder players involved in the pharmaceutical supply chain, which makes it susceptible to disruptions because of its complexity and complexities. As a result of implementing process improvement tools, you will be able to identify and mitigate risks, which will result in a more resilient supply chain.

1.4.1 Research objectives

- I. Assessment of the supply chain logistic management and their performance in pharmaceutical companies
- II. Identify pharmaceutical companies experience with the use of process improvement tools in their supply chain logistics management
- III. Analyze reverse logistics management in pharmaceutical supply chains during withdrawals
- IV. Investigate the quality of outsourcing supply chain logistics by pharmaceutical companies to third parties or fourth parties
- V. Identify Pharmaceutical companies that do supply chain distribution domestically and internationally: Comparison of tools.

1.4.2 Research Questions

- What are the most commonly used tools for pharmaceutical supply chain logistics management? Would the process improvement tools and methodologies differ between the different types of logistic management?
- What are the reasons for the implementation of the process improvement tools into your workplace?
- How did pharmaceutical companies improve their supply chain logistic management by using process improvement tools?
- What are the most commonly used tools for pharmaceutical supply chain reverse logistics management?
- Is there a connection between some tools performing better than others based on their geographical location?

1.5 Overview of the dissertation

The study was conducted using a quantitative survey with a hope of 100 participants but only 58 participants were obtained, who were working in the pharmaceutical logistics industry. In this study, the primary objective was to gain insight into how supply chain logistics are managed in the pharmaceutical industry, by using process improvement tools, and how these tools are used to manage supply chain logistics. Participants were selected based on their roles within the supply chain logistics industry and their experience in the field of supply chain logistics management, primarily Logistics Managers, Logistics Coordinators and Logistics Engineers, as well as on their knowledge of the supply chain logistics sector in general. In order to ensure diversity in our sample, Microsoft Form was used to conduct the survey and participants were selected from around the world in order to ensure a diverse sample. Participants of the survey were asked about their experiences with supply chain logistics management, their roles in the industry, and whether they had used process improvement tools in the past as part of the survey. As part of the questionnaire, they were also asked to share their opinions about the effectiveness of these tools. The survey data was analyzed using both statistical analysis and content analysis to identify recurring themes and patterns in the survey data. In general, the study aimed to identify any potential gaps or limitations in the application of process improvement tools in pharmaceutical logistics management as well as to provide insights into the effectiveness of these tools.

Chapter 2

Literature review

2.1 Supply chain logistics management

In the pharmaceutical industry, supply chain logistics management is the process of planning, implementing, and controlling the movement and storage of pharmaceutical products and materials from their originating point to their final destination, from the point where they originate to the point where they return (Jaberidoost *et al.*, 2013). Using a novel approach to improving supply chain design and optimization, Goodarzian *et al.*'s paper emphasizes the importance of effective supply chain logistics management in the pharmaceutical industry. In order to improve the management of pharmaceutical supply chains, it uses a multi-objective optimization approach to design pharmaceutical supply chain networks. Pharmaceutical supply chains are faced with several key challenges relating to information technology, such as the need to balance conflicting objectives, such as cost reduction and customer service, as well as the need to ensure product quality and safety (Moosivand *et al.*, 2019). Taking uncertainty and risk into account when designing pharmaceutical supply chain networks. Supply chain design is optimized using this model, which includes objectives such as minimizing total supply chain cost, minimizing lead time, and maximizing customer service (Goodarzian *et al.*, 2020). According to 22 pharmaceutical stakeholders in Pakistan, the pharmaceutical supply chain logistics has many advantages, Table 2.1 (Malik *et al.*, 2022). The availability of quality medicines can be increased through effective supply chain logistics management, which ensures timely and efficient delivery of medicines to patients. A successful supply chain logistics management program can contribute to improved patient outcomes by ensuring the availability of quality medicines (Arora and Gigras, 2018). Pharmaceutical companies can reduce inventory management, transportation, and distribution costs with effective supply chain logistics management. Procurement, production, and distribution decisions can be improved with real-time data about inventory levels, demand, and supply provided by effective supply chain logistics management (Pathy and Rahimian, 2023). Collaboration in the supply

chain plays a mediating role in enhancing sustainability and competitiveness. A sustainable supply chain strategy can give firms a range of competitive advantages, such as improved cost efficiencies, reduced environmental impact, and enhanced customer satisfaction (Govindan *et al.*, 2020). Collaboration across the supply chain can facilitate the adoption of sustainable practices and achieve these benefits, according to the study. In addition to reducing transaction costs, increasing flexibility, and enhancing innovation, effective collaboration between supply chain partners can increase firms' competitiveness (Alzoubi *et al.*, 2020). There are several risks associated with pharmaceutical supply chain logistics management that need to be considered. There are a number of risks associated with the supply chain, including the possibility of counterfeit drugs entering, the possibility of supply chain disruptions caused by natural disasters or man-made events, the possibility of inadequate quality control measures, the possibility of intellectual property theft, and the risk of regulatory non-compliance (Haji *et al.*, 2021). These risks have an impact on patient safety, the quality of pharmaceutical products, and the financial performance of pharmaceutical companies as a result of these risks. There is a need for effective risk management strategies, as well as the use of advanced technologies such as blockchain and AI (artificial intelligence) to mitigate these risks (Jaberidoost *et al.*, 2013).

Indicators	Regulators	Manufacturers	Distributors	Hospitals	Community Pharmacies
Operational Framework of Supply Chain Management					
Availability of government guidelines/ policies	Available	Available	Not available	Partially available	Not available
Availability of SOPs	Available	Available	Available	Available	Not available
Availability of checklist for supply chain process	Available	Available	Available	Available	Available
Key Indicators for Supply Chain Management					
Selection criteria for supplier	Available	Available	Available	Available	Decided by pharmaceutical company
Availability of performance evaluation criteria	Available	Available	Available	Available	Available
Factors Effecting Supply Chain Management in Pakistan					
Procurement process	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
Financial resources	Strongly agreed	Strongly agreed	Strongly agreed	Agreed	Strongly agreed
Supplier institute relationship	Strongly agreed	Strongly agreed	Strongly agreed	Partially agreed	Strongly agreed
Consumer satisfaction	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
Trainings and skill development programs	Partially available	Available	Not available	Partially available	Not available

1 Table 2.1: Stakeholder perceptions of factors affecting Pakistan's pharmaceutical supply chain (Malik et al., 2022)

According to Table 2.1, stakeholders identified 14 factors that affect Pakistan's pharmaceutical supply chain into four categories. A number of factors contribute to the shortage of genuine drugs on the market, including inadequate enforcement of regulations, insufficient regulatory capacity, inefficient supply chain operations, inadequate funding, counterfeit drugs, and a lack of awareness. Policy reforms and interventions addressing these issues can be derived from the table (Malik et al., 2022).

2.1.1 Types of logistics management

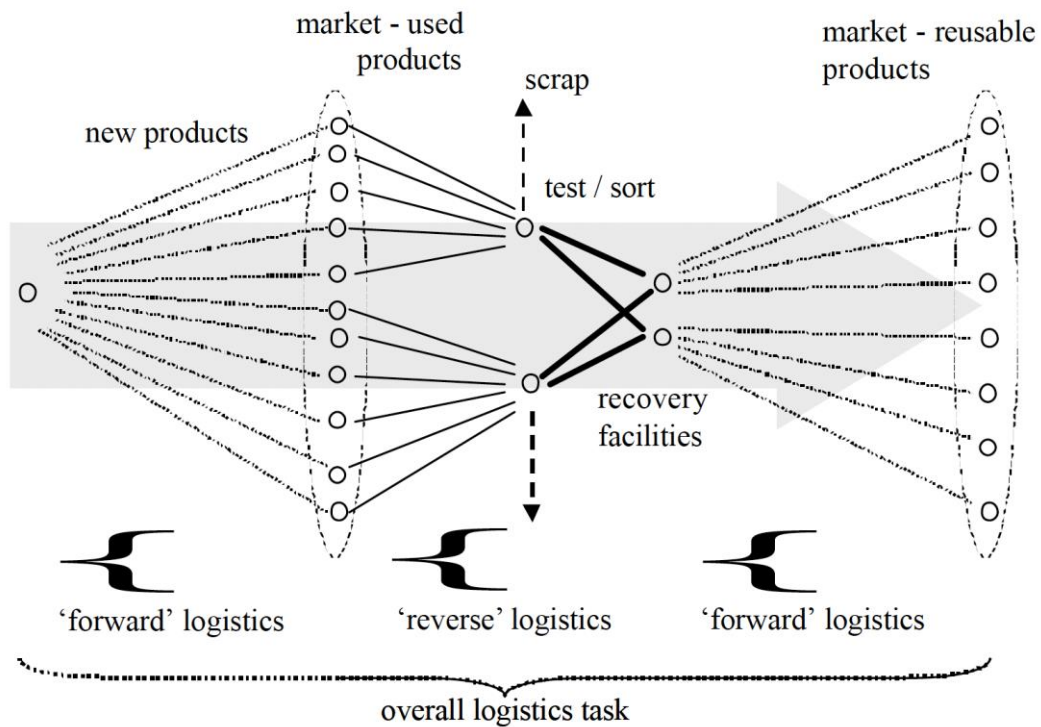
Distribution and inventory management logistics such as just-in-time distribution, vendor-managed inventory, and consignment stock, as well as centralized and decentralized distribution (Li and Huang, 2015). Pharmaceutical companies can use these models to design and optimize their distribution networks by taking into account factors such as transportation costs, delivery times, and inventory holding costs (Milewski, 2020). Delivery times are improved, transportation costs are reduced, and service levels are improved by using distribution network models. In highly regulated environments, these models may require significant data inputs. Pharmaceutical distribution and logistics, emphasizing real-time information and collaboration between stakeholders in the supply chain, rely on information technology and decision support systems (Settanni *et al.*, 2017). The impact of modern sales logistics mechanisms on business performance in enterprises. A successful sales logistics management process increases customer satisfaction, reduces costs, and improves operational efficiency. As a part of the pharmaceutical industry, the logistics of sales is essential in order to ensure that pharmaceuticals are delivered to pharmacies and hospitals on time (Abdur Razzaque and Chen Sheng, 1998). By managing their sales logistics effectively, pharmaceutical companies can minimize stockouts and reduce inventory costs, as well as ensure that the drugs are available at the point of sale at all times (Gebicki *et al.*, 2014). A lack of timely access to medicines is one of the most significant obstacles to the treatment of many diseases, which can have a significant effect on patient outcomes. In the pharmaceutical industry, modern sales logistics mechanisms can improve the efficiency of their supply chains, reduce costs, and ensure the availability of medicines to patients by improving the efficiency of their supply chains. Customer satisfaction can be increased, business performance can be improved, and ultimately patient outcomes can be enhanced by this (Иманбаев, 2023). Customer service management involves managing the delivery of pharmaceutical products to customers while ensuring their satisfaction, which is a critical step in pharmaceutical supply chain logistics management (Uthayakumar and Priyan, 2013). It is possible to utilize customer data for improving customer experience and streamlining the supply chain by improving data

collection, data analysis, and decision making in order to make the process more efficient. To fulfill the customer's requirements, to ensure that products are delivered on time, and to address any issues or concerns promptly (Anshari *et al.*, 2019). In order to maintain customer satisfaction, it is imperative that customer service management is as efficient and accurate as possible. Orders must be processed accurately, inventory must be managed effectively, and products must be delivered on time. Additionally, it is also necessary to establish and maintain strong relationships with customers in order to ensure repeat business and customer loyalty. (Svoboda *et al.*, 2021). The green logistics strategy involves implementing environmentally sustainable practices throughout the pharmaceutical supply chain, which may include reducing carbon emissions, minimizing waste, and switching to renewable energy sources to power the supply chain. Pharmaceutical supply chain management practices that are environmentally sustainable include reducing carbon emissions, minimizing waste, and utilizing renewable energies throughout the entire logistics process in order to achieve an environmentally sustainable pharmaceutical supply chain (Rupa and Saif, 2022). As a result, there are a number of factors that influence managers' ability to adopt green logistics practices, such as attitudes, subjective norms, and perceptions of a sense of control over their actions which may influence their ability to adopt green logistics practices. (Arslan and Şar, 2018).

2.1.2 Reverse logistics

Pharma companies use reverse logistics to handle products that flow backwards through the supply chain, from end-users to manufacturers and distributors. This includes recalling products, returning them, and disposing of expired or unused medications. Pharmaceuticals supply chain safety and public health are ensured using reverse logistics (Lima *et al.*, 2022). Based on Paula *et al.*'s systematic literature review, collaborative relationships between partners and trust between parties can enhance knowledge sharing, improve problem solving, and improve innovation in reverse logistics. In order to achieve successful outcomes in reverse logistics, it was also highlighted that effective communication and cooperation are essential. The paper emphasizes the importance of collaboration and trust for driving reverse logistics innovation and improving their effectiveness (Paula *et al.*, 2019). According to a study conducted in Indonesia, expired drugs are distributed for processing and reusing by a company

specializing in distributing them. Analyzing reverse logistics distribution was done using the DMAIC Six Sigma approach (Antony *et al.*, 2016). There were 47 defects per million opportunities in the distribution process, on average, according to the study. It identified the root causes and proposed improvement initiatives, including revising the process flow, developing workforce skills, and automating the process using an Ishikawa diagram. It was concluded that Six Sigma can help companies reduce defects in their reverse logistics distribution processes (Poncotoyo *et al.*, 2022). In 203 manufacturing companies in Pakistan, structural equation modeling (SEM) was used to study the relationship between green-lean practices and reverse logistics. Green-lean practices have a significant positive impact on reverse logistics and reduce environmental impact. Suggesting that the companies could improve their reverse logistics performance by implementing them (Ahsan *et al.*, 2022).



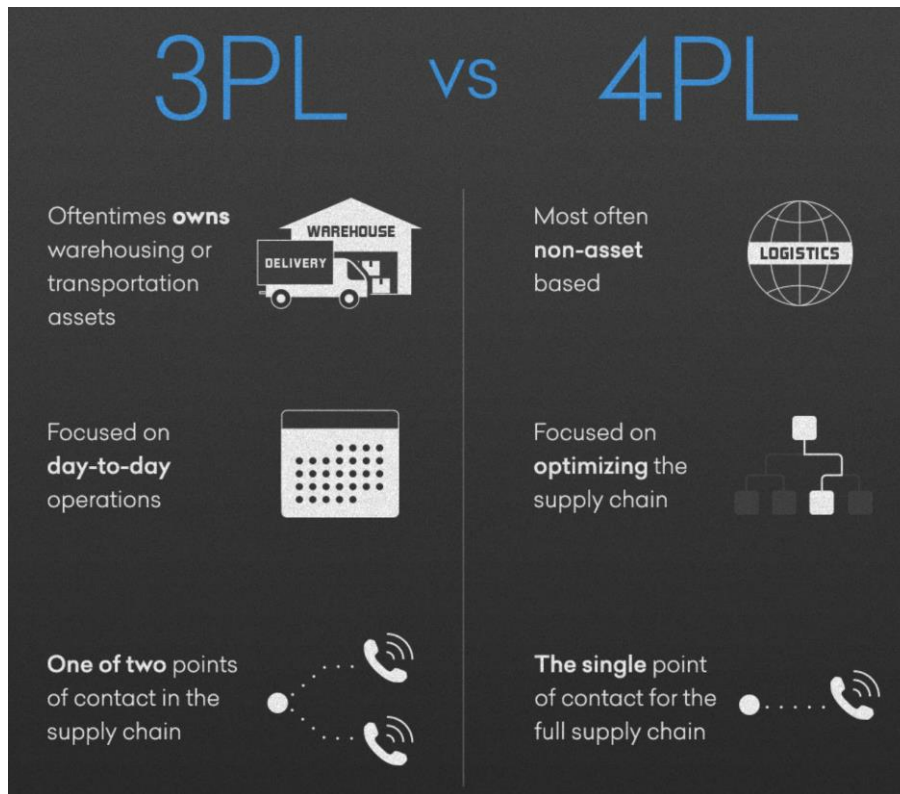
1 Figure 2.1.2: Structure of the reverse logistics network (FLEISCHMANN, 2001)

According to Figure 2.1.2 A reverse logistics network achieves values recovery, waste reduction, and environmental sustainability through collection, sorting, processing, and redistribution. There are a variety of channels for collecting products, sorting and processing

them, and redistributing them. Controlling quality and tracking products are important components of information management (FLEISCHMANN, 2001)

2.1.3 Third party and Fourth Party Logistics

3PL (Third party logistics) refers to outsourcing logistics activities in the pharmaceutical industry to an external provider (Vasiliauskas and Jakubauskas, 2007). This company specializes in supply chain management services, including transportation, warehousing, distribution, and inventory control. Due to the highly regulated nature of the pharmaceutical industry, 3PL are common (Ghaouta *et al.*, 2017). 4PL (Fourth Party Logistics) providers can be highly beneficial to the pharmaceutical industry since they manage the entire supply chain network, including coordinating 3PL providers (Gruchmann *et al.*, 2020). Providers can ensure regulatory compliance, manage inventories, and coordinate the transportation of pharmaceutical products in temperature-controlled environments as well as manage the production of raw materials and delivery of finished products (M. Coe, 2014). The pharmaceutical industry can benefit from the implementation of a 4PL provider by improving efficiency, reducing costs, and reducing risks. In general, pharmaceutical companies can benefit from smoother, more effective supply chain management (Kalkan, 2018). A comparative analysis of four modes of financing for pharmaceutical 3PLs with capital constraints was conducted: 4PL-driven financing, private lending-driven financing, and a combination of both. Financial institutions drive private lending, while 4PL providers drive 4PL financing by providing financing and other resources. In contrast to private lending-driven financing, 4PL-driven financing provides more resources and reduces financing costs for capital-constrained 3PL firms. Furthermore, in comparison to a financing mode based on private lending, the 4PL-driven financing mode can provide better risk management and value-added services as compared to a financing mode based on private lending. This paper discusses the possibility of 4PL-driven financing for capital-constrained 3PL firms in the pharmaceutical industry, and it is suggested that further research is needed to investigate the most suitable financial mode for them in the future (Zhang *et al.*, 2022).



2 Figure 2.1.3: Comparison of 3PL vs 4PL in a warehouse (Ciemcioch, 2018)

The figure shows a comparison of third-party logistics providers (3PL) and fourth-party logistics providers (4PL) in a warehouse setting. Comparing 3PLs to 4PLs reveals that while 3PLs specialize in offering specialized services, 4PLs provide a higher level of integration and coordination (Ciemcioch, 2018).

2.2 Process Improvement Tools

2.2.1 Lean Principle

Lean management emphasizes reducing waste and continuously improving processes. In lean, you identify the root cause of problems, develop and test solutions, and implement improvements based on data and feedback (Rotter *et al.*, 2019). The idea of Lean emphasizes the importance of involving employees in the improvement process as well as creating a culture of continuous improvement within the organization. A literature review carried out by Vinodhini A et al states that Lean is a holistic approach to process improvement that aims to improve efficiency, reduce costs, and improve quality of the process being improved (Vedala,

2018). There are challenges facing the pharmaceutical industry in terms of reducing costs and timelines in order to improve efficiency and profitability. In the pharmaceutical industry, lean applications are still limited because of regulatory compliance that emphasizes quality and safety. Nevertheless, they are essential to achieve operational excellence and profitability (McDermott *et al.*, 2022). The scope of Lean practices differs from regulatory compliance, but they share common characteristics such as standardized work, relationships, communication, and simple flow (Yu *et al.*, 2013). As a result of the implementation of lean, lead times in the overall supply chain have been reduced by 50-75% according to Vedala 2018, and production has been doubled with the same resources. By implementing lean principles to the pharmaceutical supply chain, pharmaceutical companies could become competitive differentiators without investing massive amounts of capital (Argiyantari *et al.*, 2020). According to a study that looked at four hospitals in Brazil that implemented Lean principles to improve operational efficiency and patient care (Régis *et al.*, 2018). implementing Lean practices led to improved operational performance and improved quality of care in hospitals (Kim *et al.*, 2006). As a result of Lean implementation, patient flow was improved, wait times were reduced, patient satisfaction increased, and staff morale was improved. Furthermore, the study found cultural resistance, a lack of leadership support, and inadequate training and education to be barriers to implementing Lean principles in the healthcare sector (Régis *et al.*, 2018). An Indian case study on generic drugs showed that the implementation of a lean logistics strategy increased delivery reliability, reduced transportation costs, and reduced lead times for drug distribution. Additionally, visual management tools and standard work procedures were found to reduce process variability and improve efficiency in logistics management (Dixit *et al.*, 2020). Implementing Lean Manufacturing through logistics is particularly important for reducing supply chain waste. Through cross-functional teams and collaborative planning, logistics efficiency can be improved through effective communication and collaboration among different stakeholders in the supply chain. Maintaining the benefits of Lean Manufacturing also requires continuous improvement and problem-solving (Osman *et al.*, 2020).

2.2.2 Six Sigma

The Lean Six Sigma method of DMAIC (Nandakumar *et al.*, 2020) is integrated with the Theory of Constraints (TOC) (Nave, 2002) to improve quality. By using the DMAIC method of Lean Six Sigma, you can identify and eliminate waste, defects, and variability in processes, while by using the TOC method, you can identify and eliminate bottlenecks in the system. A Lean Six Sigma approach to logistics for supply chains can improve their efficiency and effectiveness. As a result of the use of DMAIC, companies are able to reduce lead times, improve inventory management, and enhance collaboration and visibility in supply chains (Adeodu *et al.*, 2023). The implementation of Lean Six Sigma in supply chain logistics management requires top management support and employee engagement on the part of employees. In order to ensure that employees understand and participate in the process, they must be trained and educated (Khorasani *et al.*, 2020). An overview of 129 research papers revealed that Lean and Six Sigma are widely used in the pharmaceutical industry for improving supply chain management, reducing waste, and improving operational efficiency (Makwana and Patange, 2021).. Pharma companies most commonly use the DMAIC method of Six Sigma. A number of challenges have been addressed in the pharmaceutical industry through the use of lean and six sigma strategies such as the reduction of production costs, the improvement of quality control, the reduction of delivery times, and to enhance overall customer satisfaction (Byrne *et al.*, 2021). It has been demonstrated that lean and six sigma are effective methodologies for improving supply chain logistics within the pharmaceutical industry. An analysis of 70 respondents from 14 pharmaceutical companies examined Lean Six Sigma's impact on the performance of the Jordanian pharmaceutical industry. It was found that Lean Six Sigma significantly improves industrial performance, particularly in areas such as quality control, inventory management, and delivery times. Pharmaceutical companies' revenue and profitability improve after implementing the Lean Six Sigma program, resulting in positive financial results (Alkunsol *et al.*, 2019). There was also positive results obtained through a quantitative approach, and data was collected from 88 respondents from different pharmaceutical companies in Indonesia (Purwanto, 2021). However, Lean Six Sigma implementation in pharmaceutical supply chain logistics is hindered by lack of top management commitment, inadequate training, and resistance to change. The lack of resources,

the lack of knowledge and understanding of the methodology, and the lack of employee involvement all contributed to the failure (Ali *et al.*, 2020).

-
1. *Define*: problem selection and benefit analysis
 2. *Measure*: translation of the problem into a measurable form (CTQ), and assessment of the current situation
 3. *Analyze*: identification of influence factors and causes that determine the CTQ's behavior
 4. *Improve*: design and implementation of adjustments to the process to improve the performance of the CTQs
 5. *Control*: adjustments of the process management and control system in order that improvements are sustainable
-

3 Table 2.2.2: *The phases of the DMAIC tool in Six Sigma's CTQs (De Mast and Lokkerbol, 2012)*

In Table 2.2.2, Six Sigma's critical-to-quality (CTQs) are outlined as phases of the DMAIC tool, including Define, Measure, Analyze, Improve, and Control. Identify customer needs, gather data, analyze the data, implement solutions, and monitor progress are examples of how these phases can be applied to improve processes and deliver CTQs (De Mast and Lokkerbol, 2012)

2.2.3 Total Quality Management

Total Quality Management (TQM) means improving the quality of products and services in an organization by reducing the process of conflict, ensuring continuous improvement, and involving employees in the improvement process. An effective inventory management and supply chain optimization are essential to improve the quality of the products produced in the pharmaceutical industry (Sadikoglu and Olcay, 2014). A hard TQM approach involves the use of quantitative and technical tools, such as statistical process control and quality audits, whereas a soft TQM approach is more qualitative and focuses on improving quality and performance in the supply chain through the use of qualitative and people-oriented tools, such as employee empowerment and teambuilding (Modgil and Sharma, 2017), Table 2.2.3 for hard and soft practices. Among the technologies that can be used to improve logistic efficiency as well as ensure timely delivery of products, supply chain management software can be one of the most helpful solutions for maintaining customer satisfaction as it is one of those technologies that can help improve logistics efficiency (Hadrawi, 2019). A recent study by Jain et al. (2022) suggests that companies looking to improve their inventory management and supply chain processes can benefit from implementing software of this type. In order to enhance the quality of their products and to reduce the amount of waste that they produce, pharmaceutical companies need to prioritize customer satisfaction and implement TQM principles in order to increase profitability. An Indonesian study examined the impact of TQM practices on logistics performance by surveying 98 pharmaceutical companies in a quantitative approach. Logistics performance is significantly improved by TQM practices in the industry, according to the study. Additionally, the reserve supply chain (Lücker *et al.*, 2019) was found to moderate the correlation between TQM practices and logistics performance, suggesting that having a reserve supply chain can enhance the positive effects of TQM practices. In terms of logistics performance, reserve supply chains were found to have a positive impact, suggesting that good logistics performance can be maintained by having a reserve supply chain in place (Sriyakul *et al.*, 2019). In India, 163 pharmaceutical companies took part in a survey questionnaire. According to the study, TQM practices significantly improve operational performance in the Indian pharmaceutical industry. In addition, SCM practices are also associated with significant improvements in operational performance. Furthermore, the study

found that SCM practices mediate the relationship between TQM practices and operational performance. For the Indian pharmaceutical industry to improve operational performance, TQM and SCM practices should be implemented simultaneously. Customer satisfaction and supply chain performance can be improved by integrating TQM and SCM practices. Further, to effectively implement TQM and SCM practices, companies should foster a culture of continuous improvement and employee involvement(Sharma and Modgil, 2019).



4 Figure 2.2.3: TQM process flow (Anre, 2018)

<i>Soft TQM practices</i>	<i>No. of firms supporting</i>	<i>%</i>
Top management support (TMS)	214	84.25
Customer focus (CF)	209	82.28
Training and development (T&D)	122	48.03
Employee empowerment (EE)	116	45.67
<i>Hard TQM practices</i>	<i>No. of firms supporting</i>	<i>%</i>
Research and development (R&D)	210	82.68
Product quality (PQ)	196	77.17
Total productive maintenance (TPM)	180	70.87
Quality data and reporting (QDR)	108	42.52

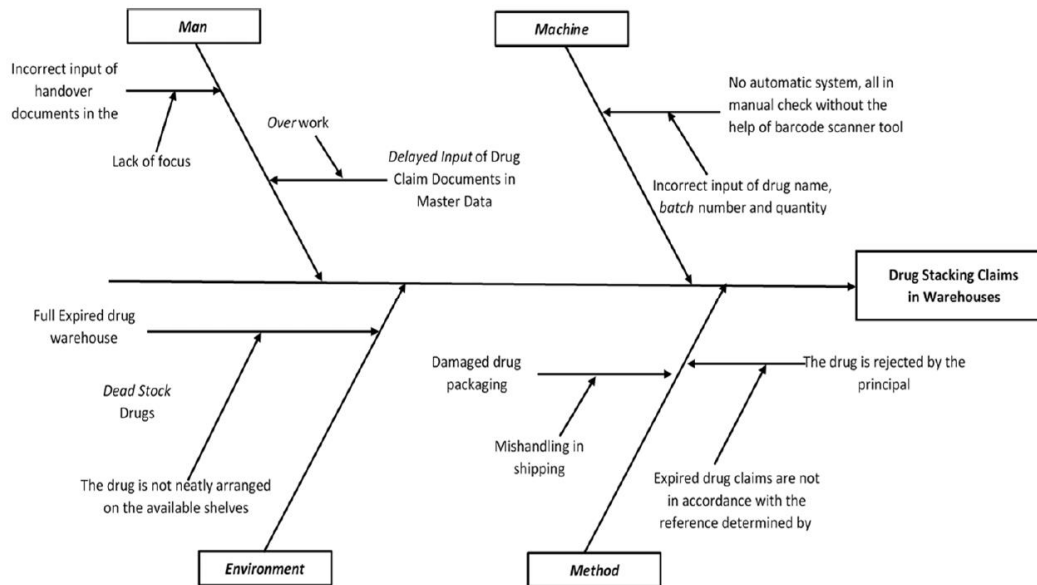
2 Table 2.2.3: frequency distribution of Hard and Soft TQM (Modgil and Sharma, 2017)

According to figure 2.2.3, TQM involves four main steps: planning, implementation, evaluation, and improvement. A plan is created during the planning stage, while the plan is executed during the implementation stage. During the evaluation stage, outcomes are assessed, and continuous improvements are made to improve the process (Anre, 2018). According to the table 2.2.3 Hard TQM practices TMS was more prevalent, however, with soft TQM practices, R&D were more prevalent (Modgil and Sharma, 2017).

2.2.4 Ishikawa Diagram

Ishikawa diagrams, which can also be referred to as cause-and-effect diagrams or fishbone diagrams, are diagnostic tools that help to identify the root causes of various issues and problems, such as the occurrence of a particular issue (Brundage *et al.*, 2017). This method was developed by Kaoru Ishikawa, and it has been widely used in the management of quality, solving of problems, and resolving conflicts in the workplace as its name suggests (Suárez-Barraza and Rodríguez-González, 2019). For applications involving continuous improvement, Ishikawa diagrams and Bayesian belief networks (BBNs) Models represent relationships and probabilities among variables using probabilistic graphical representations. (Hanea *et al.*, 2010) could be very useful. Continuous improvement efforts can be made more effective when these two techniques are combined together. A case study has been dissected that describes how a company was able to identify the root cause of a production problem using Ishikawa diagrams and BBNs in order to determine the root cause of that problem. Using both of these techniques in combination led to an improvement in identifying the root cause of the problem, as well as identifying the most appropriate solution to the problem, as a result of the combination of these two techniques. Furthermore, it suggests that it may also be possible to prioritize improvement efforts by identifying the most critical factors that have the greatest impact on the outcome of a process by using BBNs in this regard. In order to improve the performance of a company's processes, it is crucial that it focuses on the most critical factors (Rodgers and Oppenheim, 2019). There are many factors that can affect the quality and availability of medicines in the pharmaceutical supply chain, but the Ishikawa diagram can be applied as an useful tool for identifying the root causes of issues related to quality and

availability. In order to improve the overall performance of the supply chain, it is necessary to identify the root causes of these issues and develop solutions to address the issues in order to address them (Benazzouz *et al.*, 2019). In the case of inventory management, distribution, or quality control, as an example, the Ishikawa diagram can be used to identify issues related to that area and then develop a solution to solve those problems.



5 Figure 2.2.4: Fishbone diagrams are used to determine both the main cause and its root cause of a problem (Poncotoyo *et al.*, 2022)

Figure 2.2.4 describes fishbone diagrams for warehouse reverse logistics as a tool for finding both primary and underlying root causes of problems. These diagrams can also be called Ishikawa diagrams or cause-and-effect diagrams, and they are used to map out potential causes of problems and to facilitate problem solving (Poncotoyo *et al.*, 2022).

2.2.5 Value Stream Mapping

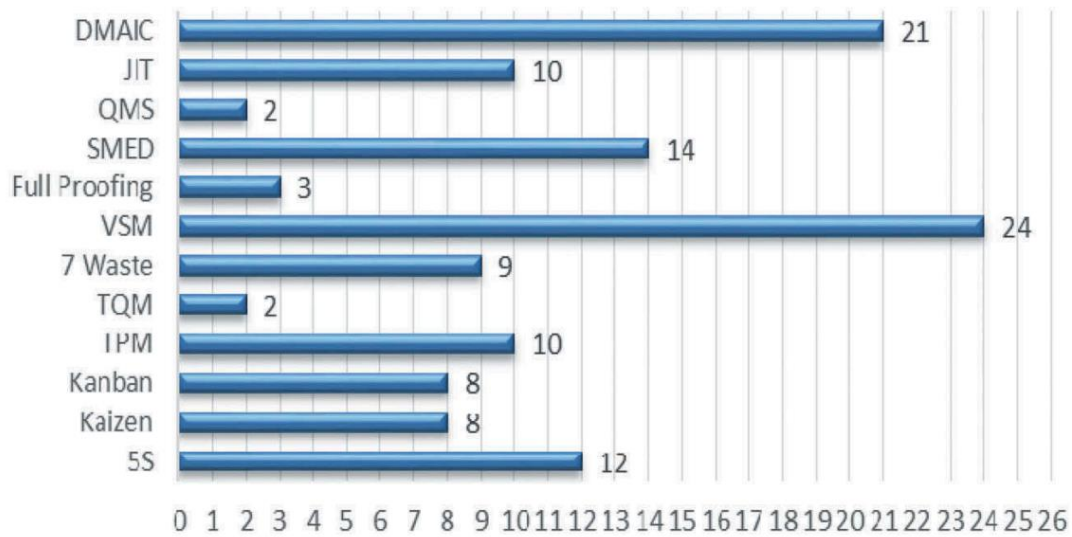
The value stream mapping process in the context of lean management involves analyzing and improving the flow of both materials and information in a manufacturing or service process. This involves analyzing and improving the flow of both information and materials in a manufacturing or service process (Singh *et al.*, 2019). This graphical tool provides a good overview of the process flow and it can be used in order to identify wastes in the process and

to put emphasis on improvement areas throughout the process as a whole. As a result of a value stream mapping, a process can be streamlined, lead times can be reduced, and there will be a reduction in activities that are not bringing value to the company (Tyagi *et al.*, 2015). As a tool for improving supply chain efficiency, value stream mapping can identify waste and identify improvement opportunities (Abideen and Mohamad, 2021). According to a paper by Xiao-Yong Zhu, Hua Zhang, and Zhi-Gang Jiang, the purpose of the study is to investigate how to integrate and implement lean and green practices in a Chinese manufacturing company by means of the use of green-modified value stream mapping (GMVSM). The authors explain how GMVSM is a tool that combines the principles of value stream mapping (VSM) with green manufacturing principles in order to help identify and eliminate waste within the operational process while also taking the environmental impact into account. Using the case study presented in the paper, it can be seen that by using GMVSM it was possible to reduce waste generation, energy use, and carbon emissions, while improving productivity, product quality, and product efficiency (Ahmad and Khan, 2022). In addition, the study demonstrates that the integration of lean and green practices was made more efficient and sustainable through the use of GMVSM, leading to a more sustainable and efficient production process. According to the paper, the use of GMVSM could be incorporated into a manufacturing process in order to integrate lean and green practices in order to continuously improve efficiency and profitability (Wen *et al.*, 2021). An essential component of the GMVSM is that it provides a comprehensive and systematic approach to the identification and elimination of waste, while minimizing the operation's impact on the environment. As a result of the study, it is evident that a sustainable manufacturing practice must consider both economic factors as well as environmental factors in order to be effective (Zhu *et al.*, 2019).

2.2.6 5S Methodology

Japan introduced the 5S methodology for organizing and standardizing workplaces. Five steps are in the 5S methodology, which are Sort, Set in Order, Shine, Standardize, and Sustain in order to ensure continuous improvement (Gupta and Jain, 2015). To begin with, sorting involves removing all unnecessary items from the workplace in order to create a cleaner, safer and more efficient working environment. This step is done in order to eliminate clutter and make the workplace safer. It is important to keep the remaining items organized in a logical

and efficient manner to ensure they are easy to find and retrieve when the need arises, as the second step, Set in Order, involves organizing the items. There is a third step that should be followed, which is called Shine. It involves cleaning the workplace thoroughly, and this assists in improving the appearance of the workplace and helping to identify potential hazards and problems (simplilearn, 2015). It is vitally important to ensure that the first three steps are maintained over time, in order to create a culture of continuous improvement and prevent backsliding. The fourth step is to standardize procedures and guidelines in order to ensure that the first three steps are supported over time (Fortino, 2022). It is very important to remember that setting up a 5S methodology is the first step, but continuing to improve it is the next and final step. Ensure that all personnel in the organization are following the established procedures by ensuring that regular audits and training are conducted at regular intervals. There are a number of industries where the 5S methodology is used to improve the efficiency, productivity, security, and organization of work environments (Veres (Harea) *et al.*, 2018). An evaluation of the 5S methodology in Peru has been reported in a paper that examines how it has been implemented by small and medium-sized enterprises (SMEs) that market pharmaceutical products in the country (Tereshchenko *et al.*, 2022). Having implemented the 5S methodology, the researchers found that there was a marked improvement in workplace organization and cleanliness, employee motivation and engagement, as well as overall productivity, as a result of its implementation (Jaca *et al.*, 2014). According to the authors, the 5S methodology in the pharmaceutical sector may provide SMEs with a useful tool to improve the level of service provided by them in order to differentiate themselves from their competitors. While the study found that 5S methodologies require a large investment of time and resources, it also revealed that employees who are not used to such changes may be skeptical about being implemented, and the implementation may face resistance from their colleagues. Prior to implementing the 5S methodology in SMEs in the pharmaceutical sector, the authors point out that the benefits and challenges of such an initiative need to be carefully weighed before embarking on it (Rodriguez-Quispe *et al.*, 2022).



6 Figure 2.2.6: Case studies and papers based on LSS tools and techniques (De Mast and Lokkerbol, 2012)

Figure 2.2 shows that VSM had 24 case studies, followed by DMAIC with 21, and SMED with 14. Kanban and Kaizen each had 8 case studies, JIT and TPM had 10, and 5S had 12. Full Proofing had 3 case studies while QMS and TQM had 2 each (De Mast and Lokkerbol, 2012).

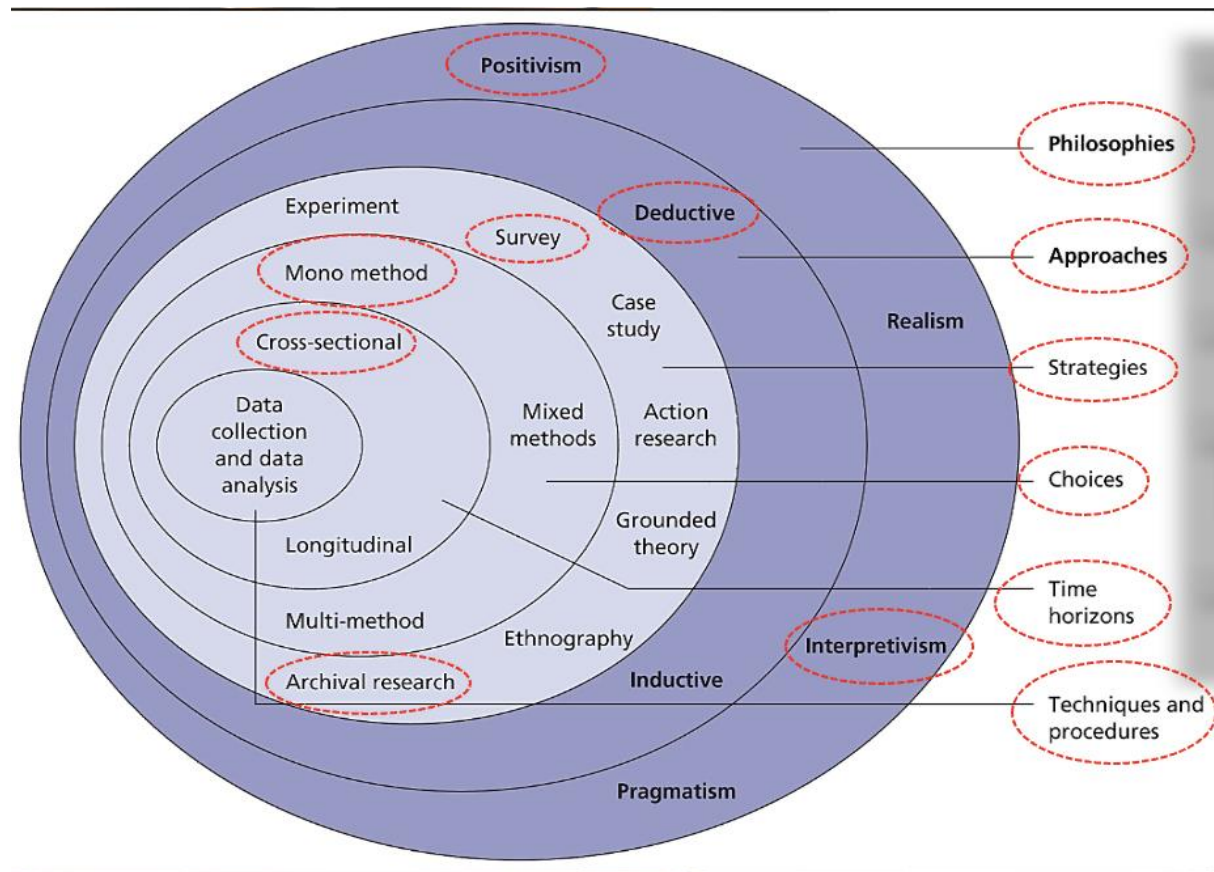
Chapter 3

Research Methodology

3.1 Research Methodology

Research methodology, collected, analyzed, and interpreted data are systematically gathered, analyzed, and interpreted in order to answer research questions or test hypotheses in order to advance scientific knowledge (Whittemore and Melkus, 2008). As part of this process, a research project will be planned, implemented, and analyzed in order to gather and analyze data. This will involve many different techniques and methods, such as surveys, interviews, experiments, case studies, and analytical methods. The methodology is an important aspect of the entire research process when it comes to any research; this includes determining the research problem and determining the outcome, as well as making recommendations and drawing conclusions from the results. It is a tool that helps researchers design a study in a rigorous and credible manner, as well as ensuring that researchers can draw valid and reliable conclusions from the data. In order to develop a sound research methodology, it is necessary to have a good grasp of the research problem and to develop an appropriate research design according to the nature of the question and the nature of the research problem (Snyder, 2019). There are several decisions that must be made regarding the research approach, sampling methods, data collection techniques, data analysis techniques, and ethical issues related to the research. According to the nature of the research problem, the availability of resources, and the objectives of the research, the choice of research methodology will depend on the research problem (Palinkas *et al.*, 2015). In addition to their strengths and weaknesses, each research methodology has its own benefits and drawbacks, which is why researchers should carefully consider the approach best suited to their particular research question and their particular research context before choosing an approach. It is essential to note that the research methodology is a crucial aspect of the research, since it determines the quality and credibility of the findings based on the research. The creation of insights and knowledge that can be used

for the improvement of business practices and to inform decision-making relies greatly on a well-designed and executed research methodology (Saunders *et al.*, 2012).



7 Figur 3.1: Research Onion (Saunders *et al.*, 2012)

The research onion provides researchers with a metaphorical framework for understanding the complexities of designing and conducting research. There are six interrelated layers in the framework created by Saunders *et al.* (2012): (1) philosophy, (2) approach, (3) strategy, (4) time horizon, (5) data collection methods, and (6) data analysis methods. It is important to recognize that each layer builds on the previous one and contributes to the overall quality of the research.

3.1.1 Research Philosophy

There are several beliefs, assumptions, and principles that take into account when designing and conducting a research study, and these define the research philosophy. The positivism approach in research philosophy emphasizes the use of quantitative data in order to gain a better understanding of how the world works, as well as objective measurements to make this possible. Statistical analysis is typically used by positivist researchers to identify causal relationships and to test hypotheses based on the results. In contrast, interpretivism is a form of intellectual inquiry that emphasizes the importance of the context and meaning of social phenomena, as well as the subjective interpretation of these phenomena (Ramsberg, 2018). It is common for interpretivist researchers to employ qualitative data and methods such as interviewing and observing in order to better understand the complexities of human behavior and social interactions. Through emphasizing the practical nature of research and its context-specific nature, pragmatic approaches seek to bridge the gap between these two perspectives (Saunders *et al.*, 2012). Considering the fact that this research mainly uses quantitative data and statistical analysis, it tends to lean towards positivism. In addition to the option of open-ended questions, open-ended questions also offer the possibility of creating an interpretation of the data, which is aligned with interpretivism. As a general rule, there is no rule stating that positivism and interpretivism are mutually exclusive, and depending on the study's goals and the research questions it is appropriate to incorporate elements of both into a research design.

3.1.2 Research Approach

Deductive analysis begins with a hypothesis and is tested empirically by observing and analyzing data. This approach involves formulating a hypothesis and designing a study to test it. Upon collecting the data, analyzing it, and drawing conclusions, conclusions are drawn. Quantitative research uses this approach, where variables are measured and quantified (Pedaste *et al.*, 2015). As opposed to the deductive approach, the inductive approach uses empirical observations to develop a hypothesis or theory. Data is collected first, followed by observations and theories, in this approach. Based on the results of the analysis, conclusions are drawn.

Typically, this approach is used in qualitative research, aimed at understanding and interpreting social phenomena (Saunders *et al.*, 2012). Specifically, the hypothesis being tested in this study is "Lean and Six Sigma are the best process improvement tools for supply chain logistics in pharmaceutical manufacturing, in comparison to other process improvement tools." The approach being used is deduction, as this hypothesis is being tested using quantitative data that has been collected through a survey with many closed-ended questions. With the indication that there is a specific hypothesis in mind and that empirical data will be used to test that hypothesis. Quantitative research is commonly carried out using the deductive approach. In the deductive approach, variables are measured and quantified in order to establish a connection between sets of variables (Borgstede and Scholz, 2021). As a result, a hypothesis is formulated and the data collection and analysis are designed accordingly. As a result of this data, conclusions were drawn regarding the relationship between the use of Lean and Six Sigma in the pharmaceutical industry and the effectiveness of supply chain logistics with respect to this process.

3.1.3 Research Strategy

Researchers are using three main research strategies to collect, analyze, and interpret data to answer their research questions: experiments strategies, surveys, and case studies. Experimental strategies are involve manipulating one or more variables to determine how they affect the outcome of interest. Surveys are involve interviewing or surveying a sample of respondents (Saunders *et al.*, 2012). Generally, the case study strategy is used to examine a certain phenomenon or situation in depth in the context of a real-life situation within a specific period of time. A research strategy should be selected based on the nature of the research question and the type of data required to answer it. Questionnaires that are used for the purpose of collecting data from supply chain logistics employees in the pharmaceutical industry that will help them answer questions concerning the relationship between process improvement tools and pharmaceutical supply chain logistics in the industry (Crowe *et al.*, 2011). Furthermore, as well as using a survey as a primary data collection method, a comprehensive literature review was also conducted as part of the archival research strategy in the context of the study. This literature review entails the analysis and synthesis of previously published studies, reports, and other relevant sources for information related to pharmaceutical supply

chain logistics management that have been previously published in scientific journals, magazines, and other online and print publications. In order to develop a more informed understanding of the research questions, it is necessary to review the existing literature to identify any gaps in knowledge and to identify knowledge gaps that may exist. The goal of archive research is to use existing data sources as a basis for the analysis of the results of an experiment to be carried out. An analysis of historical trends and patterns is generally used in business research in order to examine the relationship between variables over time as well as to examine historical changes over time (Farrugia *et al.*, 2010). For the purposes of this study, a literature review is used as a method of archival research that facilitates the identification and analysis of relevant data from previously published studies that might be of importance to the analysis. As a result, using archival research as part of a comprehensive literature review is a helpful way of eliminating inefficiencies within the research design, as well as providing a deeper understanding of research objectives through the use of archival research as part of a comprehensive literature review (Hamilton and Finley, 2019).

3.1.4 Research Choice

Research choice is an essential component of any research project, since it involves choosing the specific approaches and methods needed to achieve the research goals. In order to be successful, it must take careful consideration of the research questions, data requirements, and ethical implications involved. It is crucial for researchers to make a decision on whether they will use a qualitative approach to their research, a quantitative approach, or a mix of both approaches (Whittemore and Melkus, 2008). There are two main types of research: quantitative and qualitative. Quantitative research makes use of numerical data and statistical analyses to determine relationships between variables, while qualitative research makes use of non-numerical data such as qualitative interviews, observations, and case studies to gain a deeper understanding of social phenomena. The mixed-methods approach consists of collecting and analyzing both quantitative and qualitative data as part of the same research project. In order to collect the data for this study, we are using a mono-method, collecting primarily quantitative data from employees working in supply chain logistics management of a pharmaceutical company (Saunders *et al.*, 2012). This study focuses on the development of tools for improvement of supply chain and logistics management in pharmaceutical companies with an

emphasis on process improvement tools. Based on the hypothesis, Lean and Six Sigma are the most effective process improvement tools across all logistics management, and the research will investigate whether some process improvement tools are more effective than others.

3.1.5 Time Horizon

Time horizon is used to describe the duration of the research that will take place over the course of a specific period of time. In research design, this is an important point to consider, because it can influence the type of data that will be gathered and the conclusions that will be drawn based on the data collected. It is important to note that data collected in this study have a cross-sectional time horizon, which means that all data were collected at a single point in time (Saunders *et al.*, 2012). There was a one-month period in which the primary data was collected, and the literature reviews used for the analysis are from the years 2018-2023. Using a cross-sectional research design can be a useful strategy when the research questions are aimed at elucidating the current state of a particular phenomenon, such as the attitudes or behaviors of a specific population at a particular point in time. As a result of this approach, one can provide a snapshot of a specific time period, and this approach can be useful when identifying trends and patterns in the data over time. In addition to the time horizons stated above, there are also longitudinal studies. This type of study is conducted over an extended period of time, with data collected at several points throughout the study period. This type of study is aimed at observing changes over time and observing how they are affected by various variables over time. Retroactive Studies: This type of study is concerned with analyzing data that has already been collected or events that have already occurred in the past (Caruana *et al.*, 2015).

3.1.6 Research Techniques and Procedures

The research design used in this study is conclusive, which means that the aim of the study is to provide a clear and definitive answer to the research questions (Caliskan *et al.*, 2016). Primary data was collected using questionnaires that were created on an Microsoft form and sent via a variety of different platforms, including LinkedIn, email, Twitter, and WhatsApp, in order to gather the primary data. This study was designed to sample a purposive population of

logistics managers, coordinators, and engineers working in the pharmaceutical industry worldwide from a variety of locations. It was expected that approximately 100 people would respond, but a total of 60 people responded. This study involved extracting content from the open-ended questions and performing statistical analysis on the close-ended questions in order to analyze the data for this study (Saunders *et al.*, 2012). Due to the fact that the study was international, there were no restrictions concerning a specific country, which allowed for an array of different types of responses from various parts of the world. Overall, this study made many careful choices when selecting research techniques and procedures based on the objectives of the study as well as the aim of gaining meaningful insights into the use of process improvement tools in pharmaceutical supply chain logistics management in order to align with the objectives of the study.

3.1.7 Ethical Consideration

In order for researchers to make ethical decisions and conduct research in a responsible and ethical manner, they must take ethical considerations into account. Keeping people's personal information confidential and treating them with respect is part of the process. Furthermore, ethical considerations include obtaining informed consent from participants, conducting the research in a transparent manner, and preventing any harm to participants (Saunders *et al.*, 2012). The research was conducted in accordance with ethical considerations. Participants were informed about the research and the impact it might have on them through a consent form that was created. The supervisor appointed by Innopharma and Griffith College for the dissertation had to sign the application and declaration form prior to distributing the surveys to the Participants. Participants also received a participant information letter explaining the purpose and protection of their personal information. Approval from the supervisor and the ethics committee from Innopharma was requested before sending the questionnaires to logistics manager, coordinator, and logistic engineer before conducting my research so that my questionnaires would be appropriate for them. Throughout the research process, several steps were taken to ensure that the research was ethical and compliant with applicable guidelines.

Chapter 4

Finding and Analysis

4.1 Demographic

Demographics consists of the study of the human population and focuses on the characteristics of people, such as their age, their gender, their income, their education, their occupation, and their ethnicity. An analysis of the distribution of these characteristics within a given population or region, along with the change in these characteristics over time, is what this discipline is concerned with analyzing and understanding. Social and economic research often employs demographic data to explore patterns of behavior, consumption, and production, as well as to predict future trends, in order to explore patterns of behavior, consumption, and production. Also, it can be applied to determine target audiences for marketing and advertising and then develop strategies to target these audiences in order to reach them. Surveys, censuses, and administrative records are some of the methods by which demographic data is collected, and it is important as a tool for policymakers and business owners, as well as researchers to gather this data (National Geography, 2022).

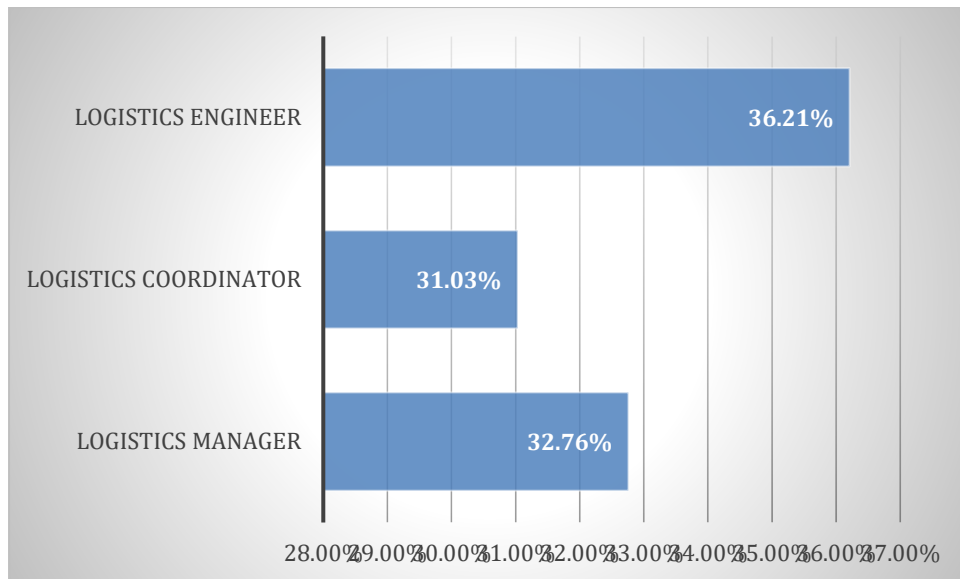
As part of this research, 58 participants were surveyed, and they were distributed through the use of Microsoft forms, LinkedIn, and email messages. The surveys were distributed via Twitter, Facebook, and WhatsApp. Each of the participants in this study holds either a position of logistic manager, logistic coordinator, or logistics engineer in the pharmaceutical supply chain logistics sector, as part of the pharmaceutical supply chain logistics sector. There was a wide range of demographic information collected from the participants in the study, including their professions, their gender, their age distribution, the number of years they have had experience in the pharmaceutical field, their level of education, and their current country of employment. The data was collected from participants around the world.

4.1.1 Participants Occupations in the Logistics sector in pharmaceutical Supply Chain Management

logistic managers, coordinators, and engineers have a better understanding of the process improvement tools implemented in their operations, the study focused on specific job roles within pharmaceutical supply chain logistics management. Their involvement in selecting and implementing process improvement tools would have enabled them to observe firsthand how these tools improved their value streams. Managers and coordinators of logistics, in particular, would have a comprehensive understanding of how process improvement tools affect daily operations and overall supply chain performance. Communication, efficiency, and other features would have improved as a result of the changes in their responsibilities. Additionally, logistics engineers were able to assess how the process improvement tools increased the efficiency of their operations. In order to get a better understanding of how process improvement tools were utilized in the pharmaceutical industry's supply chain logistics management, specific job roles were selected for the study. A more comprehensive view of supply chain logistics management will require future research to include other job roles and perspectives.

Respondents	Frequency	Frequency (%)
Logistics Manager	19	32.76%
Logistics Coordinator	18	31.03%
Logistics engineer	21	36.21%
Total	58	100.00%

3 Table 4.1.1: Occupational distribution of supply chain logistics management participants



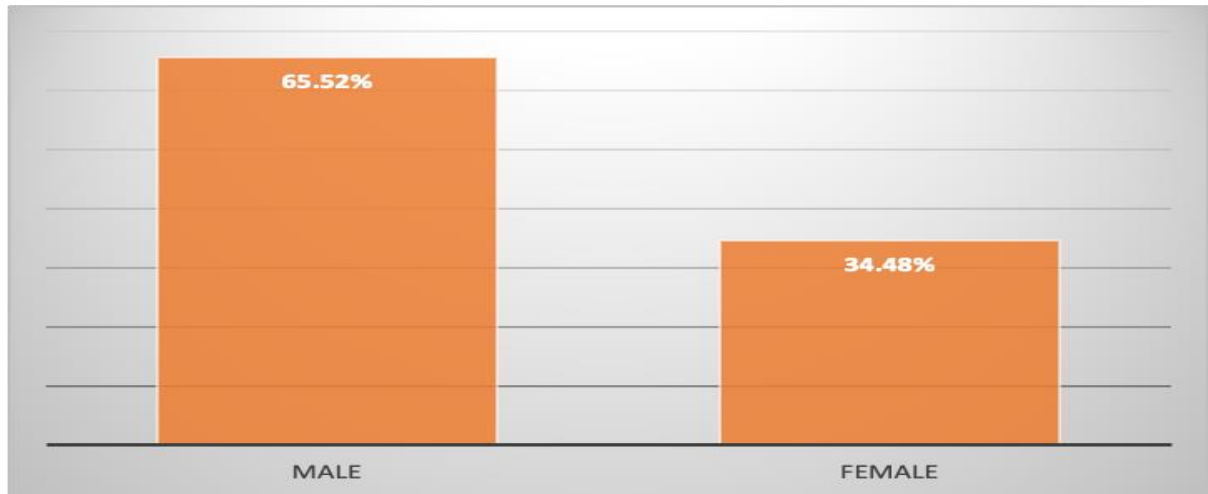
8 Figure 4.1.1: A bar chart showing the distribution of participants' occupations in supply chain logistics management

There were a total of 58 participants who took part in the survey, as shown in Table 4.1.1 and Figure 4.1.1. Among the participants, 36.21% identified themselves as logistics engineers, making up the majority of respondents to the survey. A total of 32.76% of the participants in this study were logistics managers, whereas a total of 31.03% were logistics coordinators.

4.1.2: Distribution of Participants by gender

Gender	Frequency	Frequency (%)
Male	38	65.52%
Female	20	34.48%
Total	58	100.00%

4 Table 4.1.2: Gender distribution by participants



9 Figure 4.1.2: Distribution of participants by gender

The data presented in the table and figure 4.1.2 illustrate that out of a total of 58 (100%) participants, 38(65.52%) of them are males, which equates to 38 individuals, while 20(34.48%) participants are females based on the data presented in the table and figure. According to the distribution of genders in the sample, there is a slight predominance of males.

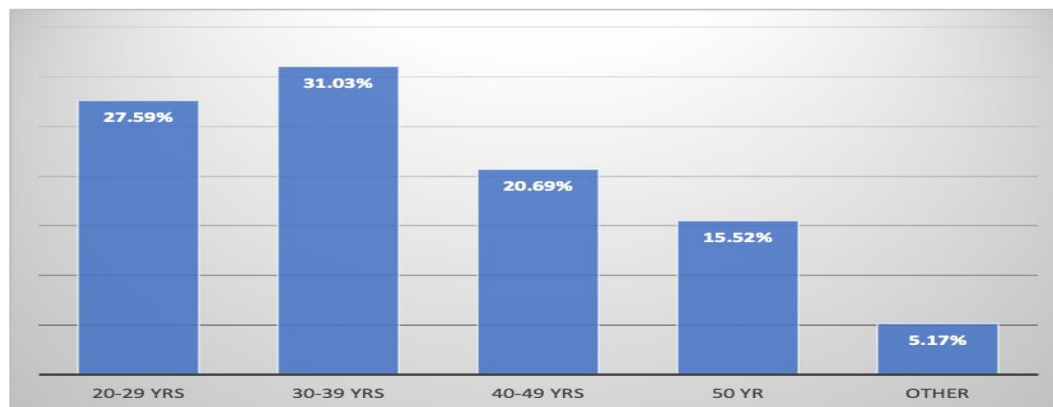
In this study, it is not possible to determine whether logistics jobs are dominated by men. It is possible, however, that the gender distribution of respondents may have simply been a coincidence since more male respondents were interested in participating because they were more likely to do so. Research is needed to investigate any potential gender disparities in employment in the logistics industry, which may still exist due to gender bias and unequal opportunities in some industries.

4.1.3 Distribution of Participants' by age

Age	Frequency	Frequency (%)
20-29 yrs	16	27.59%

30-39 yrs	18	31.03%
40-49 yrs	12	20.69%
50 yr	9	15.52%
Other	3	5.17%
Total	58	100.00%

5 Table 4.1.3: Distribution of the participants' by age range



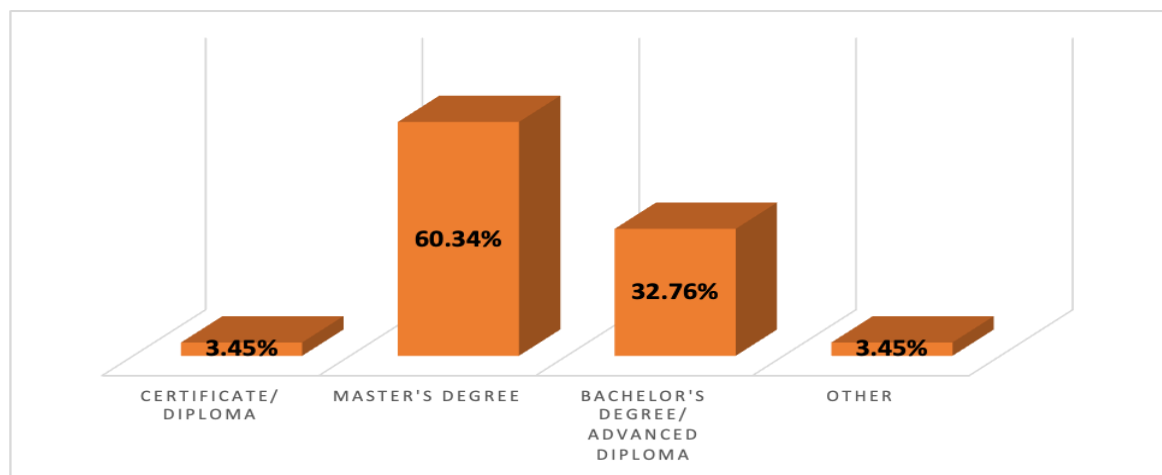
10 Figure 4.1.3: Distribution of the participants by age

Data in table 4.1.3 shows that out of the total of 58 participants, (31.03%)18 were in the 30-39 age range. The majority of participants, or (27.59 %)16, were between the ages of 20 and 29 years old. There were (20.69%) 12, who were in the age bracket of 40 to 49 years old. A total of (15.52 %) 9 of the participants were over 50 years of age, while (5.17%) 3 of the participants were classified as "others" with two participants being over 65 years of age and one being 59 years old.

4.1.4 Distribution of participants' the Level of Education

Level of Education	Frequency	Frequency (%)
Certificate/ Diploma	2	3.45%
Master's Degree	35	60.34%
Bachelor's degree/ Advanced Diploma	19	32.76%
Other	2	3.45%
Total	58	100.00%

6 Table 4.1.4: The distribution of participants' by educational levels



11 Figure 4.1.4: The distribution of participants' by educational levels

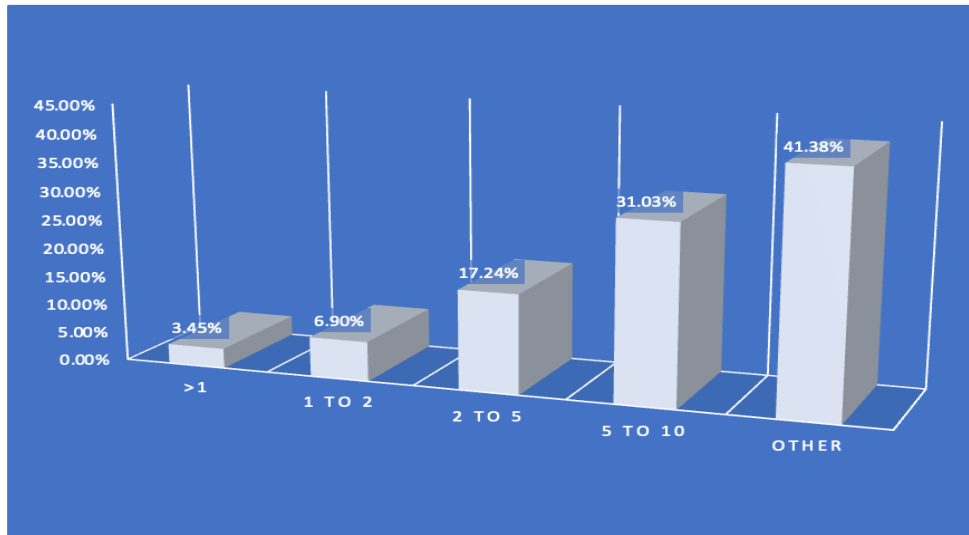
Based on the data presented in table 4.1.4 and figure 4.1.4, it can be seen that based on the 58 participants in the study, (60.34%) 35 participants, of the group held a Master's degree, which was the majority. Among the participants, (32.76%) 19 had a Bachelor's degree or an Advanced

Diploma. There was a small percentage of people, (3.45%) 2, that had either a certificate or a diploma, and the same percentage also had other levels of education in addition. There was one participant pursuing a PhD currently, while there was another who held a doctorate degree.

4.1.5 Distribution of participants' by the years of work experience in the pharmaceutical industry

Year of work Experience	Frequency	Frequency (%)
>1	2	3.45%
1 to 2	4	6.90%
2 to 5	10	17.24%
5 to 10	18	31.03%
Other	24	41.38%
Total	58	100.00%

7 Table 4.1.5: Statistical distribution of participants' by the years of work experience



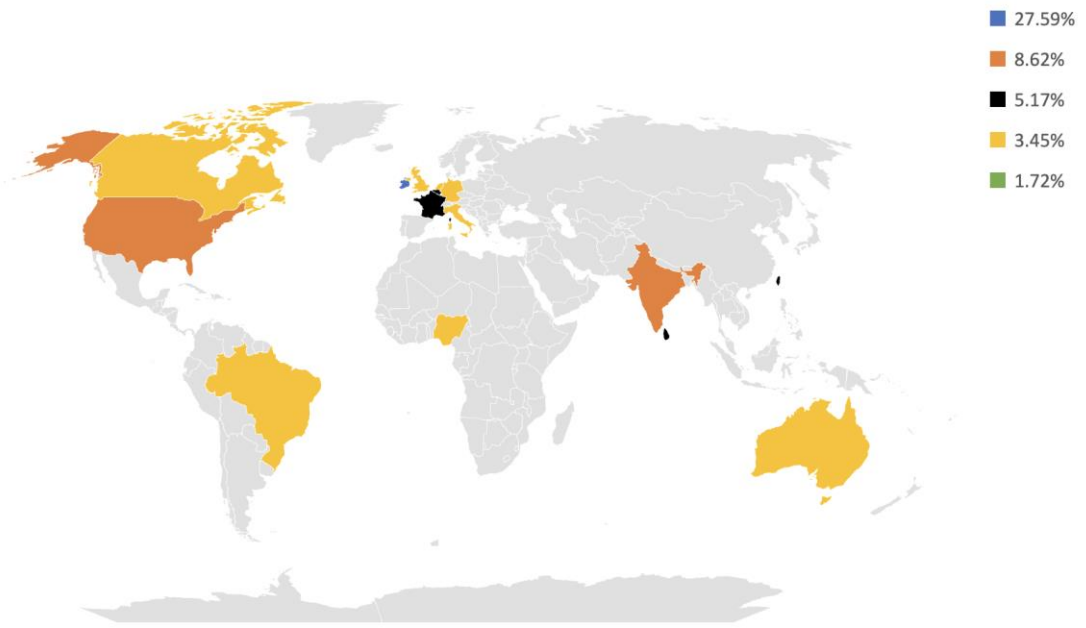
12 Figure 4.1.5: Chart distribution of participants by the years of experience in the pharmaceutical industry

As shown in the table and the figure 4.1.5 of the survey, the majority of the 58 participants surveyed (41.38%) 24 fell under the category of "Others" in terms of the amount of work experience they had in the pharmaceutical industry, which ranged from over 10 years to more than 35 years. In addition to this, (31.03%) 18 of the participants in this study had a work experience of 5 to 10 years, and (17.24%) 10 had a work experience of 2 to 5 years. Among the study participants, (6.90%) 4 had one to two years of work experience in the pharmaceutical industry, and the remaining (3.45%) 2 had less than one year of work experience in the sector.

4.1.6 Global Distribution of Participants

Country	Frequency	Frequency (%)
Ireland	16	27.59%
India	5	8.62%
USA	5	8.62%
Switzerland	3	5.17%
Sri Lanka	3	5.17%
Taiwan	3	5.17%
France	3	5.17%
Belgium	3	5.17%
Italy	2	3.45%
Australia	2	3.45%
Brazil	2	3.45%
Germany	2	3.45%
Nigeria	2	3.45%
The Netherlands	2	3.45%
UK	2	3.45%
Canada	2	3.45%
Not Applicable	1	1.72%
Total	58	100.00%

8 Table 4.1.6: Global distribution of survey respondents



13 Figure 4.1.6: Global distribution map of survey respondents

From the data in the table and the figure 4.1.6, it can be seen that the majority of the participants, which comprise (27.59%)16, were from Ireland, out of the total 58 participants. It was followed by (8.62%) 5 who were both from India and the United States. There were three participants, each of which contributed (5.17%) 3 of the survey, from Switzerland, Sri Lanka, Taiwan, France, and Belgium, respectively. In the study, there were two participants from Italy, Australia, Brazil, Germany, Nigeria, the Netherlands, the United Kingdom, and Canada, which translates to (3.45%) 2 each. The data for (1.72%) 1 of the participant could not be used due to the fact that neither their country was provided nor the data was sufficient.

4.2 Analysis of Objective 1

Assessment of the process improvement tools in supply chain logistic management and their performance in pharmaceutical companies

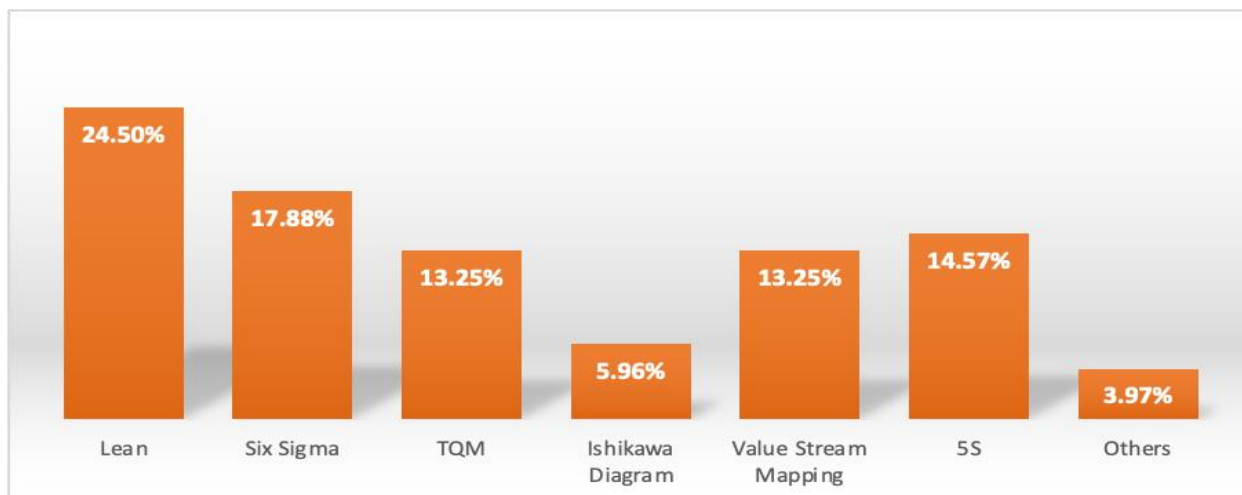
4.2.1 What are the most used tools for pharmaceutical supply chain logistics management?

Identification of the most effective supply chain logistics management tools common to the pharmaceutical industry. The 58 participants were asked the question, "What form of process improvement tool(s) currently exist in your workplace?"

Pharma companies can improve their supply chain management practices by understanding the most commonly used tools and adopting these tools if they gain a better understanding of industry best practices. By identifying the most commonly used tools, companies can identify areas of supply chain management where they are falling behind and prioritize their efforts.

Process Improvement Tools	Frequency	Frequency (%)
Lean	37	24.50%
Six Sigma	27	17.88%
TQM	20	13.25%
Ishikawa Diagram	9	5.96%
Value Stream Mapping	20	13.25%
5S	22	14.57%
Others	6	3.97%
Total	151	100.00%

9 *Table 4.2.1: Participant-response in the use of Process Improvement Tools for Pharmaceutical Supply Chain Logistics*



14 Figure 4.2.1: Graph representation of distribution of the pharmaceutical supply chain logistics system tools according to participants response

Based on the chart in figure 4.2.1 and table 4.2.1, the most commonly used process improvement tool in the pharmaceutical industry's supply chain is lean, which has the highest percentage of 24.50%. The second most popular process improvement tool, according to this table and graph, is Six Sigma, which is currently being utilized by approximately 17.88 % of the respondents to this survey. Which supports the hypothesis that the most commonly used tools should have been Lean and Six Sigma. While 5S interestingly has a higher percentage based on the table and graph of 14.57% \. The 5S methodology is a method that is used to improve efficiency and organize the workplace. There are five steps in this methodology, each represented by a Japanese word, such as seiri (sort), seiton (systemize), seiso (shine), seiketsu (standardize), and shitsuke (maintain), which represent the five steps in the method. It is a methodology based on the use of visual management tools and a structured approach that allows for the organization and sorting and organization of workplaces, eliminating unnecessary items, maintaining cleanliness, and standardizing work procedures to ensure sustained improvement. In addition to creating a safe and organized work environment, this methodology can also lead to the improvement in productivity and quality of the work produced. Aside from reducing waste and increasing efficiency, it can also help to reduce unnecessary costs (Costa *et al.*, 2018). Total Quality Management (TQM) and Value Stream

Mapping (VSM) both had a 13.25% share of the workload, while Ishikawa diagram diagrams were used at a 5.96% rate. Other tools such as APO, AGILE, D365, SCS-CARGOWISE, and SAP at 3.97%.

By developing the APO model, Asian Productivity Organization (APO) has created a knowledge management model that aims to enhance the performance of organizations by promoting the transfer and creation of knowledge through the promotion of knowledge transfer and creation within the organization. According to the model, there are six components: the creation of knowledge, the acquisition of knowledge, sharing knowledge, utilizing knowledge, protecting it, and evaluating it. In addition to being interdependent and mutually supportive, these components work together to enhance the capabilities of organizations in terms of knowledge management, thereby helping organizations continuously improve their performance. Various industries and sectors, including universities, have adopted the APO model to promote performance excellence, and the model has been widely adopted by a number of industries and sectors (Shamia *et al.*, 2018). AGILE is a term that refers to a supply chain management strategy that emphasizes flexible and adaptable processes as well as the ability to respond quickly to changing customer needs and market preferences. A key element of Agile is the close collaboration between suppliers and customers, the maintenance of a lean inventory, and the use of technology to quickly respond to changes in demand or disruptions in supply (Hämäläinen, 2019). Microsoft Dynamics 365, or simply D365, is a software suite that provides a comprehensive suite of business management tools. This software includes a wide range of programs for different types of business operations such as finance, sales, marketing, supply chain management, and human resources, among other things. A cloud-based software system developed by the company is designed to help organizations streamline their business operations and make informed decisions by using big data (Luszczak, 2019). In the field of enterprise resource planning (ERP) software, SAP is a software company that provides ERP software solutions for a wide range of industries, including the manufacturing one. In the context of data processing, SAP refers to Systems, Applications and Products in Data Processing. There are a variety of software solutions offered by companies such as it, including solutions for various business functions such as finance, supply chain management, human resources, and customer relationship management (Li *et al.*, 2019). SCS-CARGOWISE

is a cloud-based software platform designed specifically for freight forwarders and logistics service providers involved in the logistics and supply chain management industry. With this system, you can manage shipments, prepare documents, comply with customs regulations, manage finances, and report on your business intelligence in a number of different ways. There is an Australian company called WiseTech Global, which is a leading software company specializing in logistics technology, which developed and supports the platform (*What Is CargoWise*, 2015).

Ultimately, this data provides insight into the types of process improvement tools that are utilized in the pharmaceutical industry's supply chain and their relative frequencies. The results indicate that lean and Six sigma are the most commonly used tools for improving the performance of supply chains, as well as TQM and VSM as valuable tools for improving the performance of supply chains.

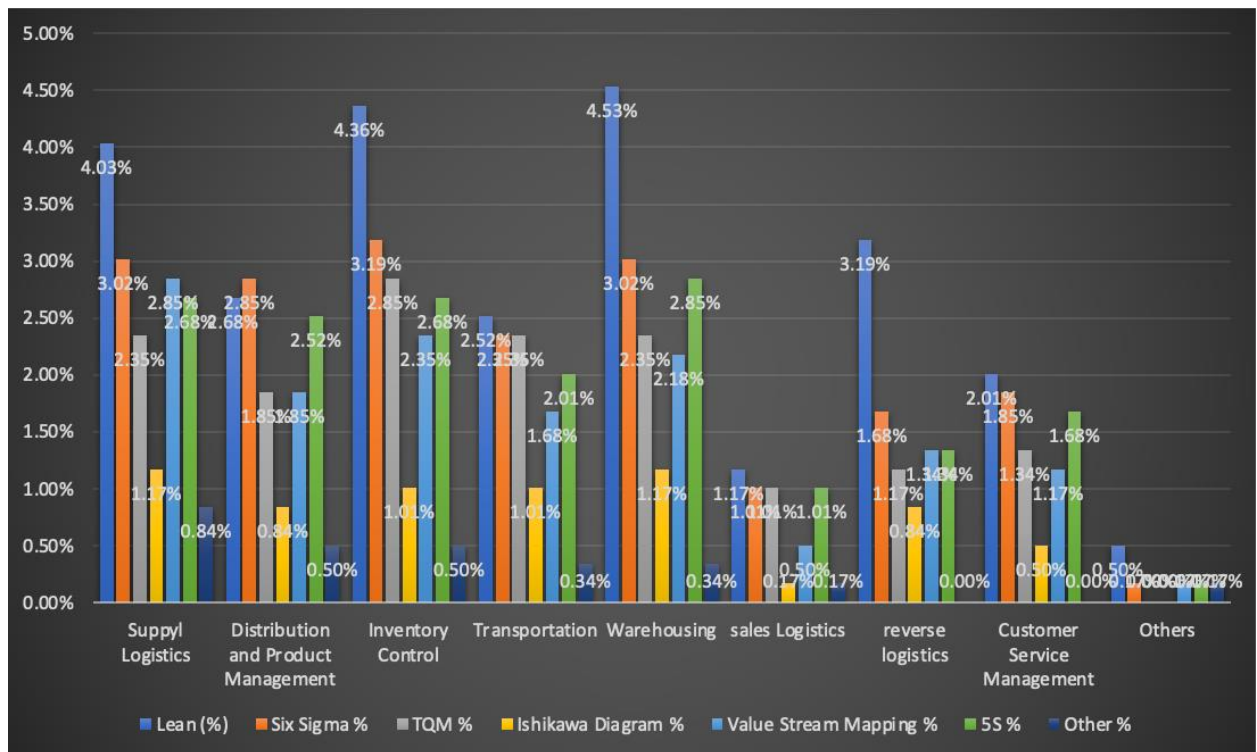
4.2.2 Would the process improvement tools and methodologies differ between the different types of logistic management?

Types of logistics Management	Lean	Six sigma	TQM	Ishikawa Diagram	Value Stream Mapping	5S	Others	Total
Supply Logistics	24	18	14	7	17	16	5	101
Distribution and Product Management	16	17	11	5	11	15	3	78
Inventory Control	26	19	17	6	14	16	3	101
Transportation	15	14	14	6	10	12	2	73
Warehousing	27	18	14	7	13	17	2	98
sales Logistics	7	6	6	1	3	6	1	30
reverse logistics	19	10	7	5	8	8	0	57
Customer Service Management	12	11	8	3	7	10	0	51
Others	3	1	0	0	1	1	1	7
Total	149	114	91	40	84	101	17	596

10 Table (a) 4.2.2: Participants report regarding the use of process improvement tools across different logistics management in pharmaceutical supply chains logistics management

Types of logistics Management	Lean (%)	Six Sigma %	TQM %	Ishikawa Diagram %	Value Stream Mapping %	5S %	Other %	Total %
Supply Logistics	4.03%	3.02%	2.35%	1.17%	2.85%	2.68%	0.84%	16.95%
Distribution and Product Management	2.68%	2.85%	1.85%	0.84%	1.85%	2.52%	0.50%	13.09%
Inventory Control	4.36%	3.19%	2.85%	1.01%	2.35%	2.68%	0.50%	16.95%
Transportation	2.52%	2.35%	2.35%	1.01%	1.68%	2.01%	0.34%	12.25%
Warehousing	4.53%	3.02%	2.35%	1.17%	2.18%	2.85%	0.34%	16.44%
sales Logistics	1.17%	1.01%	1.01%	0.17%	0.50%	1.01%	0.17%	5.03%
reverse logistics	3.19%	1.68%	1.17%	0.84%	1.34%	1.34%	0.00%	9.56%
Customer Service Management	2.01%	1.85%	1.34%	0.50%	1.17%	1.68%	0.00%	8.56%
Others	0.50%	0.17%	0.00%	0.00%	0.17%	0.17%	0.17%	1.17%
Total	25.00%	19.13%	15.27%	6.70%	14.09%	16.95%	2.85%	100.00%

11 Table (b) 4.2.2: Percentage distribution of Participants report regarding the use of process improvement tools across different logistics management in pharmaceutical supply chains logistics management



15 Figure 4.2.2: Cluster column graphs comparing logistics management tools across different pharmaceutical supply chains

From the data presented in 4.2.2 tables A and B, and based on the accompanying figure, it can be concluded that Lean is the most used process improvement tool in the pharmaceutical supply chain, with a usage percentage of 25%, based on the data presented in the tables. There are numerous applications of this tool in supply chain management, including supplier management, logistics, inventory control, transportation, warehousing, sales, reverse logistics, and customer service management. With a 19.13% usage rate, Six Sigma is the second most commonly used process improvement tool in the pharmaceutical supply chain after Lean. With the mostly used tool in distribution and product management. With a usage percentage of 16.95%, 5S is the third most popular process improvement tool. With a usage percentage of 15.27%, TQM is the fourth most commonly used process improvement tool. With a usage percentage of 14.09 %, Value Stream Mapping ranks fifth in the pharmaceutical supply chain as a tool for process improvement. Pharmaceutical supply chain management employs the Ishikawa diagram the least frequently, with a usage rate of 6.70%. There is a combined usage

percentage of 2.85% for other process improvement tools like APO, AGILE, D365, SCS-CARGOWISE, and SAP.

4.3 Analysis of Objective 2

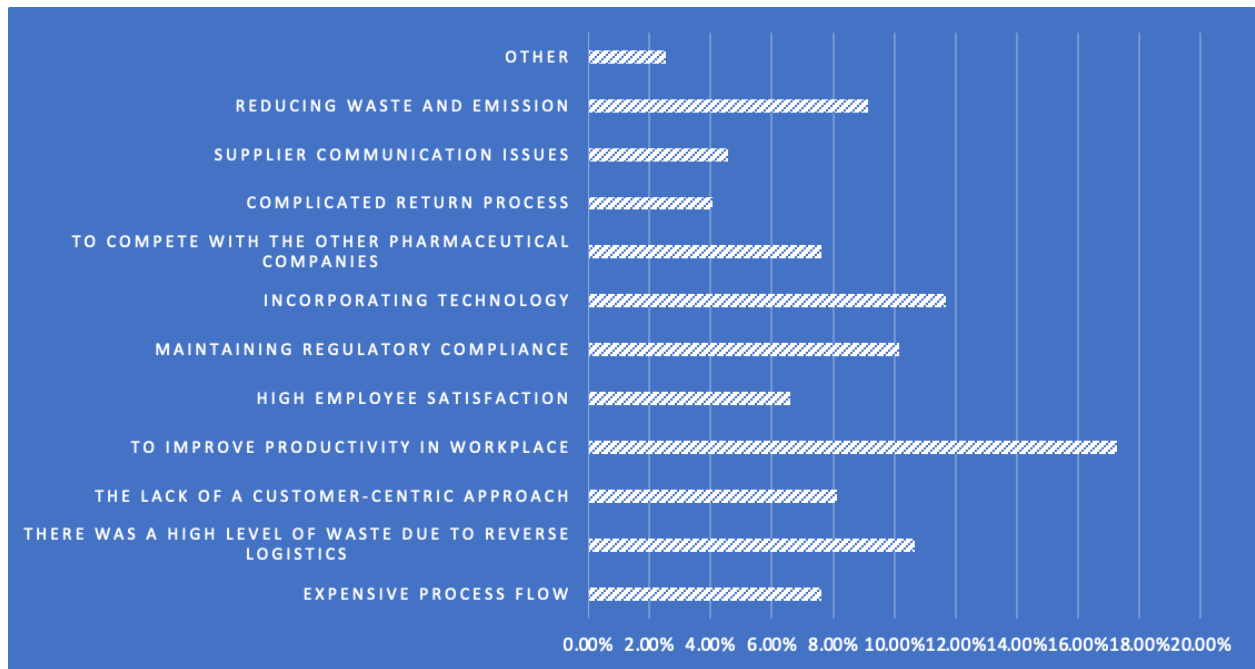
Identify pharmaceutical company's experience with the use of process improvement tools in their supply chain logistics management.

4.3.1 What are the reasons for the implementation of the process improvement tools into your workplace?

As part of supply chain logistics management, it is crucial to ask why a company is implementing process improvement tools. This provides insight into the specific challenges or issues an organization is trying to resolve. It can be helpful to determine which areas of the supply chain need improvement as well as which tools are best used to address these issues once we understand the motivations behind their implementation. It is also imperative to understand the rationale behind the implementation of process improvement tools, as it will ensure that everyone is working towards the same goals and objectives.

Reason to Implement the Process improvement tools	Frequency	Frequency (%)
Expensive process flow	15	7.61%
There was a high level of waste due to reverse logistics	21	10.66%
The lack of a customer-centric approach	16	8.12%
To Improve productivity in workplace	34	17.26%
High employee satisfaction	13	6.60%
Maintaining regulatory compliance	20	10.15%
Incorporating technology	23	11.68%
To compete with the other pharmaceutical companies	15	7.61%
Complicated return process	8	4.06%
Supplier communication issues	9	4.57%
Reducing waste and emission	18	9.14%
Other	5	2.54%
Total	197	100.00%

12 Table 4.3.1: participants response to the reasons for implementation of the Process Improvement Tools in the Supply Chain Logistics Management



16 Figure 4.3.1: Graph representation of participants response to the reasons for implementation of the Process Improvement Tools in the Supply Chain Logistics Management

Analyzing the reasons why 197 pharmaceutical industry participants implemented process improvement tools. Table 4.3.1 and figure 4.3.1 present the results, outlining the most common reasons why such tools are adopted. In the survey, 17.26% of participants stated that improving productivity in the workplace was their primary reason for participating. Supply chain management aims to optimize resource utilization and reduce task completion time. In addition, 10.68% of respondents indicated that technology was key to adopting process improvement tools in their supply chain. The pharmaceutical supply chain management process could be streamlined to improve efficiency and streamline operations. The participants agreed that reverse logistics was another area where process improvement tools were necessary, with 10.66% saying the primary purpose was to reduce supply chain waste. 10.15% of respondents said maintaining regulatory compliance was one of the most important reasons for implementing process improvement tools. Accordingly, regulatory compliance is necessary in the pharmaceutical supply chain. In addition, implementing process improvement tools improved customer-centricity and reduced waste and emissions, respectively, with 8.12% and 9.14% of participants citing these reasons. According to the study, pharmaceutical companies

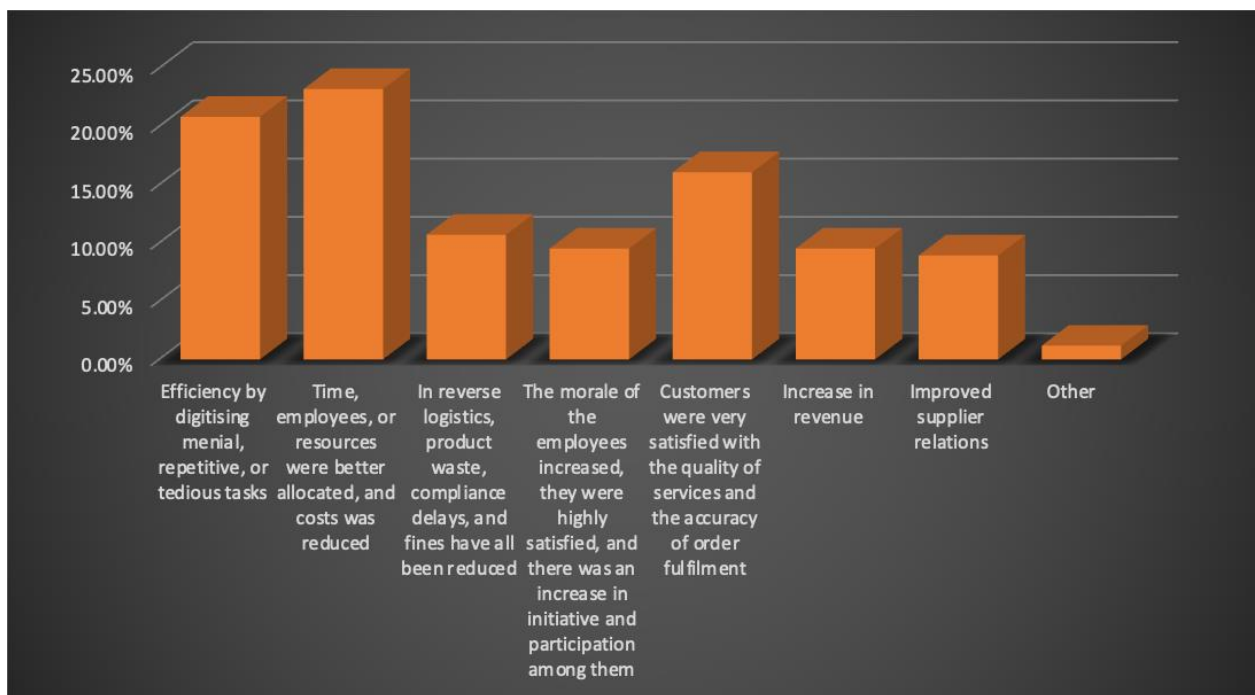
should prioritize environmental concerns and customer satisfaction when implementing process improvement tools. With a response rate less than 5%, increased employee satisfaction, communication issues, and improving supply were other reasons to implement process improvement tools.

4.3.2 How did pharmaceutical companies improve their supply chain logistic management by using process improvement tools?

Pharmaceutical companies should evaluate how process improvement tools improved their supply chain logistics management in order to gain a clearer understanding of the specific benefits and outcomes their use produced. Using these tools to manage supply chain logistics can improve the efficiency and return on investment of other companies in the industry. Identifying the best practices for successful adoption and integration of process improvement tools can also benefit other companies by understanding how the tools were implemented and what challenges were encountered during implementation. Ultimately, this question can help other companies in the pharmaceutical industry better understand how process improvement tools impact pharmaceutical supply chain logistics management and help them make better decisions.

Improvements observed	Frequency	Frequency (%)
Efficiency by digitising menial, repetitive, or tedious tasks	35	20.83%
Time, employees, or resources were better allocated, and costs was reduced	39	23.21%
In reverse logistics, product waste, compliance delays, and fines have all been reduced	18	10.71%
The morale of the employees increased, they were highly satisfied, and there was an increase in initiative and participation among them	16	9.52%
Customers were very satisfied with the quality of services and the accuracy of order fulfilment	27	16.07%
Increase in revenue	16	9.52%
Improved supplier relations	15	8.93%
Other	2	1.19%
Total	168	100.00%

13 Table 4.3.2: Distribution of the participants response regarding observed improvements in their workplace after the adoption of the Process Improvement Tools



17 Figure 4.3.2: The bar chart representing the distribution of the participants response regarding observed improvements in their workplace after the adoption of the Process Improvement Tools

Table 4.3.2 and Figure 4.3.2 provide valuable insights into how participants responded to improvements in the pharmaceutical supply chain after implementing process improvement tools. Of the total responses, 23.21% mentioned better resource allocation and cost reduction as the most significant benefits. Results from this study suggest that process improvement tools have optimized resource allocation, resulting in cost savings. 20.83% of the total response is related to automation of menial, repetitive, or tedious tasks, resulting in increased efficiency. Supply chain productivity and efficiency have increased as a result of automation and streamlining using process improvement tools. The responses from participants also indicate that after implementing process improvement tools, customers are more satisfied with the quality of service and accuracy of orders for fulfillment. A total of 16.07 percent of the response is in support of process improvement tools improving customer satisfaction. Additionally, 10.71% of the total responses were related to reducing product compliance delays and fines and improving reverse logistics. Reverse logistics management has improved with the help of process improvement tools, resulting in a reduction in fines. 9.52% of respondents reported an increase in employee morale, satisfaction, and initiative, simultaneously increasing revenue, while 8.93% reported an improvement in supplier relationships.

4.4 Analysis of Objective 3

Analyze the use of reverse logistics management in pharmaceutical supply chains during withdrawals.

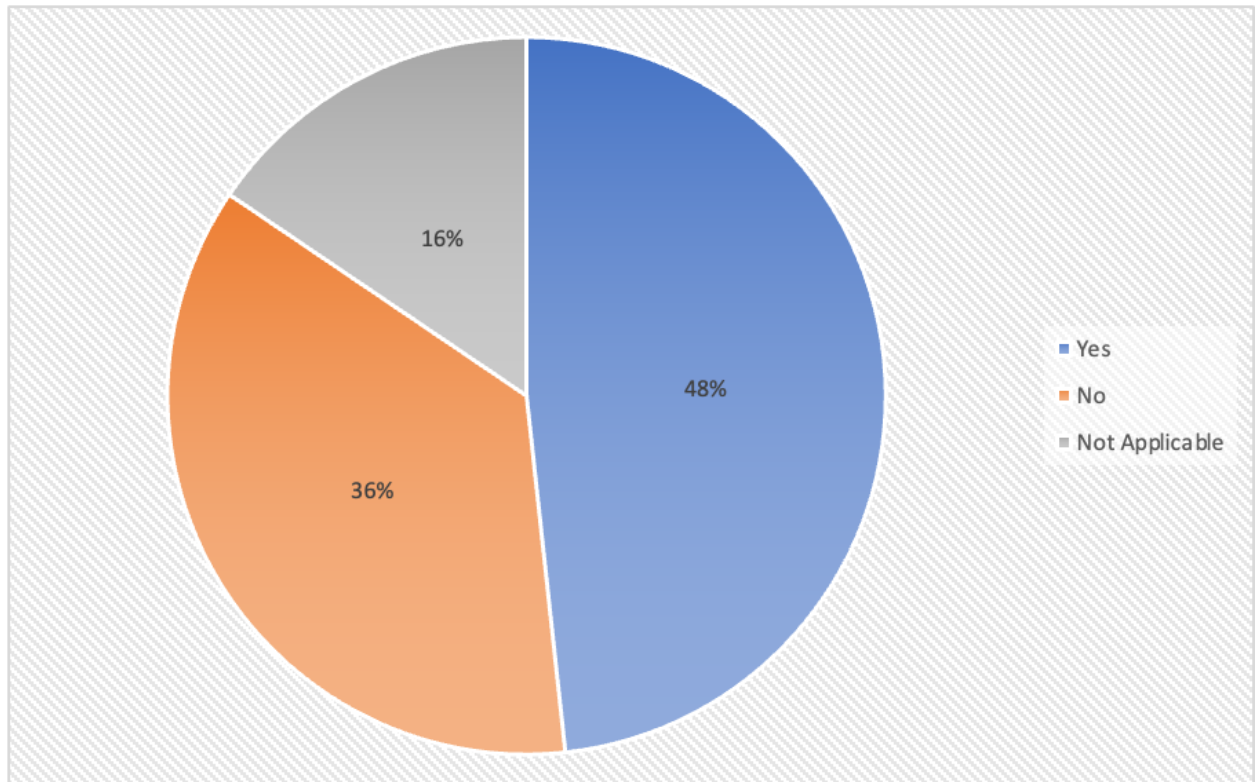
As a process, reverse logistics involves the flow of goods and materials back to the point of origin for the purpose of recovering value or properly disposing of them. In other words, it involves managing the flow of goods and materials from their final destinations to their origins in order to recoup value, minimize waste, and minimize the impact on the environment (Li and Olorunniwo, 2008). In addition to reducing waste, it promotes reuse and recycling of materials, which reduces companies' environmental impact. As a result of reverse logistics, organizations can also optimize the flow of items and reduce inventory levels, thereby improving their supply chain efficiency. By providing more reliable and faster exchanges and returns for products, reverse logistics can also increase customer satisfaction (Ahsan et al., 2022).

4.4.1 Are you using reverse logistics management in your pharmaceutical supply chain?

An important aspect of supply chain logistics management is to ask a pharmaceutical company whether it uses reverse logistics management for product returns, recalls, and waste management. It includes activities such as returns, repair, and recycling as well as managing the flow of products back to their origin point. As a result of stringent regulations around product safety and disposal in the pharmaceutical industry, this is of particular importance. Ultimately, logistics employees can learn how the company manages its supply chain sustainability and complies with regulatory requirements by asking this question. A supply chain management process can also be improved through the analysis of potential improvement areas.

Reverse Logistics Adoption		
	Frequency	Frequency (%)
Yes	28	48.28%
No	21	36.21%
Not Applicable	9	15.52%
Total	58	100.00%

14 Table 4.4.1: participants response regarding the use of the reverse logistics in their Supply Chain Management



18 Figure 4.4.1: A pie chart representation of the distribution of the participants response regarding the use of reverse logistics in their Supply Chain Managements

According to the table and the figure 4.4.1, among the respondents to a survey carried out on reverse logistics management in pharmaceutical supply chain management, it was found that 48% of respondents confirmed that their supply chain management used reverse logistics as part of their supply chain management process. However, 36% of those surveyed answered negatively, indicating that they don't use reverse logistics as part of their pharmaceutical supply chain in order to reduce costs. Moreover, 16% of respondents indicated that the question was not applicable to them, which also gives insufficient details.

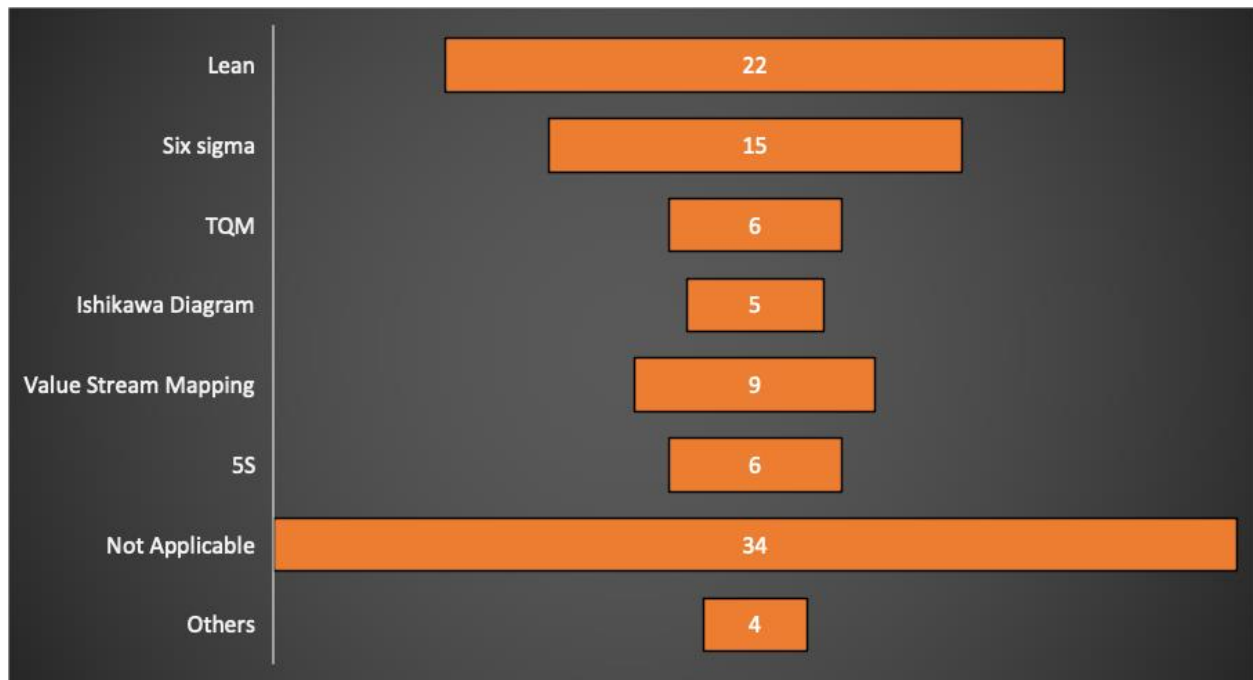
4.4.2 What types of the Process Improvement Tools are mostly used for the Reverse Logistics in your workplace?

When you are looking for the most effective methods to improve efficiency and sustainability in a pharmaceutical supply chain, you should ask about the specific process improvement tools that are used for reverse logistics. Decisions about future improvements to the supply chain

can be made based on this information, which can reduce waste and improve resource management. As a result, it can help other companies improve their own reverse logistics operations by providing insights into best practices. To optimize the supply chain and improve sustainability, it is important to understand how process improvement tools are used in reverse logistics.

Process Improvement tools used for Reverse logistics		
Process Improvement tools	Frequency	Frequency (%)
Lean	18	21.95%
Six sigma	12	14.63%
TQM	5	6.10%
Ishikawa Diagram	4	4.88%
Value Stream Mapping	7	8.54%
5S	5	6.10%
Not Applicable	28	34.15%
Others	3	3.66%
Total	82	100.00%

15 Table 4.4.2: The participants' response regarding the use of the different process improvement tools in reverse logistics



19 Figure 4.4.2: Funnel chart representation of the participant's response regarding the use of the different process improvement tools in reverse logistics

Table and figure 4.4.2 show that the majority of respondents answered "not applicable" to the question about the most commonly used tools for pharmaceutical supply chain reverse logistics management. The absence of evidence may be due to a lack of familiarity with the tools or it may be due to the participants not having implemented reverse logistics management in their pharmaceutical supply chain. However, there is not enough evidence to support the claim. As a result, a part of the reverse logistics management process improvement tool that was the most commonly used by those who did respond was lean, with a percentage of 21.95%, found to be the most commonly used process improvement tool. The principle of Lean is that all waste and inefficiencies in a system should be eliminated or minimized in an effort to improve efficiency. With a percentage of 14.63 percent, Six Sigma was second in terms of the most commonly used process improvement tool. As a result of its data-driven approach, Six Sigma aims to minimize defects in processes. Following these two major tool types, Value Stream Mapping was found to be the tool that was most commonly used with a percentage of 8.54%. In order to reduce waste and improve efficiency in a process, this tool helps to identify the value-added and non-value-added activities in the process. A total of 6.10 percent of respondents used Total

Quality Management and 5S in reverse logistics management, indicating that both of these tools are also used in the pharmaceutical supply chain for reverse logistics management as well. In addition to this, other forms of process improvements were also reported, with a percentage of 3.66%.

4.5 Analysis of Objective 4

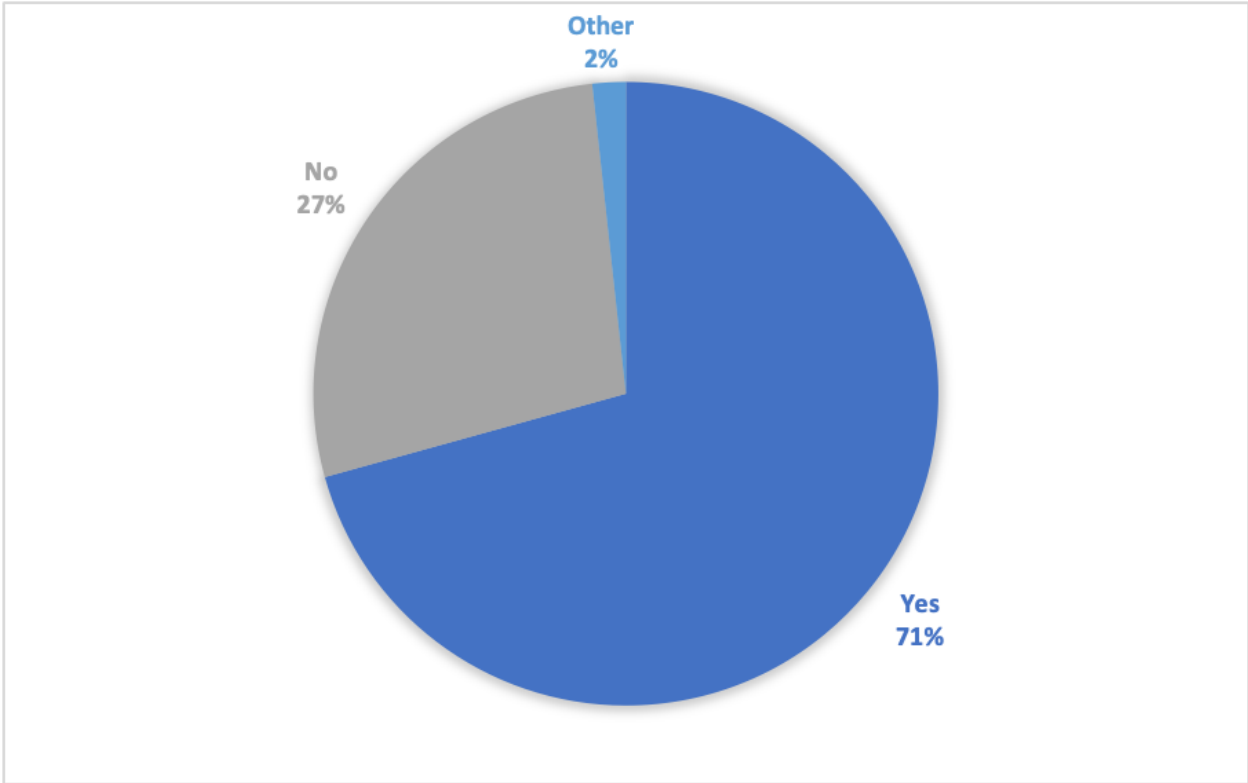
Investigate the outsourcing supply chain logistics from other external services. Use of third parties and fourth parties.

It can be advantageous for companies to outsource their logistics to third parties and fourth parties. It can reduce logistics costs, such as those associated with transportation and warehousing, while also allowing companies to focus on their core competencies. Companies can improve their logistics operations' efficiency and effectiveness by using third-party and fourth-party logistics providers who often have different knowledge and expertise than those in-house. As a result of outsourcing, companies can more easily adjust logistics operations to meet changing market conditions and demand, allowing them to adjust to changes in demand (Gautam *et al.*, 2019). Fourth-party logistics have some risks, including the lack of control over the logistics process, the possibility of communication breakdowns between the outsourcing company and the fourth-party logistics provider, as well as the possibility of the fourth-party logistics provider gaining access to the outsourcing company's intellectual property (Huang *et al.*, 2019).

4.5.1 Have you outsourced your logistics from other external services?

Responses	Frequency	Frequency (%)
Yes	41	70.69%
No	16	27.59%
Other	1	1.72%
Total	58	100.00%

16 Table 4.5.1: A report of the participants' responses to outsourcing logistics services to external provider in the pharmaceutical industry



20 *Figure 4.5.1: Pie chart representations of the participants' responses regarding on the outsourcing supply chain logistics services to external providers in the pharmaceutical industry*

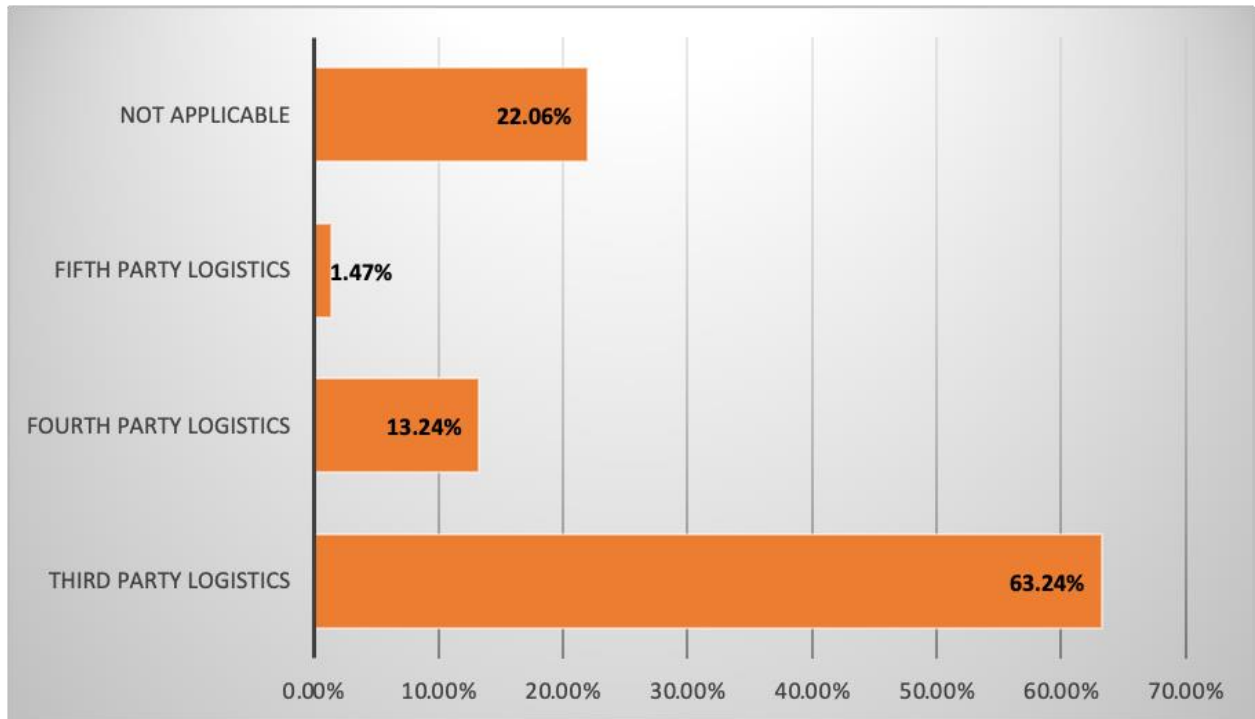
Based on the results presented in the table and figure 4.5.1, the majority of the participants indicated that they have outsourced their logistics service to an external provider, with a response rate of 70.69% indicating that they have done so. This suggests that pharmaceutical supply chain firms are commonly adopting the practice of outsourcing logistics as a way to boost efficiency. A total of 27.59% of respondents responded with "No", indicating that they do not outsource their logistics services to outside agencies. In addition, 1.72% of respondents answered "Others", the respondent works as an external party but because there is not enough information available to draw any conclusions from this response, it can be excluded from further analysis since there is insufficient data available to do so.

4.5.2 Which external logistics service(s) are being used as part of your supply chain logistics system management?

In order to determine how much outsourcing is taking place in the company's logistics operations, it is important to ask what external logistics services are being used. Making strategic decisions based on this information can be as simple as evaluating the current logistics system and selecting the most appropriate logistics service provider. Logistics employees can also use this information to better understand the roles and responsibilities of external logistics service providers in a company's supply chain logistics management system.

External Logistics Service Providers	Frequency	Frequency (%)
Third Party Logistics	43	63.24%
Fourth Party Logistics	9	13.24%
Fifth Party Logistics	1	1.47%
Not Applicable	15	22.06%
Total	68	100.00%

17 Table 4.5.2: Participants' response regarding the use of External Supply Chain Logistics Service Providers



21 Figure 4.5.2: Graph representations of the participants' response regarding the use of the External Logistics Service Providers

Based on the results from the table and figure 4.5.2 above, a majority of the participants (63.24%) reported that they use third-party logistics as an external logistics service provider for the management of their pharmaceutical supply chain. Third-party logistics providers are commonly used in many industries due to the benefits they provide, such as cost savings, expertise, and flexibility. Alternatively, 22.06 % of the participants chose "not applicable," therefore indicating that there was insufficient data to draw any conclusions based on the data submitted. Further analysis cannot be performed on this result due to its inapplicability. A lack of data can be attributed to various reasons, some of which are unclear and may need to be explored in future research in order to understand why this may be the case. 13.24% of the participants reported that they had used fourth-party logistics providers, which is a smaller percentage. In addition to managing multiple logistics service providers, such as third-party logistics providers, fourth-party logistics (4PL) providers offer more comprehensive solutions for supply chain management. In addition, only 1.47% of the respondents reported that they

used fifth-party logistics providers in their business process. Essentially, 5PLs (fourth-party logistics) are a network of integrators or coordinators that make up a supply chain that provides end-to-end supply chain solutions. The integrator, also known as a 5PL, aims to provide a one-stop shop for clients and manage the relationships between 4PLs. Five-party logistics (FPL) outsourcing can provide pharmaceutical companies with increased visibility and control over their supply chains, as well as cost reductions and better risk management. A 5PL outsourcing arrangement, however, can result in the loss of direct control over the supply chain, communication breakdowns, and intellectual property and data security problems (Hosie *et al.*, 2012). In the world of supply chain management, 5PL suppliers are relatively new to the market and offer networked and technology-based solutions that are geared towards supply chain management. Some participants seem to be using a combination of third party logistics providers, such as a third party logistics provider (3PL), a fourth party logistics provider (4PL), and a fifth party logistics provider (5PL).

4.6 Analysis of Objective 5

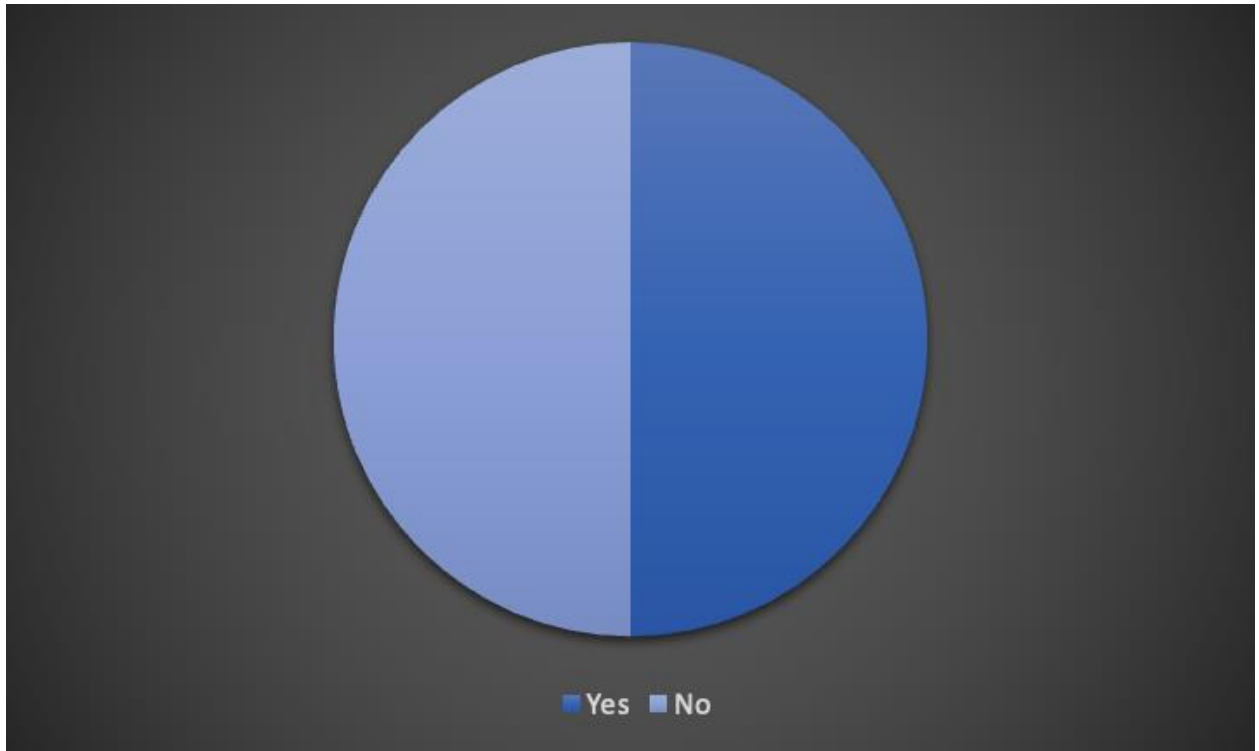
Identify Pharmaceutical companies that do supply chain distribution domestically and internationally: Comparison of tools.

In determining the logistics strategy that a pharmaceutical company will use, it is important to identify whether it will distribute products domestically or internationally. In contrast to companies who distribute internationally, companies who distribute domestically have different logistics requirements (El Mokrini *et al.*, 2015). Various regulations may apply to international distribution, and items may be shipped over longer distances. It is important for logistics employees to know whether a company distributes domestically or internationally so they can tailor their operations and processes to match the company's distribution needs and challenges. Additionally, it can identify opportunities for improving logistics operations as well as potential risks

4.6.1 Did the company outsource Internationally as part of their process improvement?

Responses	Frequency	Frequency (%)
Yes	29	50%
No	29	50%
Total	58	100.00%

18 Table 4.6.1: The report of the participants' responses on international outsourcing for process improvement



22 *Figure 4.6.1: A pie chart of participants' responses to improving processes through international outsourcing*

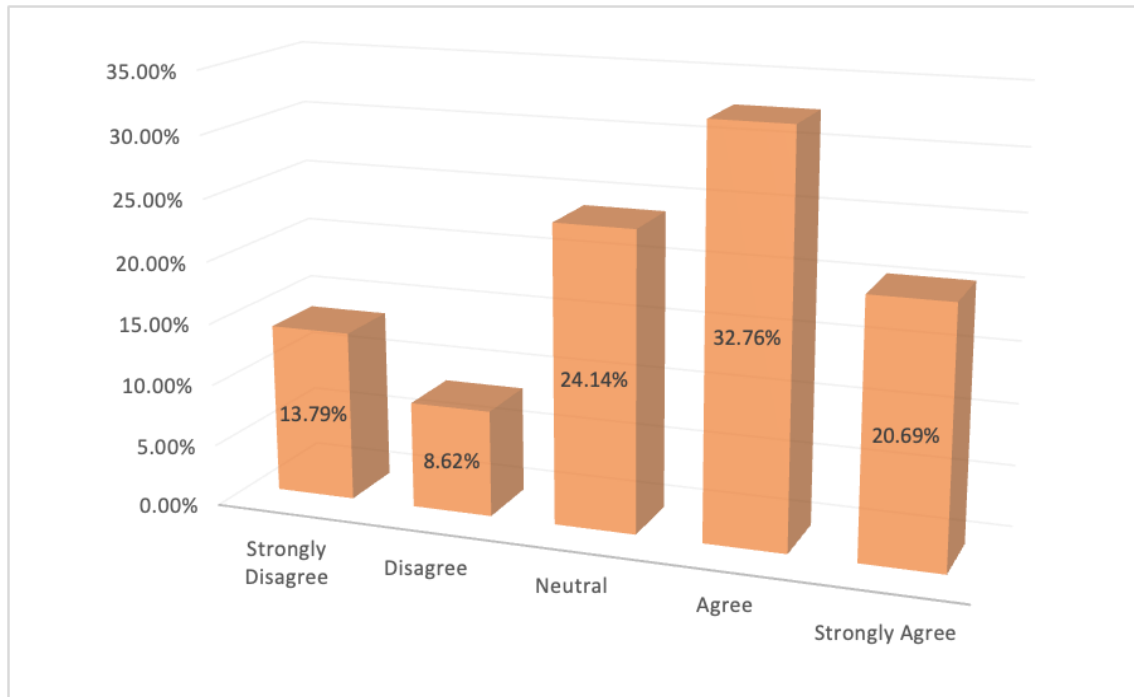
According to the results obtained by the participants, we can observe from the table and figure 4.6.1 that 50% of the participants agreed with the notion that their supply chain is be outsourced internationally as part of their adpotion on process improvement tool, while the remaining 50% disagreed with the notion of outsourcing their supply chain internationally.

4.6.2 Do you agree with the statement that the geographical location of the country affect the performance of supply chain logistics?

As geographical location of a country has a considerable impact on the performance of supply chain logistics, this question is important for supply chain logistics managers. An infrastructure such as a country's transportation network can affect the time and cost of transporting goods, which can affect the supply chain logistics' overall efficiency and effectiveness. It is thus necessary to understand how geography impacts supply chain logistics to be able to identify potential challenges and opportunities, as well as develop strategies in order to optimize the performance of supply chain logistics.

Responses	Frequency	Frequency (%)
Strongly Disagree	8	13.79%
Disagree	5	8.62%
Neutral	14	24.14%
Agree	19	32.76%
Strongly Agree	12	20.69%
Total	58	100.00%

19 Table 4.6.2: participants' opinions regarding correlation between outsourcing supply chain logistics internationally and improved performance



23 *Figure 4.6.2: Distribution of participants' opinions on regarding correlation between outsourcing supply chain logistics internationally and improvement in process performance*

As shown in Table 4.6.2 and Figure 4.6.2, according to the results of the survey, the majority of the participants agreed that the geographical location of a country plays a significant role in the performance of supply chain logistics, with a response rate of 32.76 %. Moreover, there were 24.14 % of participants that were neutral regarding the statement, which indicates that neither they were in agreement nor disagree with it in any way. Interesting to note, the statement was strongly agreed by a significant percentage of the participants (20.69%), indicating that a large portion of the participants are of the opinion that a country's geographical location significantly affects the performance of its supply chain. In contrast, 13.79% of the participants strongly disagreed with the statement, indicating that their opinion is that the geographical location of the country doesn't have a major impact on the performance of supply chain logistics. The statement was disagreed with by 8.62% of the participants, so it's worth noting. The results of this study suggest that some participants believe that factors other than geography play a major role in influencing the performance of supply chain logistics in a greater way than geographical location. According to the responses to this question, overall,

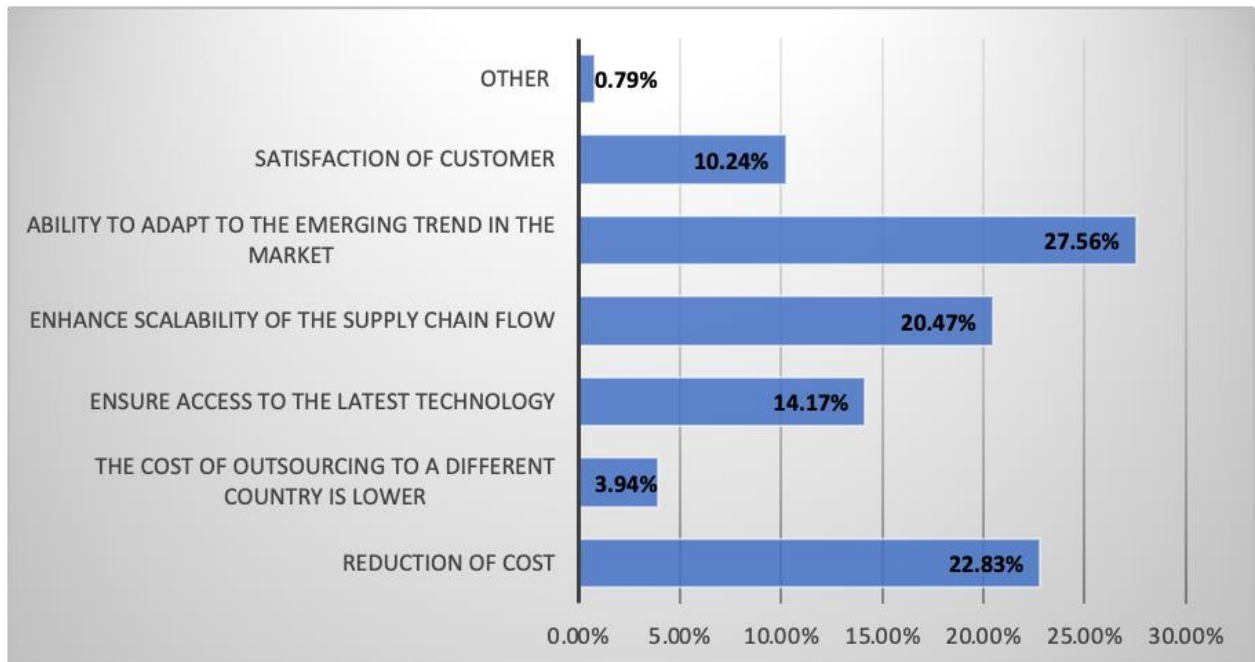
the responses to this question suggest that there is a range of opinions among participants regarding how geographical location affects the performance of supply chain logistics in terms of its efficiency.

4.6.3 What are the reasons for the outsourcing of the supply chain Logistics internationally?

In logistics management and for logistics employees, asking about the reasons for outsourcing supply chain logistics internationally can help them better understand the advantages and risks of this strategy. Additionally, it can provide insight into how decisions are made regarding outsourcing, as well as influencing factors when choosing international logistics service providers. Understanding these reasons can help companies develop effective strategies for managing their global supply chain networks and make informed decisions regarding outsourcing logistics.

Reasons	Frequency	Frequency (%)
Reduction of cost	29	22.83%
The cost of outsourcing to a different country is lower	5	3.94%
Ensure access to the latest technology	18	14.17%
Enhance scalability of the supply chain flow	26	20.47%
Ability to adapt to the emerging trend in the market	35	27.56%
Satisfaction of customer	13	10.24%
Other	1	0.79%
Total	127	100.00%

20 Table 4.6.3: participants' responses regarding the reasons for outsourcing supply chain logistics internationally



24 Figure 4.6.3: Distribution of participants' responses regarding the reasons for outsourcing supply chain logistics internationally

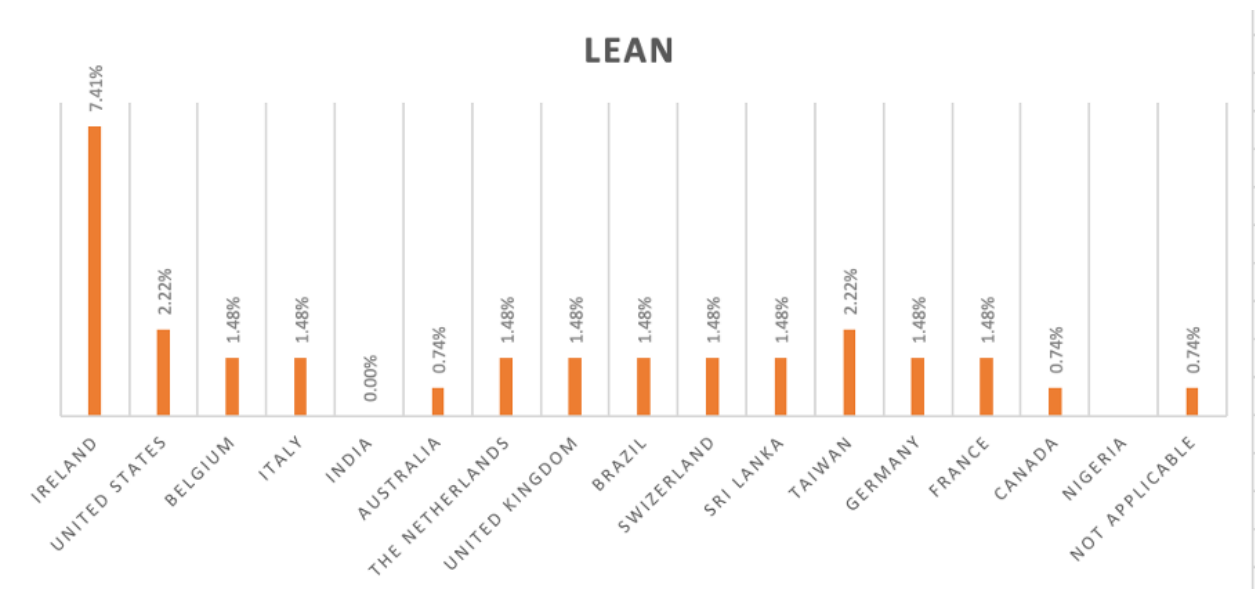
As shown in section 4.6.3, companies outsource their supply chain logistics internationally for a number of reasons. Among the respondents, 27.56% agreed that outsourcing makes it easier to adapt to emerging trends in the market. Companies may be able to stay current with the latest market trends and remain competitive by outsourcing to international providers, since they can access technology and innovations that aren't available in their home country. Secondly, 22.83% of participants agreed that outsourcing supply chain logistics internationally would reduce costs. It is possible for companies to reduce their operational costs and increase their profits by outsourcing to countries with lower labor and manufacturing costs. 20.47% of the participants agreed that scalability is another important reason for outsourcing supply chain logistics internationally. The outsourcing of supply chain operations and market entry can enable companies to expand without having to add new infrastructure and resources. Additionally, 14.17 percent of participants agreed that outsourcing enabled them to access the

latest technology. Companies can improve their supply chain operations by utilizing new technologies and innovations. Outsourcing supply chain logistics internationally does not increase customer satisfaction according to 10.24% of participants. Despite the benefits of outsourcing, it can also present new challenges such as language barriers and cultural differences, which can adversely affect customer experiences. There are a variety of reasons why companies outsource supply chain logistics internationally, depending on their specific goals and needs.

4.6.4 Is there a connection between some tools performing better than others based on their geographical location?

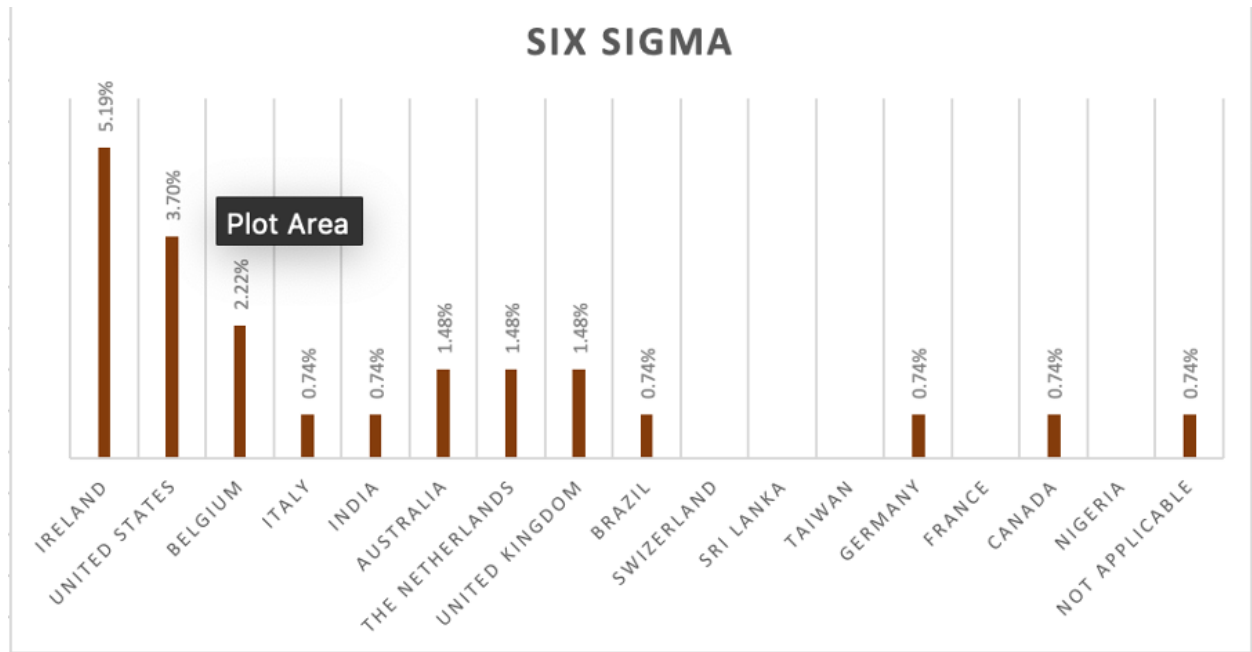
Identifying regional differences in the effectiveness of different tools for supply chain logistics management can be possible by asking this question to supply chain logistics managers and logistics employees. In a specific region, this data may be used to optimize logistics operations to save money, improve efficiency, and serve customers better. Furthermore, it can assist in identifying any unique challenges that certain regions face when it comes to logistics operations and developing solutions for those challenges.

Survey responses were collected from 58 subjects across 17 countries on tools for improving supply chain logistics. Multiple tools were reported by some participants as being used in process improvement. Using responses from all participants, the table below presents a comprehensive view of their usage of each tool which have been tallied up.



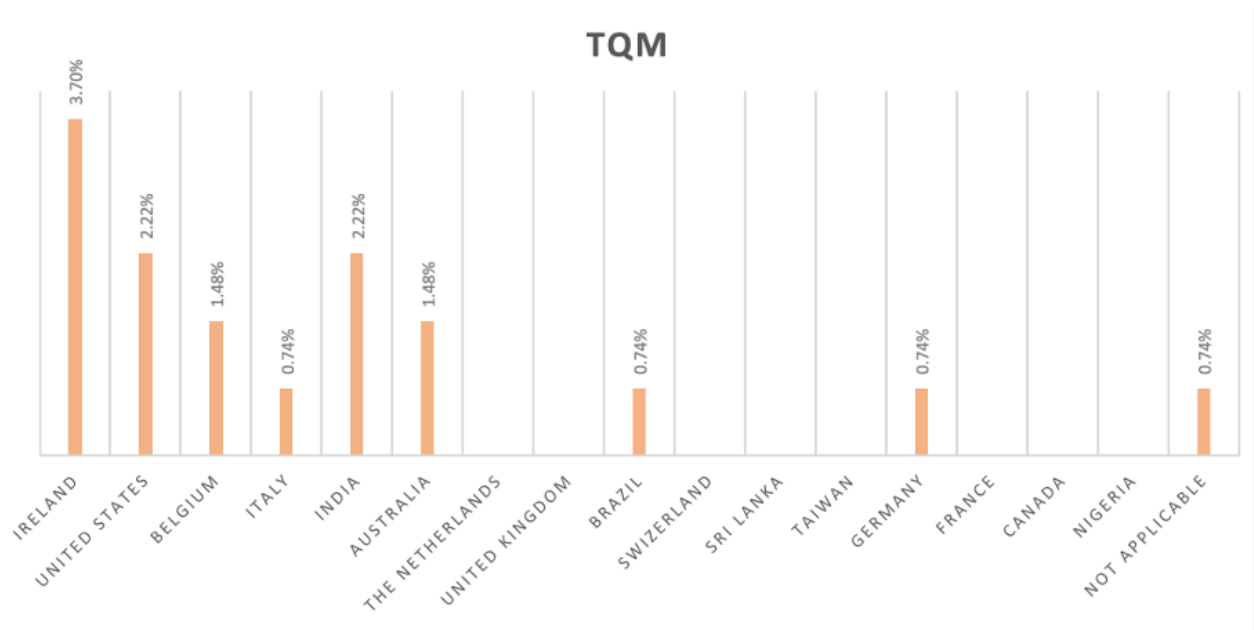
25 Figure (a) 4.6.4: 2-D column graph of the Lean distribution around the world

Figure 4.6.4 (a) reveals that Ireland is the country with the highest percentage of usage of Lean methodology, accounting for 7.41%. A usage volume of 2.2% is recorded by the United States and Taiwan. Belgian, Italian, Netherlands, United Kingdom, Brazil, Swiss, Sri Lanka, Germany, and France are the next countries with the highest interest in Lean. The Lean usage volume in Australia and Canada is 0.74%.



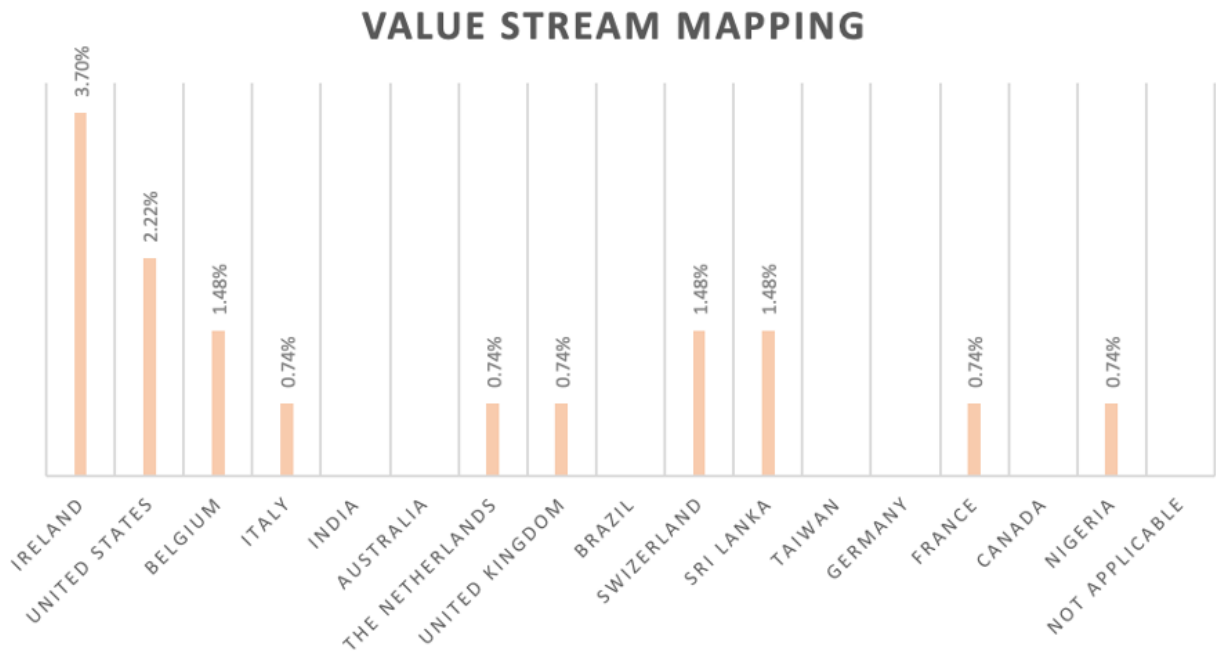
26 Figure (b) 4.6.4: 2-D column graph of the Six Sigma distribution around the world

As shown in figure 4.6.4(b), Six Sigma is most frequently used in Ireland at 5.19%, followed by the United States at 3.7% and Belgium at 2.22%. As the percentages of users decrease, Australia, the Netherlands, and the United Kingdom have 1.48%, and Italy, India, Brazil, Germany, and Canada have 0.74%.



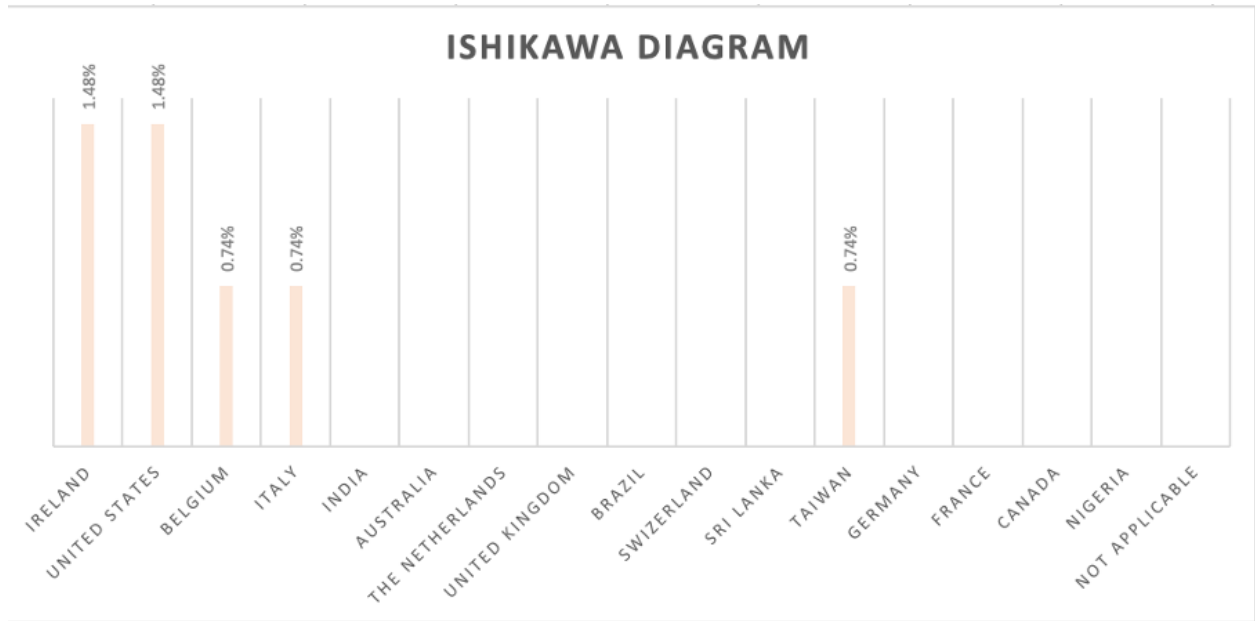
27 Figure (c) 4.6.4: 2-D column graph of the TQM distribution around the world

According to figures, 4.6.4 (c) TQM is mostly used in Ireland at 3.7%, United States and India at 2.22% following that is Belgium and Australia at 1.48%, and lastly, Italy, Brazil, Germany, add 0.74%.



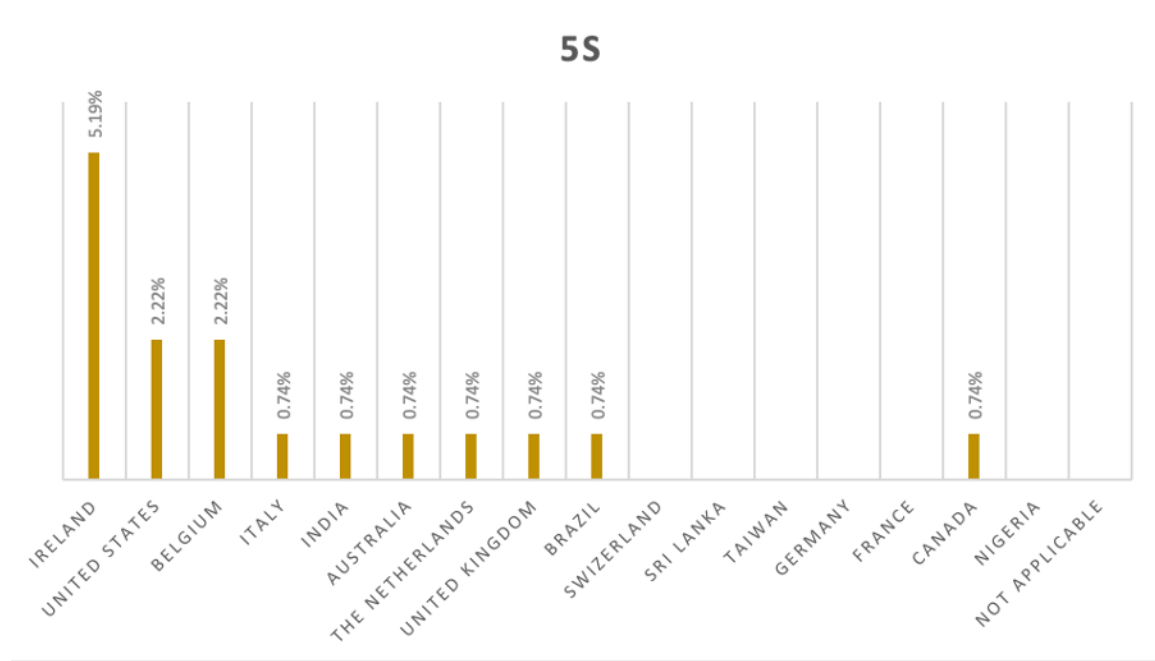
28 Figure (d) 4.6.4: 2-D column graph of the VMS distribution around the world

According to section 4.6.4 (d), VSM is most commonly used in Ireland, accounting for 3.7%, followed by the United States at 2.22% and India at 2.22%. Following Belgium, Australia, and Germany with 1.48% usage rates each, Italy, Brazil, and Germany with 0.74%.



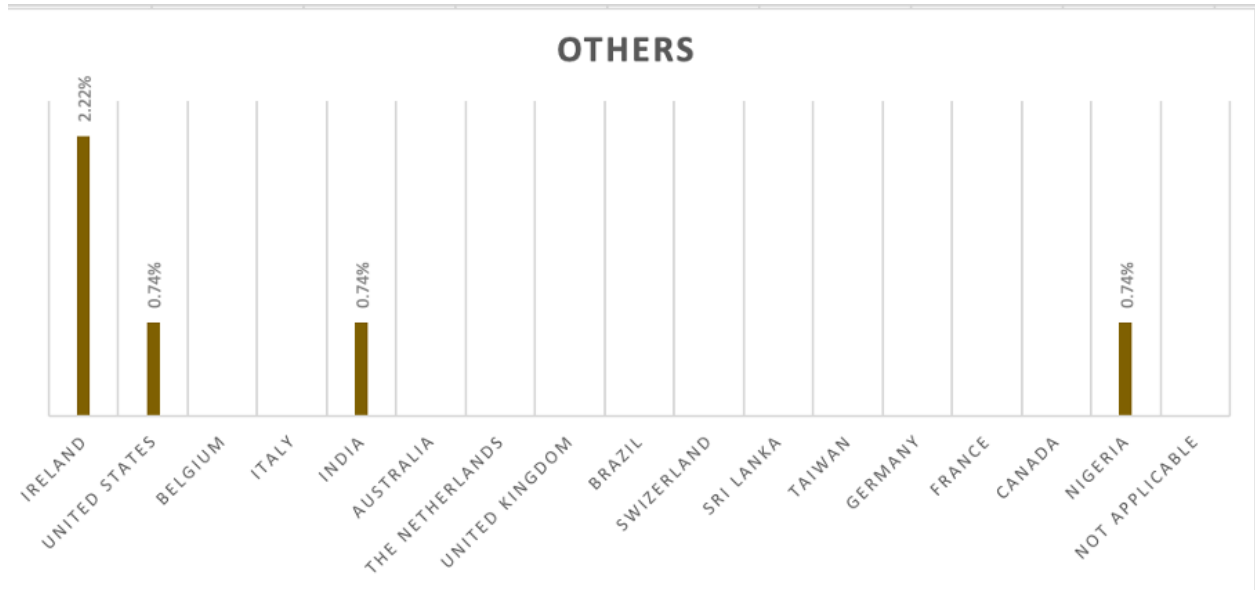
29 Figure (d) 4.6.4: 2-D column graph of the Ishikawa Diagram distribution around the world

According to Figure 4.6.4 (d), the Ishikawa diagram is most commonly used in Ireland and the United States, where it accounts for 1.48%, followed closely by Belgium, Italy, and Taiwan with 0.74%.



30 Figure (e) 4.6.4: 2-D column graph of the 5S distribution around the world

Figure 4.6.4 (e) shows that the 5S methodology is predominantly used in Ireland with 5.19%, followed by the United States and Belgium at 2.22%. Italy, India, Australia, The Netherlands, United Kingdom, Brazil and Canada each contribute 0.74% to the total usage.



31 Figure (f) 4.6.4: 2-D column graph of the Others distribution around the world

Based on figure 4.6.4 (f) In terms of APO, AGILE, D365, SCS-CARGOWISE, and SAP, Ireland has the highest usage rate at 2.22%, while the United States, India, and Nigeria have usage rates of 0.74% each

Based on the data in Section 4.6.4, it appears that lean has been the most commonly used process improvement tool worldwide, with a usage rate of 27.41%, followed by Six Sigma with a usage rate of 20.00%, and 5S with a usage rate of 14.81%. Among process improvement tools, TQM and Value Stream Mapping are both used 14.07%, while the Ishikawa diagram is only used 5.19%. The combined usage rate of APO, AGILE, D365, SCS-CARGOWISE, and SAP is 4.44%.

Additionally, the data shows that process improvement tools are used differently in different countries. Ireland uses Lean process improvement tools the most (7.41%), whereas the United States uses Six Sigma the most (3.70%). In Belgium, Six Sigma and 5S are the most commonly used process improvement tools, while in Italy, Lean is the most commonly used tool. With 2.22% of the total tool usage in India, TQM is the most commonly used tool. According to the Australian data on Six Sigma, TQM and Lean, both of which are employed at a rate of 1.48%,

followed by Lean and 5S at 0.74% each. Both Lean and Six Sigma are the most commonly used tools in both the Netherlands and the United Kingdom, with the two tools being used at 1.48% each, followed by Value Stream Mapping and 5S at 0.74% each. In Brazil, the Lean method appears to be the most common tool used (8.97%), followed by Six Sigma (0.74%) and 5S (8.24%). Among the process improvement tools being used in Switzerland and Sri Lanka, only Lean and Value Stream Mapping are being used at a rate of 1.48 percent each. Taiwan has the highest prevalence of Lean at 22.1%, followed by Germany and France with 1.48% and 0.74 %, respectively. The most commonly used process improvement tools in Canada are lean, six sigma, and 5S, all three at 0.74%. In Nigeria, Value Stream mapping and other tools are used by 0.74% of respondents to improve processes.

Chapter 5

Discussion and Conclusion

5.1 Discussion

5.1.1 Assessment of the process improvement tools in supply chain logistic management and their performance in pharmaceutical companies

The purpose of this paper is to present an overview of how process improvement tools can be used to improve the pharmaceutical supply chain. According to the study, Lean is the most common tool used in the process improvement industry, with a usage rate of 24.5%, followed by Six Sigma at 17.88% , which shows that Lean and Six sigma are.5S in contrast is used more widely, the 5S methodology, an organization can improve their efficiency and organization on the job by using visual management tools that are based on a structured approach. Furthermore, it should also be noted that Total Quality Management (TQM) and Value Stream Mapping (VSM) are also valuable tools for improving the performance of supply chains, as they can significantly reduce the amount of waste produced. With an average usage rate of 15.27%, TQM can be considered a comprehensive approach to management that is aimed at improving the quality of products and services by focusing on customer satisfaction in order to achieve company goals. In terms of its use rate, VSM is utilized by 14.09% of companies and can be used to map out the value stream of a process so as to identify waste in the process and opportunities for improvement. Furthermore, according to the analysis, the Ishikawa diagram shows a usage rate of only 6.70 percent, which makes it the least frequently used tool for process improvement. By mapping out the potential causes of the problem, this tool is used to identify the root cause of a problem and determine what is at the core of it all. In addition, the analysis also pointed out that other process improvement tools, such as APO, AGILE, D365, SCS-CARGOWISE, and SAP, which had a combined usage rate of 2.85%, can also be considered to be used in process improvement. In spite of the fact that these tools are not as widely used as the other tools mentioned above for process improvement, they are still useful in the improvement of supply chain efficiency.

5.1.2 Identify pharmaceutical company's experience with the use of process improvement tools in their supply chain logistics management.

It has become increasingly common for pharmaceutical companies to use process improvement tools in their supply chain logistics management. The goal is to optimize resource allocation, reduce task completion times, as well as improve overall efficiency by using these tools. According to the study, the primary reasons for using process improvement tools were to improve workplace productivity, utilize technology, reduce supply chain waste, ensure regulatory compliance, and improve customer-centricity, all of which were identified as the most important factors when it comes to implementing process improvement tools. According to the study, pharmaceutical companies must prioritize environmental concerns as well as customer satisfaction when implementing process improvement tools in an effort to improve their efficiency.

In addition, it sheds light on the fact that process improvement tools, when used effectively, are capable of improving employee satisfaction, communication, and supply chain management. By implementing process improvement tools in their supply chain logistics management processes, pharmaceutical companies can achieve multiple benefits as a result of these findings. In addition to providing valuable insights into the benefits pharmaceutical companies have experienced after implementing process improvement tools, the results of this study are also worth mentioning. According to 23.21% of those who participated in the survey, the most significant benefits were improved resource allocation and cost reduction. In this study, it was found that resource allocation has been optimized through the use of process improvement tools, resulting in cost savings for the organization. A second most significant benefit was the automation of menial, repetitive, or tedious tasks, which was highlighted by 20.83% of the respondents in their responses. With the help of automation, supply chain productivity and efficiency have been improved by streamlining processes in the supply chain, thus freeing up time for more important tasks. Furthermore, the study found that by implementing process improvement tools, the company was able to improve customer satisfaction, reduce product compliance delays and fines, improve reverse logistics, as well as improve employee morale and satisfaction with their jobs. Based on these results, it can be concluded that process improvement tools are not only effective for optimizing the logistics of

the supply chain, but also have an impact on the entire organization, from the employees to the clients and suppliers.

In conclusion, the study provides important insights into how pharmaceutical companies can improve the efficiency and effectiveness of their supply chain logistics management by implementing a number of process improvement tools within their processes. It highlights the need to prioritize customer satisfaction and environmental concerns, as well as the possibility of reducing costs, increasing productivity, and improving employee satisfaction through this strategy. A pharmaceutical company can gain a competitive advantage in the pharmaceutical industry by optimizing their supply chain logistics management processes with the aid of process improvement tools.

5.1.3 Analyze reverse logistics management in pharmaceutical supply chains during withdrawals.

The reverse logistics of pharmaceutical supply chain management plays a crucial role in managing withdrawals from the supply chain, particularly when it comes to managing the supply chain. For this reason, it is important to analyze how pharmaceutical companies manage their reverse logistics processes so as to ensure that their supply chains are operated more efficiently in this context. Based on the results of the study, it is revealed that almost half of the respondent group (48%) used reverse logistics as part of their pharmaceutical supply chain management process, while 36% answered negatively, indicating that they did not use reverse logistics as part of their cost reduction process. In addition, it is important to note that approximately 16 percent of respondents indicated that their answer was not applicable to them, which may be a consequence of a lack of understanding of the term "reverse logistics" or the lack of implementation of this process. The results indicate that there are still many pharmaceutical companies that do not use reverse logistics as part of their supply chain management, which could provide an opportunity for them to improve their efficiency and reduce the amount of waste they produce.

As a result of the analysis of the data, the majority of respondents opted to answer "not applicable" to the question regarding the most common tools used for reverse logistics management in pharmaceutical supply chains. Perhaps this is due to a lack of familiarity with these tools or a lack of implementing reverse logistics management into their pharmaceutical supply chain as a strategy to improve supply chain performance. Nevertheless, among those who responded to the survey, 21.95% of respondents reported that they had used Lean as a method of process improvement in some capacity. The Lean method is a framework for improving the efficiency of a system by eliminating waste and inefficiencies from it. In the second most common tool used by respondents, Six Sigma, 14.63 percent of the respondents indicated that it was used in their business. An important part of Six Sigma is that it is a data-driven approach to minimizing processes that have defects. As the third most commonly used tool, Value Stream Mapping was reported to be the third most commonly used tool in the survey, with 8.54% of respondents stating that they have used this tool to identify value-added and non-value-added activities in their processes in order to reduce waste and improve efficiency. While 6.10% of respondents reported they used Total Quality Management and 5S in their processes. Most of the participants leaned more towards Lean when it comes to managing the reverse logistics process. Although choosing an appropriate tool for process improvement is important for pharmaceutical companies to achieve their specific results and objectives based on their unique needs and requirements.

5.1.4 Investigate the quality of outsourcing supply chain logistics by pharmaceutical companies to third parties or fourth parties.

Over 71% of respondents indicated that their logistics services have been outsourced to external agencies, making this practice a common practice among pharmaceutical companies. In the pharmaceutical supply chain management process, outsourcing is seen as a means of improving efficiency. Outsourcing has become a trend not only in the pharmaceutical industry, but in many other industries as well, which is enhancing efficiency and reducing costs. The majority of respondents (63.24%) reported that they use third-party logistics companies (3PL) to manage their pharmaceutical supply chain. In addition to cost savings, expertise, and flexibility, 3PL providers can offer many benefits to businesses. Technology and resources are advanced enough to ensure safe and timely transportation of products. There is, however, an

important point to remember: 22.06% of participants answered "not applicable", which indicates there are insufficient data for conclusions to be drawn from the data presented. There are many reasons why companies lack information, such as poor understanding of outsourcing processes, distrust in outsourcing providers, or a perception that outsourcing may result in a loss of control. For pharmaceutical companies to achieve success in outsourcing, they need to understand the benefits and overcome the challenges. In addition, only 13.24% of the respondents indicated that they personally had used a third-party logistics provider (4PL), who offers more comprehensive solutions for managing supply chains than the logistics providers themselves. In order to manage supply chain more effectively, 4PL providers manage multiple logistics service providers, including 3PLs. As 4PL providers are still relatively underused, more education is needed to help pharmaceutical companies understand the benefits. Also, only 1.47% of respondents utilized a fifth-party logistics provider (5PL) for their business.

In order for traditional business to become virtual organizations, 5PL providers provide the foundation for scientific research. 5PL operators facilitate flexible network cooperation among all participants in virtual organizations' logistics networks and regulate all flows in them. As a result of the evolution of the 5PL concept, there will be no intermediaries in the logistics chain, which means there will be no need for a zero-level logistics model (Karkhova, 2019). 5PLs are relatively new to the market, offering supply chain management solutions based on networks and technology. As of now, 5PL providers are only widely used by a small number of pharmaceutical companies, which may indicate that these providers are still not fully known for their benefits. Logistics services are often outsourced by pharmaceutical companies to external providers. 3PL providers are used by the majority of respondents, while 4PL and 5PL providers are not widely used. Pharma companies need to be educated and aware of the benefits of utilizing these providers in their supply chain management processes to reduce costs and improve efficiency.

5.1.5 Identify Pharmaceutical companies that does supply chain distribution domestically and internationally: Comparison of tools

The analysis is intended to identify pharmaceutical companies that offer supply chain distribution services both domestically and internationally, and to compare the tools used for

process improvement. Based on the results of a survey conducted among participants, this analysis identifies whether they outsourced their supply chains internationally, whether geography affected supply chain logistics, why they outsourced, and whether they used process improvement tools. The majority of participants agreed that they would outsource their supply chain internationally, while the remaining 50% disagreed. Based on this, it is apparent that opinions regarding outsourcing supply chain logistics internationally are divided among pharmaceutical companies. Different countries present different challenges and opportunities depending on the company's specific goals and needs. The findings in this study focused on the impact of geography on supply chain logistics. With a response rate of 32.76%, it was found that the geographical location of a country plays a significant role in supply chain logistics performance. Hence, supply chain operations should be designed taking suppliers, customers, and distribution centers into account. It should be noted, however, that some participants were neutral or disagreed with the statement, suggesting that other factors may also affect supply chain logistics efficiency. Various reasons were explored for outsourcing supply chain logistics internationally. Adapting to emerging market trends (27.56%), reducing costs (22.83%), and achieving scalability (20.47%) were the most commonly cited reasons. As a result, outsourcing has become an effective strategy for achieving these goals, while staying competitive and increasing profits. Despite this, outsourcing did not seem to increase customer satisfaction, suggesting that businesses that are considering outsourcing should carefully consider the risks and benefits of doing so.

There were several process improvement tools used in the results. Among all tools, Lean is the most widely used, with a usage rate of 27.41%. Six Sigma is 20% and 5S is 14.81%. Countries use process improvement tools differently; Ireland, Italy, Brazil, Taiwan, and Switzerland use Lean most commonly, while the United States, Belgium, and Netherlands use Six Sigma most commonly. In India, TQM was often used, while in Sri Lanka, Value Stream Mapping was often used. As a result, different countries may have different preferences and approaches to improving their supply chains.

As a result of the analysis, pharmaceutical companies' perspectives, practices, and challenges surrounding supply chain distribution and process improvement can be gained. In order to

improve their overall performance, companies need to understand these factors in order to optimize their supply chain operations.

5.2 Conclusion

Managing supply chain logistics in the pharmaceutical industry is a crucial process. The importance of pharmaceuticals makes it crucial for companies to continually improve their processes, decrease costs, and increase efficiency. Implementing process improvement tools is one way to achieve these goals. A comprehensive overview of how pharmaceutical companies can optimize their supply chain logistics management processes was provided by this study that investigated the usage of various process improvement tools in the pharmaceutical supply chain management process.

According to the study, Lean is the most widely used process improvement tool, with a 27.41% usage rate, followed by Six Sigma at 20% and 5S at 14.81%. According to the data, different countries have different preferences and approaches to process improvement, with Ireland, Italy, Brazil, Taiwan, and Switzerland using Lean the most, and the United States, Belgium, and the Netherlands using Six Sigma the most. The TQM is often used in India, while the Value Stream Mapping was frequently used in Sri Lanka.

Process improvement tools like Lean and Six Sigma are most commonly used in supply chain logistics management. Among the areas where lean is most commonly used are supply chain management, logistics, inventory control, transportation, warehousing, sales, reverse logistics, and customer service. Six Sigma, however, is more often used in product management and distribution. Additionally, 5S consistently ranked third in supply chain logistics, indicating its significance in achieving efficiency and effectiveness.

Through the implementation of process improvement tools, pharmaceutical companies can improve their supply chain logistics management processes. Using these tools, companies can reduce costs, increase productivity, and improve employee satisfaction while prioritizing customer satisfaction and environmental concerns. In order to stay competitive in the

pharmaceutical industry, pharmaceutical companies should optimize their supply chain logistics management processes.

Pharmaceutical companies interested in improving their supply chain logistics management processes can benefit from the results of this study. In addition to reducing costs, improving efficiency and productivity, businesses can increase customer satisfaction by implementing process improvement tools. Companies must, however, choose the tools that best fit their unique needs and requirements, as different countries have different preferences and approaches to process improvement.

In conclusion, the study emphasizes the importance of process improvement tools in improving supply chain logistics management. Lean and Six Sigma are frequently used tools, with 5S playing an important role in efficiency and effectiveness. In order to gain a competitive edge in the pharmaceutical industry, pharmaceutical companies need to understand the perspectives, practices, and challenges surrounding supply chain distribution and process improvement. This study provides insight into how companies can improve their supply chain logistics management processes to achieve excellence in their operations based on the insights gained from this study.

5.2.1 Limitations

There are several limitations that must be considered when discussing the use of process improvement tools in the pharmaceutical industry's supply chain logistics management, despite the fact that the study provides valuable insights into this use. A limitation of this study was the time horizon, which was a very short period of time, only two to three weeks. Because of this, it may have been difficult for the participants to provide a comprehensive account of their experiences with the various tools used to improve the supply chain management process in their respective organizations.

There is also a limitation with the small sample size, with only 58 participants from 17 countries taking part in the study. There are limitations to the size of the sample, which reduce the study's

ability to be representative of the general population as a whole. In addition, there is a possibility that there may have been some predetermined choices given to the participants prior to the study, which could have influenced their decision-making and, therefore, the results of the study as well. In order to obtain reliable and generalizable results in future research, there is a need to conduct further research with a larger and more diverse sample size in order to obtain a more reliable and generalizable set of results for use in future research.

Although there are some limitations associated with this study, it provides valuable insights into how process improvement tools can be used in the pharmaceutical industry's supply chain logistics management in spite of these limitations. These insights can be used by researchers to conduct further studies in order to address the limitations of this research, as well as develop a better understanding of the challenges faced by the pharmaceutical industry in order to optimize its supply chain management processes based on these insights.

5.2.2 Recommendation

As a result of the limitations of this study, future research can explore useful directions that can be explored in the future. In terms of supply chain logistics management, one area that could be explored further is providing a mechanism for managing risk, managing inventory, and managing supplier relationships in a supply chain. A comprehensive understanding of these areas could give researchers a better understanding of how pharmaceutical companies can optimize their supply chain processes in order to achieve better results by examining these areas in more detail.

There was also a limitation to this study in that it only compiled the opinions of professionals in the supply chain management field. To gain a more complete understanding of the supply chain operations in the pharmaceutical industry, future studies could also include the viewpoints of other stakeholder groups, such as customers, suppliers, and regulators. It would be possible for such an assessment to provide a more holistic view of the challenges and opportunities faced by the different players in the sector as a whole.

Reference

- Abideen, A. and Mohamad, F.B. (2021) 'Improving the Performance of a Malaysian Pharmaceutical Warehouse Supply Chain by Integrating Value Stream Mapping and Discrete Event Simulation'. *Journal of Modelling in Management*, 16(1), pp. 70–102. DOI: 10.1108/JM2-07-2019-0159.
- Ali, S.M. *et al.* (2020) 'Barriers to Lean Six Sigma Implementation in the Supply Chain: An ISM Model'. *Computers & Industrial Engineering*, 149, p. 106843. DOI: 10.1016/j.cie.2020.106843.
- Alkunsol, W.H. *et al.* (2019) 'Lean Six Sigma Effect on Jordanian Pharmaceutical Industry's Performance'. *International Journal of Lean Six Sigma*, 10(1), pp. 23–43. DOI: 10.1108/IJLSS-01-2017-0003.
- Alzoubi, H.M. *et al.* (2020) 'Empirical Study on Sustainable Supply Chain Strategies and Its Impact on Competitive Priorities: The Mediating Role of Supply Chain Collaboration'. *Management Science Letters*, pp. 703–708. DOI: 10.5267/j.msl.2019.9.008.
- Argiyantari, B., Simatupang, T.M. and Basri, M.H. (2020) 'Pharmaceutical Supply Chain Transformation through Application of the Lean Principle: A Literature Review'. *Journal of Industrial Engineering and Management (JIEM)*, 13(3), pp. 475–494. DOI: 10.3926/jiem.3100.
- Arslan, M. and Şar, S. (2018) 'Examination of Environmentally Friendly "Green" Logistics Behavior of Managers in the Pharmaceutical Sector Using the Theory of Planned Behavior'. *Research in Social and Administrative Pharmacy*, 14(11), pp. 1007–1014. DOI: 10.1016/j.sapharm.2017.12.002.
- Carter, C.R. *et al.* (2019) 'Sustainable Supply Chain Management: Continuing Evolution and Future Directions'. *International Journal of Physical Distribution & Logistics Management*, 50(1), pp. 122–146. DOI: 10.1108/IJPDLM-02-2019-0056.
- Costa, C., Pinto Ferreira, L. and Sá, J. (2018) 'Implementation of 5S Methodology in a Metalworking Company'. In pp. 001–012. DOI: 10.2507/daaam.scibook.2018.01.
- Demography*. Available at: <https://education.nationalgeographic.org/resource/demography> (Accessed: 13 May 2023).

- Duijzer, L.E., van Jaarsveld, W. and Dekker, R. (2018) ‘Literature Review: The Vaccine Supply Chain’. *European Journal of Operational Research*, 268(1), pp. 174–192. DOI: 10.1016/j.ejor.2018.01.015.
- Ghaouta, A. *et al.* (2017) *Application Du Lean Six Sigma Au Sein d’un Entrepôt 3PL : Etude de Cas*.
- Goodarziyan, F. *et al.* (2020) ‘A Multi-Objective Pharmaceutical Supply Chain Network Based on a Robust Fuzzy Model: A Comparison of Meta-Heuristics’. *Applied Soft Computing*, 92, p. 106331. DOI: 10.1016/j.asoc.2020.106331.
- Grangeia, H.B. *et al.* (2020) ‘Quality by Design in Pharmaceutical Manufacturing: A Systematic Review of Current Status, Challenges and Future Perspectives’. *European Journal of Pharmaceutics and Biopharmaceutics*, 147, pp. 19–37. DOI: 10.1016/j.ejpb.2019.12.007.
- Green - Lean Practices and Reverse Logistics: Evidence from Manufacturing Industry of a Developing Economy*. (2022) In *Proceedings of the International Conference on Industrial Engineering and Operations Management*. The 1st Australian Conference on Industrial Engineering and Operations Management in Sydney. Sydney, Australia: IEOM Society International, pp. 2–12. DOI: 10.46254/AU01.20220007.
- Hämäläinen, H. (2019) *Improving Supply Chain Management in Pharmaceutical Industry - Lean or Agile?*. Available at: <http://www.theseus.fi/handle/10024/169857> (Accessed: 13 May 2023).
- Jaberidoost, M. *et al.* (2013) ‘Pharmaceutical Supply Chain Risks: A Systematic Review’. *Daru: Journal of Faculty of Pharmacy, Tehran University of Medical Sciences*, 21(1), p. 69. DOI: 10.1186/2008-2231-21-69.
- Jain, A. *et al.* (2022) ‘Brief Review on Total Quality Management in Pharmaceutical Industries’. 7, pp. 1030–1037. DOI: 10.35629/7781-070510301037.
- Kalkan, Ö.G.B. ‘A CONCEPTUAL STUDY ON FOURTH PARTY LOGISTICS ACTIVITIES IN TURKEY’.
- Karkhova, S.A. (2019) ‘From 5PL Providers to Zero-Level Logistics’. *Economic Consultant*, 25(1), pp. 17–24.
- Khorasani, S.T., Cross, J. and Maghazei, O. (2019) ‘Lean Supply Chain Management in Healthcare: A Systematic Review and Meta-Study’. *International Journal of Lean Six Sigma*, 11(1), pp. 1–34. DOI: 10.1108/IJLSS-07-2018-0069.

- Li, S., Peng, G.C. and Xing, F. (2019) 'Barriers of Embedding Big Data Solutions in Smart Factories: Insights from SAP Consultants'. *Industrial Management & Data Systems*, 119(5), pp. 1147–1164. DOI: 10.1108/IMDS-11-2018-0532.
- Lima, P.A.B. *et al.* (2022) 'Medications Reverse Logistics: A Systematic Literature Review and a Method for Improving the Brazilian Case'. *Cleaner Logistics and Supply Chain*, 3, p. 100024. DOI: 10.1016/j.clscn.2021.100024.
- Luszczak, A. (2019) 'What Is Microsoft Dynamics 365/AX?' In Luszczak, A. (ed.) *Using Microsoft Dynamics 365 for Finance and Operations: Learn and Understand the Functionality of Microsoft's Enterprise Solution*. Wiesbaden: Springer Fachmedien, pp. 1–4. DOI: 10.1007/978-3-658-24107-0_1.
- Makwana, A.D. and Patange, G.S. (2021) 'A Methodical Literature Review on Application of Lean & Six Sigma in Various Industries'. *Australian Journal of Mechanical Engineering*, 19(1), pp. 107–121. DOI: 10.1080/14484846.2019.1585225.
- Malik, M. *et al.* (2022) (9) 'Stakeholders' Perspectives Regarding Supply Chain System of Pharmaceuticals and Vaccines in Pakistan: A Qualitative Study'. *Healthcare*, 10(9), p. 1738. DOI: 10.3390/healthcare10091738.
- O'Mahony, L. *et al.* (2021) (21) 'Using Lean Six Sigma to Redesign the Supply Chain to the Operating Room Department of a Private Hospital to Reduce Associated Costs and Release Nursing Time to Care'. *International Journal of Environmental Research and Public Health*, 18(21), p. 11011. DOI: 10.3390/ijerph182111011.
- Osman, A., Othman, A. and Abdul Rahim, M. kamarul I. (2020) 'Lean Manufacturing Adoption in Malaysia: A Systematic Literature Review'. 1, pp. 1–35. DOI: 10.35631/IJSCOL.11001.
- Paula, I.C.D. *et al.* (2019) 'Are Collaboration and Trust Sources for Innovation in the Reverse Logistics? Insights from a Systematic Literature Review'. *Supply Chain Management: An International Journal*, 25(2), pp. 176–222. DOI: 10.1108/SCM-03-2018-0129.
- Poncotoyo, W. *et al.* (2022) (0) 'QUALITY ANALYSIS OF REVERSE LOGISTICS DISTRIBUTION AT EXPIRED DRUG WAREHOUSE USING SIX SIGMA METHOD'. *Advances in Transportation and Logistics Research*, 5(0), pp. 911–931. DOI: 10.25292/atlr.v5i0.548.

- Purwanto, A. (2021) (3986853) Available at: <https://papers.ssrn.com/abstract=3986853> (Accessed: 9 May 2023).
- Rajabion, L. *et al.* (2019) ‘The Role of Knowledge Sharing in Supply Chain Success: Literature Review, Classification and Current Trends’. *Journal of Engineering, Design and Technology*, 17(6), pp. 1222–1249. DOI: 10.1108/JEDT-03-2019-0052.
- Régis, T.K.O., Gohr, C.F. and Santos, L.C. (2018) ‘IMPLEMENTAÇÃO DO LEAN HEALTHCARE: EXPERIÊNCIAS E LIÇÕES APRENDIDAS EM HOSPITAIS BRASILEIROS’. *Revista de Administração de Empresas*, 58(1), pp. 30–43. DOI: 10.1590/s0034-759020180104.
- Rodgers, M. and Oppenheim, R. (2019) ‘Ishikawa Diagrams and Bayesian Belief Networks for Continuous Improvement Applications’. *The TQM Journal*, 31(3), pp. 294–318. DOI: 10.1108/TQM-11-2018-0184.
- Rodriguez-Quispe, A.V. *et al.* (2022) ‘Increasing the Level of Service through the Implementation of 5S and MRP Tools in SMEs Marketing Pharmaceutical Products: A Empirical Research in Peru’.
- Saunders, M.N.K., Lewis, P. and Thornhill, A. (2012) *Research Methods for Business Students*. 6th ed. Harlow, England ; New York: Pearson.
- Settanni, E., Harrington, T.S. and Srari, J.S. (2017) ‘Pharmaceutical Supply Chain Models: A Synthesis from a Systems View of Operations Research’. *Operations Research Perspectives*, 4, pp. 74–95. DOI: 10.1016/j.orp.2017.05.002.
- Shamia, M.J. *et al.* (2018) ‘Using the Asian Knowledge Model “APO” as a Determinant for Performance Excellence in Universities- Empirical Study at Al -Azhar University- Gaza’. *Information Technology*, 7(1).
- Sharma, S. and Modgil, S. (2019) ‘TQM, SCM and Operational Performance: An Empirical Study of Indian Pharmaceutical Industry’. *Business Process Management Journal*, 26(1), pp. 331–370. DOI: 10.1108/BPMJ-01-2018-0005.
- Sriyakul, T., Umam, R. and Jermsittiparsert, K. (2019) ‘Total Quality Management and Logistic Performance: Moderating Role of Reserve Supply Chain in Pharmaceutical Industry of Indonesia’. *International Journal of Innovation*, 5(2).
- Suárez-Barraza, M.F. and Rodríguez-González, F.G. (2019) ‘Cornerstone Root Causes through the Analysis of the Ishikawa Diagram, Is It Possible to Find Them?: A First Research

Approach’. *International Journal of Quality and Service Sciences*, 11(2), pp. 302–316. DOI: 10.1108/IJQSS-12-2017-0113.

Svoboda, P. *et al.* (2021) ‘Information Systems Integration to Enhance Operational Customer Relationship Management in the Pharmaceutical Industry’. In Hassanien, A.E. *et al.* (eds.) *Proceedings of the International Conference on Artificial Intelligence and Computer Vision (AICV2021)*. Advances in Intelligent Systems and Computing. Cham: Springer International Publishing, pp. 553–572. DOI: 10.1007/978-3-030-76346-6_50.

Vedala, S. (2018) *ANALYZING THE ROLE OF LEAN MANAGEMENT IN HEALTH CARE: A SYSTEMATIC LITERATURE REVIEW*.

Veres (Harea), C. *et al.* (2018) ‘Case Study Concerning 5S Method Impact in an Automotive Company’. *Procedia Manufacturing*, 22, pp. 900–905. DOI: 10.1016/j.promfg.2018.03.127.

What Is CargoWise Directed by *What Is CargoWise*. Available at: <https://video.wisetechglobal.com/what-is-cargowise> (Accessed: 13 May 2023).

Zhang, Y. *et al.* (2022) ‘Financing Capital-Constrained Third Party Logistic Firms: Fourth Party Logistic Driven Financing Mode vs. Private Lending Driven Financing Mode’. *International Journal of Production Research*, 60(9), pp. 2963–2982. DOI: 10.1080/00207543.2021.1907472.

Zhu, Q., Johnson, S. and Sarkis, J. (2018) ‘Lean Six Sigma and Environmental Sustainability: A Hospital Perspective’. *Supply Chain Forum: An International Journal*, 19(1), pp. 25–41. DOI: 10.1080/16258312.2018.1426339.

Иманбаев, А. (2023) (1) ‘THE MECHANISM OF IMPLEMENTATION OF MODERN SALES LOGISTICS AT THE ENTERPRISE’. *Научный Журнал «Вестник НАН РК»*, 401(1), pp. 238–247. DOI: 10.32014/2023.2518-1467.435.

Appendix

Survey

Section A

1. Gender:

Please specify and tick the appropriate answer ()

Male Female Prefer not to say

2. Age:

Please specify and tick the appropriate answer ()

20-29 yrs

30-39 yrs

40-49 yrs

50 Or other (Please
specify)_____

3. level of your education

Please specify by ticking the appropriate box ()

Certificate/ Diploma

Bachelor's degree/ Advanced

Diploma

Master's degree

Or other level (Please Specify)

4. The country you're currently employed at (if applicable)

5. The number of years of work experience

Please tick the appropriate box ()

>1

1-2

2-5

5-10

Or other (Please specify) _____

Section B

Logistic Manager

1. What form of process improvement tool currently exists in your workplace?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

2. What form of process improvement tool have you adapted for reverse logistics in your workplace?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

3. In your workplace, how long has the process improvement tools been in place

Please tick the appropriate box ()

<1

>1

1-3

3-5

5-10

>10

Or other (Please specify)

4. In which area of supply chain of the pharmaceutical logistics is the quality improvement tools seen the most advancement

Please tick the appropriate boxes ()

Inventory control

Transportation

Warehousing

Supplier

management

Customer service

5. Are the process improvement tools also being used as an international outsource in your workplace

Please tick the appropriate box ()

Yes

No

Or other (Please specify)

6. Do you agree with the statement that the geographical location of the country determines the availability of the drugs?

Please tick the box that you closely relate to ()

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

7. The reasons that led to geographical outsourcing of the drug ?

Please tick the appropriate box ()

Reduction of cost on production

Ensure access to the latest technology

Enhance scalability of the supply chain flow

Ability to adapt to the emerging trend in the market

Satisfaction of customer

8. Have you outsourced logistics to other companies as part of your process improvement tool

Please tick appropriate box ()

Yes

No

Other (Please specify)

9. If so, what other types of companies are being utilized?

Please tick the appropriate box ()

Third Party

Logistics

Fourth Party

Logistics

Fifth Party

Logistics

Or other (Please specify)

10. What reasons that led to the process improvement tools being implemented into your workplace

Please tick the appropriate boxes ()

Expensive process flow

There was a high level of waste due to reverse logistics

The lack of a customer-centric approach

To Improve productivity in workplace

High employee satisfaction

Maintaining regulatory compliance

Incorporating technology

To compete with the other pharmaceutical companies

Complicated return process

Supplier communication issues

Reducing waste and emission

11. In your workplace what types of improvements were observed after the implementation of the process improvement tool(s)?

Please tick appropriate boxes ()

efficiency by digitizing menial, repetitive, or tedious tasks

Time, employees, or resources were better allocated, and costs was reduced

In reverse logistics, product waste, compliance delays, and fines have all been reduced

The morale of the employees increased, they were highly satisfied, and there was an increase in initiative and participation among them

Customers were very satisfied with the quality of services and the accuracy of order fulfillment

increase in revenue

Improved supplier relations

Section B

Logistic Coordinator

1. What form of process improvement tool currently exists in your workplace?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

2. What form of process improvement tool have you adapted for reverse logistics in your workplace?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

3. What other tools have been used in the past but have not been successful for your pharmaceutical company?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

4. In your workplace, how long has the process improvement tool been in place

Please tick the appropriate box ()

<1

>1

1-3

3-5

5-10

>10

Or other (Please specify)

5. In which area of supply chain of the pharmaceutical logistics is the quality improvement tools seen the most advancement

Please tick the appropriate boxes ()

Inventory control

Transportation

Warehousing

Supplier

management

Customer service

6. Are the process improvement tools also being used as an international outsource in your workplace

Please tick the appropriate box ()

Yes

No

Or other (Please specify)

7. Do you agree with the statement that the geographical location of the country determines the availability of the drugs?

Please tick the box that you closely relate to ()

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

8. The reasons that led to geographical outsourcing?

Please tick the appropriate box ()

Reduction of cost on production

Ensure access to the latest technology

Enhance scalability of the supply chain flow

Ability to adapt to the emerging trend in the market

Satisfaction of customer

9. Have you outsourced logistics to other companies as part of your process improvement tool

Please tick appropriate box ()

Yes

No

Other (Please specify)

10. If so, what other types of companies are being utilized?

Please tick the appropriate box ()

Third Party

Logistics

Fourth Party

Logistics

Fifth Party

Logistics

Or other (Please specify)

11. What reasons that led to the process improvement tools being implemented into your workplace

Please tick the appropriate boxes ()

Expensive process flow

There was a high level of waste due to reverse logistics

The lack of a customer-centric approach

To Improve productivity in workplace

High employee satisfaction

Maintaining regulatory compliance

Incorporating technology

To compete with the other pharmaceutical companies

Complicated return process

Supplier communication issues

Reducing waste and emission

12. In your workplace what types of improvements were observed after the implementation of the process improvement tool(s)?

Please tick appropriate boxes ()

efficiency by digitizing menial, repetitive, or tedious tasks

Time, employees, or resources were better allocated, and costs was reduced

In reverse logistics, product waste, compliance delays, and fines have all been reduced

The morale of the employees increased, they were highly satisfied, and there was an increase in initiative and participation among them

Customers were very satisfied with the quality of services and the accuracy of order fulfillment

increase in revenue

Improved supplier relations

Section B

Logistic Engineer

1. What form of process improvement tool currently exists in your workplace?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

2. What form of process improvement tool have you adapted for reverse logistics in your workplace?

Please tick the appropriate box ()

Lean

Six sigma

TQM

Ishikawa Diagram

Value Stream Mapping

5S

Or others (Please specify)

3. In your workplace, how long has the process improvement tool been in place

Please tick the appropriate box ()

<1

>1

1-3

3-5

5-10

>10

Or other (Please specify)

4. In which area of supply chain of the pharmaceutical logistics is the quality improvement tools seen the most advancement

Please tick the appropriate boxes ()

Inventory control

Transportation

Warehousing

Supplier

management

Customer service

5. Are the process improvement tools also being used as an international outsource in your workplace

Please tick the appropriate box ()

Yes

No

Or other (Please specify)

6. Do you agree with the statement that the geographical location of the country determines the availability of the drugs?

Please tick the box that you closely relate to ()

Strongly Disagree

Disagree

Neutral

Agree

Strongly Agree

7. The reasons that led to geographical outsourcing of the drug ?

Please tick the appropriate box ()

Reduction of cost on production

Ensure access to the latest technology

Enhance scalability of the supply chain flow

Ability to adapt to the emerging trend in the market

Satisfaction of customer

8. Have you outsourced logistics to other companies as part of your process improvement tool

Please tick appropriate box ()

Yes

No

Other (Please specify)

9. If so, what other types of companies are being utilized?

Please tick the appropriate box ()

Third Party

Logistics

Fourth Party

Logistics

Fifth Party

Logistics

Or other (Please
specify)

10. What reasons that led to the process improvement tools being implemented into your workplace

Please tick the appropriate boxes ()

Expensive process flow

There was a high level of waste due to reverse logistics

The lack of a customer-centric approach

To Improve productivity in workplace

High employee satisfaction

Maintaining regulatory compliance

Incorporating technology

To compete with the other pharmaceutical companies

Complicated return process

Supplier communication issues

Reducing waste and emission

11. In your workplace what types of improvements were observed after the implementation of the process improvement tool(s)?

Please tick appropriate boxes ()

efficiency by digitizing menial, repetitive, or tedious tasks

Time, employees, or resources were better allocated, and costs was reduced

In reverse logistics, product waste, compliance delays, and fines have all been reduced

The morale of the employees increased, they were highly satisfied, and there was an increase in initiative and participation among them

Customers were very satisfied with the quality of services and the accuracy of order fulfillment

increase in revenue

Improved supplier relations

12. How has the process improvement tool improved the quality of your work?

Please tick the appropriate boxes ()

Improvement in communication with the Logistics manager

efficient method analysis of the technology

Being able to Prioritize a major issue that needs to be sorted right away

Being able to devise a solution to any problem that may arise