The Effects of Reverse Logistics on Sustainable Manufacturing. A Study of Textile Firm

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Abstract

Society is paying more attention to environmental considerations, there is mounting pressure on manufacturers to embrace eco-efficient production techniques. Reverse logistics practices refer to the reverse supply chain flow in which the goods move from the manufacturer to the end consumer. The activities included in the reverse logistics comprise return management, recycling, disposal, and refurbishment. The role of reverse logistics in sustainability manufacturing practices has not, however, been sufficiently explored, especially in Pakistan. Hence, the research was carried out to investigate the role of reverse logistics in the sustainable manufacturing of apparel items in the textile industry. The study was carried out through a questionnaire survey, which was distributed among 55 employees of the case company. Statistical techniques were incorporated through the use of IBM SPSS. The findings from the results, especially the regression analysis, revealed that reverse logistics significantly and positively influenced the sustainable manufacturing of apparel items. The findings of the study were in line with numerous studies that offered similar insight that reverse logistics enhances the sustainable supply chain and thus leads to sustainable manufacturing. Based on key findings, recommendations and future implications were highlighted in the study.

Keywords: *Sustainability, Reverse Logistics, Supply Chain, Manufacturing, Textile Industry, Pakistan, Environment*

Introduction

Background of the Study

There is an emerging realization that industrial processes should be sustainable, and with this comes a remarkable transformation of the landscape of the global manufacturing sector. With society paying more attention to environmental considerations, there is mounting pressure on manufacturers to embrace eco-efficient production techniques (Waqas et al., 2021). Manufacturing sustainability should not mean a corporate responsibility only rather it is now a strategic approach that allows companies to continue their operation and save society. Sustainable business practices are possible through methods such as carbon footprint reduction, waste management programs, and even the incorporation of ethical supply chains into daily operations (Ghosh et al.). In this regard, there is a great need for a deep dive into and handling of reverse logistics. Some of the crucial processes in reverse logistics include product recalls which require effective management regarding how well the returns are managed, recycled and reused for manufacturing purposes.

The primary objective of this study is to investigate a key issue: how reverse logistics influence sustainable manufacturing practices. However, this area has not been sufficiently explored despite the fact that sustainability in manufacturing is recognized as a general concept. There is a need to research the implications of reverse logistics in creating sustainable manufacturing because it has the ability to highlight revolutionary perspectives. There are unique sustainability risks and opportunities in the reverse flow of products from the end consumers back to the manufacturers (Alnoor et al., 2018). The current study intends to add to the existing body of knowledge in this area by explaining the aspects of reverse logistics and identifying the role it can play in promoting eco-friendly and sustainable production approaches. The objective of this study is to provide useful information that can

aid practitioners in industry, policymakers and researchers who seek to understand sustainable manufacturing within a framework of reverse logistics.

Research Questions

- What is the impact of reverse logistics on sustainable manufacturing in the case of the company under study?
- What are the economic implications of integrating reverse logistics into manufacturing operations?
- What are the practical recommendations and future research implications?

This study will systematically examine the complex relationships between reverse logistics practices and sustainability in the manufacturing processes. Through a comprehensive exploration of the multifaceted dynamics involved in the reverse movement of products within the supply chain, this study seeks to reveal the direct and indirect implications of reverse logistics on the environmental, social and economic dimensions of sustainable manufacturing.

Significance of the Study

This research promises to make several key contributions to the existing body of knowledge in the field of reverse logistics and sustainable manufacturing. Firstly, it seeks to provide a holistic understanding of the impact of reverse logistics practices on sustainable manufacturing by systematically investigating their multifaceted effects. The study also intends to provide a more detailed and complex picture of how the two phenomena (reverse logistics and sustainable manufacturing) intersect than what has been achieved so far in the existing literature.

Literature Review

Introduction

The following chapter provides a literature review of the study. It briefly discusses the impact of reverse logistics on environmental sustainability in the manufacturing industry by analyzing its role in reducing waste and promoting circular economy practices. Furthermore, the chapter evaluates the contribution of effective reverse logistics strategies in promoting social sustainability. It discusses the economic implications associated with integrating reverse logistics practices. The chapter highlights the adoption and implementation of reverse logistics in different industries.

Reverse Logistics Practices and Environmental Sustainability

Through reverse logistics practices, the environmental sustainability of manufacturing processes is determined. These practices include recycling products, components and materials after their first use to revalue them or ensure adequate waste disposal. Among the key environmental advantages of reverse logistics are eliminating waste and lessening its effects on nature (Arroyo et al., 2023). Remanufacturing or recycling products and materials, thereby reducing the need for resource extraction required in raw material acquisition and energy-intensive manufacturing processes, constrains the total consumption of resources, including greenhouse gas emissions (Banihashemi et al., 2019). Sharma et al (2021) stated that using effective reverse logistics leads to a circular economy during which products and materials are in long-term utilization; the environmental impact caused by the development of new goods is minimized. Reverse logistics includes remanufacturing, which is the return of used products to almost new conditions, lengthening the product life cycle and diminishing demand for manufacturing. This saves resources and reduces the energy and emission levels associated with making new goods.

Reverse logistics also makes waste management possible. It helps divert products that have reached the end of their life cycle from landfills, thereby avoiding harmful environmental problems (Alnoor et al.,2018). Dabees et al. (2023) identify that efficient

usage of reverse logistics practices supports improvements in supply chain effectiveness. Manufacturers can improve their financial returns from investments and achieve operational efficiency by ensuring that products return optimally and recover.

Reverse Logistics Promoting Circular Economy

Reverse logistics is a structured procedure of dealing with products, components and materials after they have served their primary purpose. It incorporates the processes for extracting value, such as remanufacturing (Alamerew, 2020). Waste reduction is facilitated by product recovery and remanufacturing. Companies can now recapture products after use, restore them to their pristine condition and reintroduce them into the market (Butt et al., 2023). Mallick et al. (2023) stated that promoting the remanufacturing process, reverse logistics contributes to shifting manufacturing towards an eco-friendlier and circular option, thus reducing environmental impact when producing new products.

Another vital function it serves is the effective handling of end-of-life (EOL) products. With the help of appropriate channels such as recycling centres, manufacturers can decommission products in a structured manner, remove their valuable components and reintroduce them into the production process. This reduces the volume of landfill waste and helps preserve virgin raw materials, adhering to the tenets of circularity (Abdissa et al., 2022). In line with the thinking that materials should be in a closed-loop system by reusing and recycling instead of being thrown as waste, reverse logistics have supported its recycling aspect (Alamerew, 2020). Butt et al., (2023) stated that reverse logistics helps to minimize waste by enabling the returns and recycling of unused or outdated inventory. If they cannot be used, companies can recover components or materials and utilize them in new products, preventing excess inventory from burdening the environment.

Effective Reverse Logistics Strategies Promoting Social Sustainability

Many successful reverse logistics strategies have contributed significantly to the social sustainability of manufacturing due to their positive impact on different aspects like employment, community relations and ethical issues. However, one notable effect on the job market is strong reverse logistics practices that necessitate skilled workers for reconditioning or refurbishing and recycling (Ali et al., 2018). Manufacturers help to generate more skilled jobs that promote economic growth while increasing social welfare through training and hiring people for these positions. Reverse logistics also promotes positive relations with the community since it deals with environmental issues related to conventional waste disposal methods. Through responsible management of end-of-life products, manufacturers display environmental responsibility that may add value to their reputation with society (Sun, Yu & Solvang, 2022). Wu (2022) stated that transparent communication regarding reverse logistics practices and involving local communities in recycling initiatives can enrich the social texture, resulting in a feeling that everyone is responsible for protecting nature.

The social sustainability of manufacturing is hinged on ethical considerations, and reverse logistics strategy contributes by adherence to ethics. Properly using and disposing of these products points to an ethical approach towards sustainable practices that reflect a concern about the environment and consumer protection. By practicing ethical reverse logistics, manufacturers focus on minimizing the damage to nature and increasing positive social values, enabling them to gain the credibility of consumers and other stakeholders through trust (Andersson & Gustafsson, 2023). Ali et al. (2018) state that effective reverse logistics is a powerful tool for improving social sustainability in manufacturing, focusing on promoting a circular economy. This shift to the circular approaches highlights social demands with business, waste reduction, material reuse and minimization of environmental impacts. When manufacturers accept the practice of reverse crating in that case, they will be able to

comply with such basic rules that define a circular economy and at the same time ensure ethical approval for both solutions used.

Economic Implications of Efficient Reverse Logistics Practices

Adopting effective reverse logistics in manufacturing operations has economic effects on an organization's present and future areas. In the near future, implementing new systems and processes for effective reverse logistics management may have some cost factors associated with them. These costs include technology and infrastructure investments to help the company in proper collection processing returns. However, such costs of initiation are usually overshadowed by the long-term economic advantages, as mentioned by Ravichandran et al. (2023). Another essential benefit Waqas et al. (2018) highlighted is the possibility of saving funds on recycling materials. Effective reverse logistics practices allow companies to recover, repair or remanufacture products and parts, thereby minimizing the use of raw materials in subsequent production processes. This not only saves resources but also reduces production costs with time.

Further, reverse logistics can improve inventory management and lower obsolete or excessive supply costs. Manufacturers can improve their supply chain by effectively managing returned products, avoiding overstock situations and minimizing losses from unsold goods. This results in better cash flows and enhanced financial stability over time. From the customer retention standpoint, practical reverse logistics activities enhance consumer satisfaction and loyalty (Naseem et al., 2021). Streamlining returns may also improve the customer experience, leading to returning customers and positive word-of-mouth marketing. Retaining customers who are happy with the quality of services a brand offers is rewarding because it results in long-term economic returns through steady sales and market share (Fernando et al., 2022). Narayana (2021) stated that adopting the circular economy approach through reverse logistics will help manufacturers secure their business in future due

to a scarcity of resources and regulatory changes. Due to the rising importance of sustainability in consumers' decisions and as a regulatory frame, firms that use reverse logistics practices efficiently are better prepared to meet new market demands or environmental standards, preventing risks due later because of non-compliance or obsolete business models.

Implementation of Reverse Logistics Practices in Different Industries

The industry specificity in implementing reverse logistics of sustainable production includes a variety of factors due to the product, context and market. The product type being manufactured is one critical determinant factor for such variations. Therefore, reverse logistics have a greater incentive for adoption in industries dealing with durable and high-value products, such as electronics and automotive, because remanufacturing is also viable for them while recovering valuable materials (Abdullah & Yaakub, 2014). Rasool et al. (2023) stated that industries that deal with fast-moving consumer goods might have to grapple with difficulties in product returns and processing, which informs reverse logistics sustainability. Industry characteristics and supply chain complexity are other significant aspects. However, some industries in this category may include the electronics and fashion industry, where it is challenging to have efficient reverse logistics because of many disorganized suppliers/manufacturers /distributors. Instead, industries with more superficial supply chain structures may readily incorporate reverse logistics practices.

Reverse logistics for sustainable manufacturing are substantially influenced by regulatory and compliance requirements. However, industries subjected to strict environmental laws adopt reverse logistics to avoid penalties and comply with the set regulations. It is most noticeable in sectors with products that are highly polluting like those having dangerous substances (Dabees et al., 2023). Waseem (2019) stated that consumer attitudes and preferences influence industry-specific adoption patterns of socially responsible

products. Industries serving environmentally conscious consumers, such as the food and fashion sectors, may emphasize reverse logistics as a way of showing commitment to environmental sustainability and meeting consumer expectations. On the contrary, industries that provide products less directly connected to environmental issues may be more resistant to changes in reverse logistics unless regulations or market developments make such adjustments necessary.

Theoretical Framework

Transaction Cost Economics Theory

Appropriate reverse logistics practices contribute significantly to the sustainability of manufacturing operations within firms by enhancing resource efficiency, minimizing waste, and realizing circular economies. Reverse logistics contributes to sustainability by recovering, reusing and recycling products and materials. Transaction Cost Economics (TCE) theory gives valuable insight into the efficacy of reverse logistics by pointing out that transaction costs influence organizational decision-making (Vlachos, 2016). Zacharias & Boopathy (2022) stated that concerning sustainability, TCE focuses on the costs connected with waste disposal, environmental regulations and procurement of raw materials that are taken into consideration by a firm in determining whether it will take up reverse logistics. Implementing reverse logistics practices helps companies achieve a smart reduction in transaction costs associated with waste management and resource procurement, improving their economic efficiency while strengthening sustainability through manufacturing.

Resource-Based View Theory

Reverse logistics has proven to be effective in achieving sustainability through the manufacturing operations of corporations, agreeing with the tenets of RBV theory. The resource-based view theory focuses on the firm's competitive advantage gained from unique or distinctive assets and specific capabilities. In terms of sustainability, it is determined that

optimal reverse logistics practices will become essential assets for companies (Bentamar et al., 2021). Some of the activities that can guarantee long-term sustainability include material recycling, reuse and life extension as well as product remanufacturing among other such strategies hence giving a competitive earning to any company. Reverse logistics can improve resource effectiveness, reduce environmental burden and provide avenues of differentiation in a very competitive market environment (Cho & Linderman, 2020). De Campos (2023) observes while discussing the Resource-Based View theory that reverse logistics' capabilities to deliver value from returned products and materials make it a strategic capability in supporting sustainable manufacturing.

Conceptual Framework

Conceptual Framework

Chapter Summary

This comprehensive review highlighted the effects of reverse logistics on environmental sustainability in the manufacturing industry. It also discussed its relevance in waste reduction and advancing to a circular economy. In addition, the review evaluated how well reverse logistics strategies induce social sustainability. It further developed the financial implications associated with reverse logistics applications. Finally, this review provided a theoretical and conceptual framework that indicates the dependent and independent variables.

Research Methodology

Method and Approach

This part of the paper highlights the chosen research method, approach, data collection method and sample size. Furthermore, the chapter also indicates the selected

sampling technique and data analysis method. The chapter also highlights the ethical considerations to showcase the reliability and validity of the study's findings. In this study, a quantitative research design will be used to analyze how reverse logistics practices affect sustainable manufacturing systematically. The quantitative method is preferred for its possibility of providing numerical data that can be subjected to statistical analysis, enhancing a rigorous formulation of the research questions. Following an inductive research strategy, the study collects and analyses detailed observations and facts to generate more generalized themes or patterns. This approach is based on a bottom-up technique, allowing for an in-depth understanding of the research topic in particular instances and generalizing such insights from specific incidences to overall conclusions.

Data Collection and Analysis Method

The structured survey distribution will distribute these questionnaires to individuals occupying specific positions in supply chain management, logistics and sustainability within manufacturing industries. The main reason for employing the survey questionnaire as a data collection method is that this study presupposes additional factual information to gain better insights into the relationship between sustainable manufacturing and reverse logistics. The sample size of the study is 100 respondents. The research applies a non-probability sampling approach, meaning respondents are chosen not by random selection but based on convenience or the investigator’s judgment. Therefore, due to the ease of implementation and cost-effective nature with populations that are difficult to define or reach, this approach is often used as a more realistic option for collection. The statistical analysis of the collected survey data will determine patterns, associations and trends. Descriptive statistics will be employed to assess important aspects within the dataset precisely. Besides, inferential statistical methods such as regression analysis will be used to investigate associations among the

variables and determine whether patterns are statistically significant. The tool used for carrying out the statistical analysis is through IBM SPSS.

Results and Findings

This part of the paper represents empirical analysis on the topic of reverse logistics and sustainable manufacturing in the case of Pakistan and how reverse logistics influence sustainable manufacturing within the textile sector of Pakistan. The following discussion presents an analysis using demographic interpretations, followed by reliability that tells the internal consistency of the survey questionnaire and data. Meanwhile, Pearson's correlation has been used to determine the relation between reverse logistics and sustainable manufacturing in a case study of King's Apparel, a Textile company in Karachi, Pakistan. Meanwhile, the ordinary least square regression has also been used to determine the impact of reverse logistics on the sustainable manufacturing of King's Apparel. Lastly, the thesis provides critical discussion of the objectives of the study and key primary findings of the study. Therefore, it can be determined that there are various complications that needs to be managed.

Demographic analysis

Table 1

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	51	92.7	94.4	94.4
	Female	3	5.5	5.6	100.0
	Total	54	98.2	100.0	

Table 1 presents the gender distribution of the participants, where it can be determined that the survey consists of 92.7% male participants and around 5.5% female participants in the survey, whereas there was one missing value suggesting that one of the

participants did not reveal their gender. This suggests that the survey presents opinions of males and females, whereas the ratio of women participation may be unbalanced as compared to males but considering the cultural norms of Pakistan. However, it can be stated that the survey is not biased as it also contains responses of females. Thus, findings of the study could be generalized.

Table 2 presents the breakdown of the participants by age, and it is determined that study contains 5.5% of people with age of 18 to 23 years and 14.5% of participants fall in age category of 24 to 28 years, followed by 38.2% participants fall into the age group of 35 to 40 years and only 16% of participants fall in ag group of over 45 years. This suggests that survey consists opinion of different participants with different age group that makes survey results generalized based on the age and that there is no bias in the sample section because all age groups are included in the survey.

Table 2

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
	18 to 23 Years	3	5.5	5.5	5.5
	24 to 28 Years	8	14.5	14.5	20.0
	29 to 34 Years	21	38.2	38.2	58.2
	35 to 40 Years	14	25.5	25.5	83.6
	Over 45 Years	9	16.4	16.4	100.0
	Total	55	100.0	100.0	

Table 3

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary/Secondary	4	7.3	7.3	7.3
	Diploma	6	10.9	10.9	18.2
	Graduate	30	54.5	54.5	72.7
	Masters'	15	27.3	27.3	100.0
	Total	55	100.0	100.0	

Table 3 presents the education level of participants. It can be observed that 7.6% of the study participants had primary or secondary education, followed by 10.9% having a diploma, 54.5% being graduates, and 27.3% having at least a master's education. This suggests that the study consists of the opinions of different participants with different educational backgrounds, which makes it unbiased.

Table 4 presents the breakdown of the participants by experience, and it is determined that the study contains 5.5% of people with experience of 0 to 1 years, and 12.7% of participants fall in the experience category of 2 to 3 years' experience, followed by 32.7% participants fall into the experience group of 4 to 6 years and only 47.3% of participants fall in experience group of more than 10 years. This suggests that the survey consists of the opinions of different participants with different work experiences in the textile industry makes survey results generalized based on the experience and that there is no bias in the sample section because all participants with different experience are included.

Table 4

Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 to 1 Years' Experience	3	5.5	5.6	5.6
	2 to 3 Years' Experience	7	12.7	13.0	18.5
	4 to 6 Years' Experience	18	32.7	33.3	51.9
	More than 10 Years' Experience	26	47.3	48.1	100.0
	Total	54	98.2	100.0	
Missing	System	1	1.8		

Reliability Analysis

Table 5 presents the results of Cronbach's alpha that help to determine if the internal consistency of the survey questionnaire works in a way that is consistent and reliable or not. Since the value of Cronbach's alpha is 0.920, hence, it suggests that there is internal consistency in the data as the survey questionnaire used for the data collection is consistent and produces consistent results (Hajjar, 2018). Therefore, the data that has been collected can be used for empirical analysis and can be used to draw practical implications.

Table 5

Cronbach's Alpha

Reliability Statistics

Cronbach's Alpha	N of Items
.920	10

Correlation Analysis

The correlation analysis technique is a widely utilized tool of statistics where its fundamental function is to evaluate the interconnection of the variables with each other. There are a significant number of techniques for testing the interconnection of variables which comprises Kendall, Spearman, and Pearson's correlation (Essam, El & Ali, 2022). However, reflecting to the study of Obilor & Amadi (2018), Pearson's correlation is the commonly used method for examining the connection of variables where it examines three major components which are significance, strength, and level. The significance of the variable is measured from the p/sig-value where its dependence is upon the selected significant confidence level. In the case of correlation, the most common significance level is 95% where the p/sig-value must be below 0.05 for considering significant condition. The null hypothesis of Pearson's correlation is that the variables does not have any significant connection.

The strength of the connection is measured through the coefficient value. It is dependent upon the range where the value of coefficient 0 indicates that the variables have no relationship. There are three ranges for measuring strength in correlation which are low, moderate, and high. A lower connection is determined in a condition where the coefficient value lies between 0.1- 0.4. Moderate interrelation is specified in the range of 0.4 – 0.7 and the coefficient value above 0.7 indicates a strong connection. Lastly, the level is identified from the – or absence of a symbol in the coefficient where the – symbol signifies negative interconnection.

Table 6

Correlation

		Reverse Logistics	Sustainable Manufacturing
Reverse Logistics	Pearson Correlation	1	.982**
	Sig. (2-tailed)		0.000
	N	55	55
Sustainable Manufacturing	Pearson Correlation	.982**	1
	Sig. (2-tailed)	0.000	
	N	55	55

Table 6 represents the results of the correlation where there are specifically two variables involved as per the conceptual framework which are reverse logistics and sustainability manufacturing. The correlation technique enables in measuring the variable's interconnectedness with each other. Examining the significance, the significance value is identified to be 0.000 which is below 0.05; therefore, the null hypothesis is rejected. In other words, the p-value signifies that reverse logistics has a significant interrelation with sustainable manufacturing. As for the coefficient value, it is computed as 0.982 which illustrates a positive and strong connection. The correlation overall indicates that reverse logistics has a significant and positive interrelationship with sustainable manufacturing.

Regression Analysis

The last and most important technique that is applied on the provided data is the regression analysis. The regression analysis is a technique applied for measuring the variable's cause and effect. Based on the conceptual framework, the regression analysis is applied to test whether the reverse logistics influences the sustainability of manufacturing on King's Apparel. The major components that are examined within the regression analysis are the R-square, ANOVA and coefficient value. The purpose of the R-square is to mainly determine the explanation or predictability of the independent variable on the dependent variable. The ANOVA technique is specifically used for measuring the fitness of the model.

Table 7

R-square

Model Summary	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.982a	0.965	0.964	0.12109

Table 8

Regression Analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-0.055	0.112		-0.493	0.624
Reverse Logistics	1.014	0.027	0.982	38.184	0.000
R-square	0.982				
ANOVA	0.000				

Table 8 represents the results of the regression analysis where the impact of reverse logistics on sustainability manufacturing on King's Apparel is examined. The R-square is computed as 0.982 which depicts that the reverse logistics can predict or explain sustainable manufacturing by 0.982 or 98.2%. The ANOVA significance value is computed as 0.00 and is below the confidence threshold 0.05; therefore, this indicates that the regression model is

significant and is free from any statistical error. Lastly, the coefficient of reverse logistics is investigated in which the significance value is 0.000 and is below 0.05; therefore, reverse logistics has significant influences on sustainability manufacturing. Moreover, the coefficient value is computed as 1.014 which indicates a positive effect. This means that with every unit improvement to reverse logistics of textile companies would lead to an increase to sustainability manufacturing by 1.014 units.

Discussion

Reverse logistics refers to the reverse supply chain flow in which the goods move from the manufacturer to the end consumer. The activities included in the reverse logistics comprise of return management, recycling, disposal, and refurbishment. This enables the organization to save resources and minimize energy usage and emission levels (Sharma et al., 2021). Alamerew (2020) states that reverse logistics is considered to be a structured procedure that deals with products, materials, and components. Waqas et al. (2018) have demonstrated that the reverse cycle enables in saving funds on recycling materials. It enables the companies to recover, repair or remanufacture products and parts and thus minimize the use of raw material. Moreover, Narayana (2021) has indicated that the adoption of reverse logistics would support in the circulating the economy by helping the manufacturers in securing the business in the future due to the growing concern of scarcity of resources and regulatory changes. In terms of environmental impact Andersson & Gustafsson (2023) has indicated that practicing the reverse logistics enables in reducing the damage to the nature while also enhancing social values which enables in gaining credibility of consumers and stakeholders.

The role of reverse logistics in sustainability manufacturing practices is not however been sufficiently explored especially in the textile industry. Hence, the research was carried out to investigate the role of reverse logistics in the sustainable manufacturing of King's

Apparel (Textile Company). The study was carried out through a questionnaire survey which was distributed among 55 employees. The findings from the results especially the regression analysis revealed that the reverse logistics significantly and positively influenced on sustainable manufacturing of King's Apparel. The findings of the study were in line with several number of studies which includes Sharma et al (2021); Banihashemi, Fei & Chen (2019); Arroyo et al. (2023); Dabees et al. (2023). Alnoor et al. (2018) have indicated that the implementation of reverse logistics makes waste management possible as it supports in avoiding environmental issues.

Moreover, Mallick et al. (2023) have indicated that reverse logistics contributes to shifting the manufacturing process into an eco-friendly and circular approach which contributes to minimizing the impact on the environment while producing new products. Additionally, Butt, Ali & Govindan (2023) has illustrated that reverse logistics supports in reducing wastage by enabling the returns and recycling of outdated or unused materials. This enables in prevention of the use of excess materials that reduce the burden on the environment. Moreover, the transaction cost economics theory also supports the findings of reverse logistics significantly and positively contributing to sustainable manufacturing on King's Apparel. Vlachos (2016) indicated that the TCE theory provides valuable insights regarding the efficacy of reverse logistics as it enables in focusing in various sustainable aspects that are waste disposal, procurement of sustainable materials and complying with environmental regulations.

Conclusion And Recommendation

Conclusion

Attention to environmental considerations and sustainable practices are creating immense pressure among the manufacturing industries in embracing the eco-efficient production methods. One of the practices that are being utilized by the company is the 'reverse

logistics' where this is referred to reverse supply chain in which the common activities include return management, disposal, recycling and refurbishment. Reverse logistics also includes the product recalls in which it requires effective management as how the returns are recycled and reused for the purpose of manufacturing. Even though reverse logistics has gained major attention towards environmental benefits, its impact on sustainable manufacturing practices is not sufficiently explored. Thus, the following study was undertaken to investigate the key issue as how reverse logistics influence sustainable manufacturing practices. The study was carried through survey where it was carried out on King's Apparel which is a textile company in Korangi. The targeted audience of the survey were employees and the questionnaire survey only focused on two variables which were reverse logistics and sustainable manufacturing. Statistical techniques were applied on the dataset particularly the frequency, reliability, correlation and regression. The reliability testing was carried through Cronbach's alpha where both variables were found to be internally consistent. The findings from correlation revealed that both reverse logistics and sustainable manufacturing had significant positive and strong relation. Lastly, the regression analysis revealed that reverse logistics significantly influences on sustainable manufacturing.

Recommendation

Based on the findings, a few recommendations are provided for the textile industry of Pakistan regarding reverse logistics.

- It is recommended that the textile companies of Pakistan to develop a clear and well-defined reverse logistics strategy that is aligned with the sustainable goals
- Textile firms should focus in investing and implementing technologies that helps in tracking and managing returned produced more efficiently
- It is suggested for the firms to collaborate closely with the stakeholders especially the suppliers to integrate reverse logistics.

Future Implications

Reflecting to the research topic, the area of 'reverse logistics' is insufficiently studied by scholars which remains a major gap from the perspective of sustainable manufacturing. Thus, the study was carried out in the textile firm 'King's Apparel' in Pakistan through survey-based approach. Considering the potential of reverse logistics, few areas of future studies are highlighted where researchers can focus in covering the entire textile industry of Pakistan or any other type of manufacturing companies. Moreover, qualitative study such as interviews can also be adopted by future scholars to investigate the role of reverse logistics on sustainable manufacturing in-depth.

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