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Research Article

Impact of Emerging Technologies on the Export Performance of the Textile and Apparel Industry in Sri Lanka

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Abstract

This investigation aims to identify the impact of emerging technologies on the export performance of the textile and apparel export industry in Sri Lanka. The study conducts as a cross-sectional investigation, employs a deductive research approach, adopts positivism as a research philosophy, and utilizes the quantitative Likert-scale questionnaire research method from a methodological perspective. The study will utilize correlation and multiple linear regression models to analyze the relationships between these variables. The study found that the company's annual investment in new technology and the budget set aside for exploring new technology abroad have a significant impact on the volume of innovative products exported by the apparel industry in Sri Lanka. Organizations that have committed engineering and scientific teams to work on technology-related innovation processes and evaluate emerging technologies have a high level of significance. Management's willingness to take risks, an innovative mindset & seeking newness, and a supportive attitude toward subordinates are also highly influential on the export performance of the organization. This research endeavors to enhance comprehension regarding the impact of emerging technology on the textile and apparel export industry in Sri Lanka and aids organizational management in developing strategies aimed at enhancing the competencies of individual employees as well as employee cohorts within the organization. This research provides valuable insights for apparel exporters to embrace contemporary technology and how to effectively align with technological advancements, thereby enhancing their productivity and competitive edge.

Keywords: *Emerging technologies, export performance, firm size, innovation, technology management.*

1. Introduction

Exports can be described as the most common means of entering the global market, helping companies utilize underutilized operational capacity, increase productivity, ensure profitability, and capitalize on a highly globalized market (Sousa, Martínez-López, and Coelho, 2008). In a liberalized world, export success is more important than ever for economic performance. As a major means of earning foreign exchange, it will have a direct impact on reaping the benefits of scale and specialization economies and gaining access to new technology (Lall, 2000). To accomplish the objectives of the export venture, businesses employ export marketing strategies to control the interaction of both internal and external factors (Leonidou *et al*, 2002).

Technology is one of the key factors influencing productivity growth and global market competition. Technological innovations create new businesses and shape the nature of international competition and trade (Economic and Social Council, United Nations, 2018). Today, many manufacturing companies are investing in advanced manufacturing technologies to survive the competition (Moyano-Fuentes, Sacristán-Díaz, and Garrido-Vega, 2016) and many companies also use advanced manufacturing technologies to fragment the mass market and enhance consumer demand for customization (Zammuto and O'Connor, 1992). As stated by Dawal *et al*. (2015), companies have been introducing and implementing advanced manufacturing technologies since the 1980s to gain high profits and competitive advantage. Consequently, the last two decades have witnessed significant structural changes in exports with technological enhancements in the manufacturing and primary industries worldwide (Montobbio and Rampa, 2005).

One of the biggest participants in Sri Lanka's export business is the textile and apparel sector. Over a long period, Sri Lankan apparel suppliers and manufacturers have built a solid reputation for ethically creating high-quality clothing. As a result, they have garnered the respect of some of the world's most renowned fashion labels (EDB, 2023). The apparel manufacturing industry is the largest and most active economic sector in Sri Lanka, characterized by private and independent ownership and management. Sri Lankan apparel manufacturers have effectively tapped into global market opportunities by utilizing research and development centers, innovation centers, and outsourcing services for the fashion industry. Consequently, Sri Lankan apparel manufacturers can go beyond typical exports and tailoring designs, instead developing innovative and distinctive solutions, bridging the divide between developing and less developed nations. When comparing the amount of

apparel produced by each inhabitant, this country routinely ranks among the top exporters in the region (EDB, 2023).

Despite the numerous difficulties it faces, Sri Lanka remains a center for the creation of innovative clothing designs. Technology and innovation continue to be the most fascinating segments of the apparel business. The Sri Lankan textile and apparel sector, distinguished by its use of ethical labor methods and environmental management techniques, has achieved this status. Sri Lanka has emerged as a prominent contributor to the global apparel industry due to its production of wearable electronics, e-textiles, and smart clothing. This has positioned the country as a leading producer of advanced clothing and fashion solutions. The feasibility of this outcome is attributed to the utilization of ecologically sustainable fabric treatment and color processing agents throughout the manufacturing process (Sri Lanka Apparel, 2023). Sri Lanka has successfully positioned itself as a cutting-edge producer of innovative clothes and fashion solutions through these efforts.

Collaboration among multiple industries has made possible reusable underwear, anti-flush clothing, cutting-edge 3D printed gear, next-to-skin washable illumination technology, controlled heating technology, and other innovative advancements. These innovations offer a truly stunning celebration of design. The initiative collaborates with the Department of Textile and Clothing Technology at the Universities of Moratuwa and Peradeniya and engages the services of organizations such as SLITA (Sri Lanka Institute of Textile and Apparel) and AOD to organize events like "Innovation Island" aimed at fostering sustainable development and enhancing the potential and capabilities of the fashion industry. Industrial partnerships with organizations like SLINTEC (Sri Lanka Institute of Nanotechnology), leveraging nanotechnology and other cutting-edge technical solutions, have boosted the development of products created to meet the expectations of global markets. This has been achieved through industrial collaborations, leading to the acquisition of intellectual property and the creation of new opportunities for the technological manufacturing sector (Sri Lanka Apparel, 2023; Deepthi and Bansal, 2022).

2. Review of Literature

Exports and imports are fundamentally dependent variables on a country's resources, along with the effects of government-imposed restrictions on imports and exports (Somer, 1962). They play a vital role in stimulating economic growth and

development. Exports generate demand for economic output and create new employment opportunities (Khawar, 2003). In situations where production costs are considered high, sales volumes are insufficient to achieve the break-even point, the domestic market is not sustainable, the product has a limited lifespan for substantial direct investments, or there are unfavorable political circumstances, organizations may explore the option of exporting their products (Cherunilam, 2005). Various factors influence export performance, including exchange rates, GDP growth rates, foreign investment and capital, free trade agreements, labor, raw material costs and quality, technology, tariff and non-tariff barriers, and the direction of future research (Yoganandan *et al*., 2013). The success of a company's exports is a reflection of specific actions taken to develop resources and competencies in a global setting. Export performance is a crucial metric for evaluating the effectiveness of a company's export efforts (Abeykoon and De Alwis, 2015). The quality of the final product is influenced by several factors, with raw materials, equipment, and technology having the most significant impacts. The ability of organizations to afford and access technology, particularly in the case of exports, determines their competitiveness (Taneja, 2012).

3. Material and Methods

The researchers collected primary data for the study through a Likert scale questionnaire distributed to a selected group of exporters registered with the Export Development Board in Sri Lanka. The questionnaire consisted of 40 closed-ended questions organized into different sections. The demographic section aimed to gather information about the respondents' characteristics. The questionnaire was distributed through various digital platforms, including emails, LinkedIn, WhatsApp, Viber, and Facebook. A Google Form was made accessible to the employees of a textile and apparel export company, and data were collected from 101 respondents.

In addition to primary data, the researchers also collected secondary data from various sources such as past research, publications, newspapers, magazines, journals, and relevant websites. The secondary sources were utilized to gather empirical evidence, build the research framework, and support the research findings. To assess the reliability of the collected data, Cronbach's alpha coefficient was used. A minimum value of 0.7 is considered satisfactory for internal consistency. Cronbach's alpha measures the internal consistency and reliability of Likert scale-based questions. A value between 0.6 and 0.7 is acceptable, while a value above 0.7 is desirable.

Descriptive analysis was employed to characterize respondents' perspectives on the questionnaire items related to the independent and dependent variables. Skewness, which measures the symmetry of the variable's distribution, was also analyzed. Skewness values between -1 and +1 are excellent, between -2 and +2 are sufficient, and values greater than -2 and +2 indicate significant non-normality (Hair *et al*, 2022). Spearman's correlation coefficient, a non-parametric test, was used to analyze the correlation and significance between the variables measured on a Likert scale. The strength of the correlation was determined based on the coefficient value. Values above 0.7 indicate a stronger correlation, between 0.7 and 0.5 indicate a moderate correlation, between 0.5 and 0.3 indicate a weak correlation, and values below 0.3 indicate a negligible correlation.

The researchers used the IBM SPSS 29.0 tool to conduct linear regression analysis to examine the direct effects of the independent variables on the dependent variable. This analysis helps assess the relationships between the independent variables and the dependent variable. After conducting the linear regression analysis, a moderator analysis was performed to investigate how the moderator variable influenced the relationship between the independent and dependent variables. A moderator variable is an additional factor that influences the strength or direction of the relationship between the independent and dependent variables. In this case, the moderator variable is the company size. To conduct the moderation analysis, the researchers utilized the PROCESS macro V4.2, an extension available in IBM SPSS Statistics 29.0 specifically designed for moderation analysis. This tool allows for the assessment of the interaction effects and provides information on how the moderator variable affects the relationship between the independent and dependent variables.

t's important to note that in moderation analysis, the moderator variable should not have a causal relationship with the independent variable. In this study, the company size was assumed to be unaffected by the independent variables, allowing it to serve as a moderator in the analysis. By utilizing the moderation analysis tool in IBM SPSS Statistics 29.0, the researchers were able to explore the impact of the moderator variable (company size) on the relationship between the independent and dependent variables, providing insights into how the relationships may vary based on different levels of the moderator.

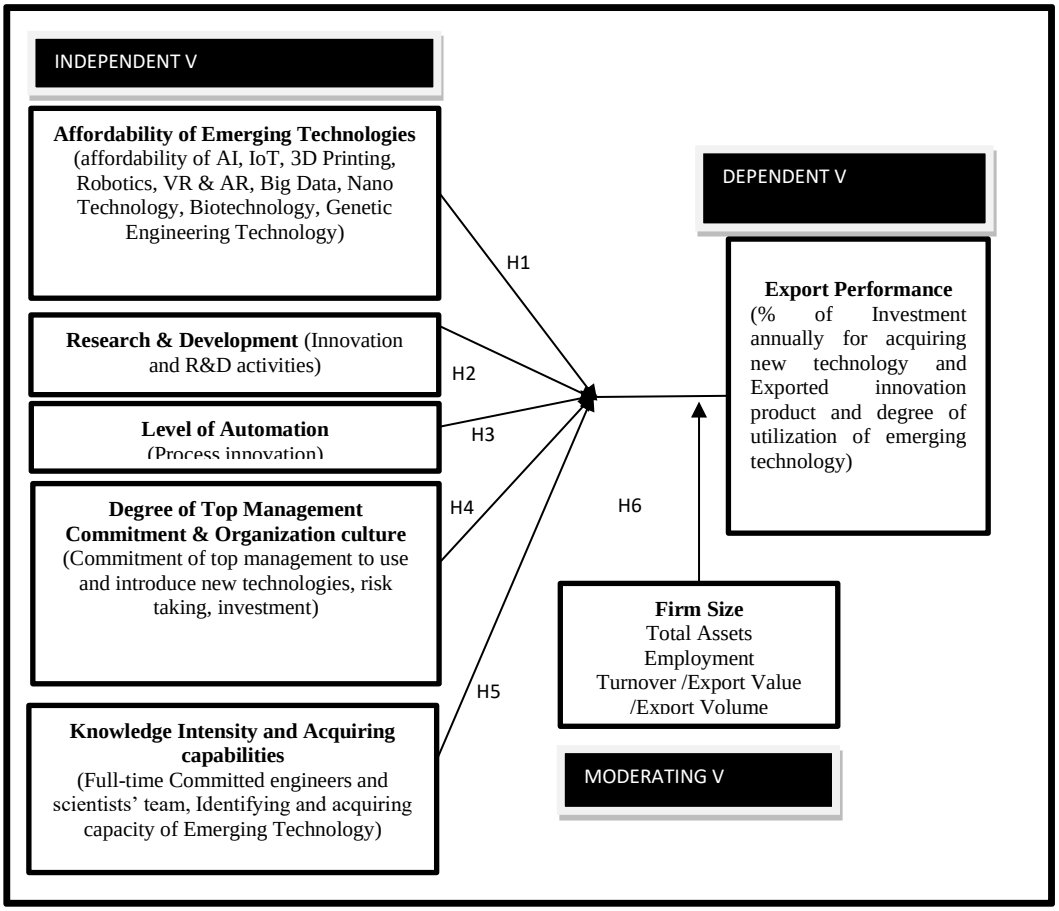

Figure 1: Conceptual Model

The research employed descriptive analytical techniques to investigate the impact of emerging technologies on the export performance of the textile and apparel sectors in Sri Lanka. The conceptual framework, presents in the Figure 1, presents the variables involved in the study. The research proposes a hypothetical model with independent variables, including affordability of emerging technologies, research and development, level of automation, top management commitment, and knowledge intensity and acquiring capabilities. The dependent variable is export performance, measured by the percentage of investment in acquiring new technology, exporting innovative products, and the degree of utilization of emerging technology. Additionally, there is a moderating variable. The main hypotheses derived are as follows.

H1 = The affordability of emerging new technologies (AI, IoT, 3D printing, robotics, VR and AR, big data, nanotechnology, biotechnology, and genetic engineering

technology) and export performance of textile and garment exporters have positive relationships.

H2 = Expenditure of research and development (innovation and R&D activities) and export performance in textile and garment exporters have positive relationships.

H3 = The level of automation and digitization (process innovation) and export performance of textile and garment exporters have positive relationships.

H4 = The degree of top management commitment and organization culture (commitment of top management to use and introduce new technologies, risk-taking attitude, and desire for investment) and export performance in textile and garment exporters have positive relationships.

H5 = Knowledge intensity and acquiring capabilities (a full-time committed team of engineers and scientists', Identifying and acquiring capacity of emerging technologies) and export performance in textile and garment exporters have positive relationships.

H6 = Firm size (small, medium, and large based on total asset value, number of employees, and turnover/export value/export volume) works as a moderating variable for determining the effects of all other independent variables on the export performance in the textile and garment sector.

The study will utilize correlation and multiple linear regression models to analyze the relationships between these variables. The research will be conducted as a cross-sectional investigation, employing positivism research philosophy, a deductive research approach, and quantitative research methods. A comprehensive literature review will be conducted, and a specialized questionnaire will be developed based on relevant literature. The validity and reliability of the questionnaire will be assessed. Participants will be selected, and the questionnaire will be distributed through social media platforms such as LinkedIn, Facebook, and WhatsApp. Statistical analysis, including correlation and regression analysis, will be used to determine the correlation between emerging technology and export performance. The study aims to identify barriers and influential factors affecting the adoption of emerging technology. Hypotheses will be formulated and empirically tested using statistical methods. Regression analysis will help evaluate the impact of each independent variable on the overall performance of the company. The researcher will analyze survey outcomes, compare them with the literature, and draw reliable

conclusions to support recommendations. These findings will serve as the foundation for the researcher's recommendations.

4. Results

The purpose of this study was to examine how the apparel and textile export business in Sri Lanka is shaped by acquiring and adapting new emerging technologies. According to Table 1, Cronbach's reliability test revealed that all five independent variable data points are within an acceptable range.

Table 1: Validation and Reliability

Variable	**Cronbach's Alpha**	**Status**
Affordability of Emerging Technologies	0.688	Acceptable
Research and Development	0.938	Desirable
Level of Automation	0.893	Desirable
Top Management Commitment	0.875	Desirable
Knowledge Intensity and Acquiring capability	0.887	Desirable

Source: Structured Questionnaire Survey

According to Table 2, the descriptive statistical result reveal that the skewness value of variables such as affordability of emerging technology, one indicator of research and development, top management commitment, export performance, and firm size data is between -1 and +1, which is considered excellent skewed. The skewness value of variables such as research and development (two indicators), level of automation, knowledge intensity, and acquiring capability data is considered sufficient. Based on the mean value of the indicators, organizational strategies for innovation management are showing the highest impact on export performance, and willingness to take risks has shown the least impact on export performance in the apparel and textile industries in Sri Lanka. Overall, level of automation is showing the highest impact, and second, third, fourth, and fifth are respectively research and development, knowledge intensity and acquiring capability, affordability of emerging technology, and top management commitment.

Table 2: Descriptive statistical indicators

Variable	Indicator	Skewness
Affordability of Emerging Technologies	Annual investment for acquiring new technology in the organization	Excellent
	Budgeting for technology related knowledge acquiring	Excellent
Research and Development	Organizational strategies for innovation management	Sufficient
	Innovation performance evaluation in the organization	Sufficient
	Product innovation performance evaluation in the organization	Sufficient
Level of Automation	Organizational strategies for innovation management	Sufficient
	Process innovation performance evaluation in the organization	Sufficient
Top Management Commitment	Willing to take risk	Excellent
	Innovative mindset & seeking for newness	Excellent
	Competitive behavior	Excellent
	Supportive management	Excellent
Knowledge Intensity and Acquiring capability	Committed engineering and scientist team for working on technology related innovation	Sufficient
	Evaluated and researched emerging technology out in the world	Sufficient

Source: Structured Questionnaire Survey

According to Table 3, the correlation analysis revealed that the correlation coefficient of all indicators of affordability of emerging technology, research and development, level of automation, knowledge intensity, and acquiring capability with export performance showed a moderately positive correlation between the variables. The correlation coefficient of all indicators of top management commitment with export performance and firm size showed a weak and negligible correlation between the variables. The correlation coefficient of affordability of emerging technology, research and development, level of automation, knowledge intensity, and acquiring capability with firm size showed a weak positive correlation between the variables. The relationship between all indicators of affordability of emerging technology, research and development, level of automation, knowledge intensity and acquiring capability, and top management commitment is highly significant with the export performance of the organization as well as the firm size.

Table 3: Correlation analysis

Variable	Indicator	Correlation with Export Performance	Correlation with Firm Size
Affordability of Emerging Technologies	Annual investment for acquiring new technology in the organization	Moderately positive	Weak positive
	Budgeting for technology related knowledge acquiring	Moderately positive	Weak positive
Research and Development	Organizational strategies for innovation management	Moderately positive	Weak positive
	Innovation performance evaluation in the organization	Moderately positive	Weak positive
	Product innovation performance evaluation in the organization	Moderately positive	Weak positive
Level of Automation	Organizational strategies for innovation management	Moderately positive	Weak positive
	Process innovation performance evaluation in the organization	Moderately positive	Weak positive
Top Management Commitment	Willing to take risk	Negligible	Weak positive
	Innovative mindset & seeking for newness	Weak positive	Weak positive
	Competitive behavior	Negligible	Negligible
	Supportive management	Negligible	Weak positive
Knowledge Intensity and Acquiring capability	Committed engineering and scientist team for working on technology-related innovation	Moderately positive	Moderately positive
	Evaluated and researched emerging technology out in the world	Moderately positive	Weak positive

Source: Structured Questionnaire Survey

According to Table 4, the regression analysis revealed that the affordability of emerging technology, research and development, level of automation, top management commitment (exception: competitive behavior), and knowledge intensity and acquiring capability are significantly impacted on the export

performance of the organization without considering the moderator. The p value less than 0.05 for the interaction effect of all five dependent variables indicated that the null hypothesis of no moderator effect of firm size between independent variable and dependent variable was not rejected. Therefore, none of the relationships are moderated by firm size. Finally, the hypothesis was validated and finalized with the result that H1, H2, H3, H4, and H5 are significant and H6 is not significant.

Table 4: Regression analysis

Variable	**Indicator**	**Significant without moderator**	**Significant with moderator**
Affordability of Emerging Technologies	Annual investment for acquiring new technology in the organization	Significant	Insignificant
	Budgeting for technology related knowledge acquiring	Significant	Insignificant
Research and Development	Organizational strategies for innovation management	Significant	Insignificant
	Innovation performance evaluation in the organization	Significant	Insignificant
	Product innovation performance evaluation in the organization	Significant	Insignificant
Level of Automation	Organizational strategies for innovation management	Significant	Insignificant
	Process innovation performance evaluation in the organization	Significant	Insignificant
Top Management Commitment	Willing to take risk	Significant	Insignificant
	Innovative mindset & seeking for newness	Significant	Insignificant
	Competitive behavior	Insignificant	Insignificant
	Supportive management	Significant	Insignificant
Knowledge Intensity and Acquiring capability	Committed engineering and scientist team for working on technology related innovation	Significant	Insignificant

	Evaluated and researched emerging technology out in the world	Significant	Insignificant

Source: Structured Questionnaire Survey

The provided text highlights several suggestions for the Sri Lankan textile and apparel sector to stay competitive and embrace emerging technologies. The sector needs to acknowledge that it will become more digital in the future and align its innovation strategies to meet the needs of international clients. This includes adopting technologies that enable flexibility, efficient resource management, and customer and partner participation in the business process. View technological advancements as investments rather than costs. Sri Lankan apparel has the capabilities to compete with products from other major nations, but there is a need for more businesses to develop future-oriented innovations. Research suggests that there is no connection between firm size and the export of innovative products in the sector. Regardless of the company size and external challenges, it is crucial to implement cutting-edge technology now to establish a competitive edge in global markets. Establishing a services-related apparel business can help increase export performance. Utilizing technologies like virtual or augmented reality and 3D printing can have a significant impact on the company's success. The absence of government initiatives to promote innovation is a primary reason for the lack of significant inventions or brands originating in Sri Lanka. The government and clothing associations should take the lead and provide support, along with cooperation between apparel companies, international research organizations, and universities. Organizations should create a governance framework for investigating and managing emerging technologies. Innovation networks can be established to evaluate, test, and implement novel technologies in different functional segments of the clothing manufacturing company.

Organizations should collaborate and scale operations gradually, understanding that growing as a group is more productive than individual enterprises. Start with use cases and focus on solving significant business problems before building a business case for investing in new technologies. Carefully choose strategic technology partners who can provide solutions that align with the organization's needs. Foster closer communication and active involvement of technology partners in maturing the technology for its intended purpose. By following these suggestions, the Sri Lankan textile and apparel sector can adapt to the digital future, maintain its market share, and compete effectively with other countries in the industry.

5. Discussion

The purpose of this study was to examine how the apparel and textile export business in Sri Lanka is shaped by acquiring and adapting new emerging technologies. A hypothetical model of independent variables such as affordability of emerging technology, research and development, level of automation, top management commitment, knowledge intensity, and acquiring capability of the organization's effect on dependent variable export performance with and without moderator firm size was analyzed throughout the research. A sample of 101 experts was selected from the textile and apparel industries in Sri Lanka, and primary data was collected through a questionnaire. The data is subjected to descriptive, correlational, and regression analyses for the purpose of analysis. The researcher employed correlation analysis and regression analysis to validate the proposed hypotheses of the study. Furthermore, the purpose and goal of currently used emerging technology in the industry were discovered. Based on the findings, the examiner was able to provide some insight to the apparel and textile industries in terms of emerging technology acquisition and adaptation in order to enhance export performance.

Findings of the Cronbach reliability test revealed that all five independent variable data points are within an acceptable range. Findings of the descriptive statistical result reveal that the skewness value of variables such as affordability of emerging technology, one indicator of research and development, top management commitment, export performance, and firm size data is between -1 and +1, which is considered excellent skewed. The skewness value of variables such as research and development (two indicators), level of automation, knowledge intensity, and acquiring capability data is considered sufficient. Based on the mean value of the indicators, organizational strategies for innovation management are showing the highest impact on export performance, and willingness to take risks has shown the least impact on export performance in the apparel and textile industries in Sri Lanka. Overall, level of automation is showing the highest impact, and second, third, fourth, and fifth are respectively research and development, knowledge intensity and acquiring capability, affordability of emerging technology, and top management commitment. Findings of the correlation analysis revealed that the correlation coefficient of all indicators of affordability of emerging technology, research and development, level of automation, knowledge intensity, and acquiring capability with export performance showed a moderately positive correlation between the variables. The correlation coefficient of all indicators of top management

commitment with export performance and firm size showed a weak and negligible correlation between the variables. The correlation coefficient of affordability of emerging technology, research and development, level of automation, knowledge intensity, and acquiring capability with firm size showed a weak positive correlation between the variables. The relationship between all indicators of affordability of emerging technology, research and development, level of automation, knowledge intensity and acquiring capability, and top management commitment is highly significant with the export performance of the organization as well as the firm size. Findings of the regression analysis revealed that affordability of emerging technology, research and development, level of automation, top management commitment (exception: competitive behavior), and knowledge intensity and acquiring capability are significantly impacted on the export performance of the organization without considering the moderator. The p value less than 0.05 for the interaction effect of all five dependent variables indicated that the null hypothesis of no moderator effect of firm size between independent variable and dependent variable was not rejected. Therefore, none of the relationships are moderated by firm size. Finally, the hypothesis was validated and finalized with the result that H1, H2, H3, H4, and H5 are significant and H6 is not significant.

Table 5 summarized the above results regarding emerging technology is, 3D printing technology is highly utilized in the new product development process. Robotic technology, VR and AR, and AI technologies are the next most commonly used technologies for the new product development stage. Robotic technology is heavily used in the new process development process. IoT, AI, and 3D printing technologies are the next most commonly used technologies for the new process development stage. Robotic technology is very widely used in the existing product development stage. Nanotechnology, biotechnology, and 3D printing technologies are the next most commonly used technologies for existing product development stages. Robotic technology is heavily used in the existing process development stage. IoT, big data, and AI technologies are the next most commonly used technologies for existing process development stages. According to the results, 3D technology is the most used, and genetic engineering technology is the least used technology in the apparel industry in Sri Lanka.

Table 5: Availability of emerging technology in the apparel industry in Sri Lanka

Emerging Technology	**Heavily used in the industry**
3D printing	1
Robotic	2
AI	3
IoT	3
VR & AR	4
Nano Technology	5
Big Data	6
Biotechnology	7
Genetic engineering technology	8

Source: Structured Questionnaire Survey

The main limitation of this study is the strategic innovation structures of companies of all sizes were not addressed. Therefore, additional in-depth company analyses, including an analysis of strategic innovation, a revenue and cost analysis of the previous three to five fiscal years, an analysis of the innovative product portfolio, and a case study of consumer perception, are highly advised. Future studies will need to take into account and compare the infrastructure of chosen organizations in each category for at least five years with actual data and their precise innovation performance. Finally, the supporting role of the government as moderating or mediation by using structural equation model a better study for others to undertake.

6. Conclusions

A research study revealed that the volume of innovative products exported by the apparel industry in Sri Lanka, which was considered the export performance in the study, was highly influenced by the company's annual investment in acquiring new technology and the budget allocated for exploring new technology overseas. It further revealed that having an organizational innovation strategy and evaluating overall innovation as well as product and process innovation also increased the firm's export performance. Further, research has found that organizations that have committed engineering and scientific teams to work on technology-related innovation processes and evaluating emerging technologies around the world have a high level of significance toward innovative product export. Finally, the research

found that management's willingness to take risks, an innovative mindset & seeking newness, and a supportive attitude toward subordinates are also highly influential on the export performance of the organization.

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