

Impact of Lean Innovation, Process Standardization and Employee Efficiency on Cost Reduction in Manufacturing Firms

Samaun Al Farecee

*Department of Management Studies, Bangladesh University of Professionals
Dhaka, Bangladesh*

Shuverthee Monjur

*Department of Management Studies, Bangladesh University of Professionals
Dhaka, Bangladesh*

Shajnin Osmani

*Department of Management Studies, Bangladesh University of Professionals
Dhaka, Bangladesh*

Rubaiya Zaman

*Department of Management Studies, Bangladesh University of Professionals
Dhaka, Bangladesh*

Abstract

This study emphasizes the relationship between lean innovation and the reduction of manufacturing costs, with a particular emphasis on the mediating roles of process standardization and labor efficiency. In the current competitive industrial environment, manufacturers are facing growing pressure to lower operating costs while maintaining or enhancing productivity and quality. Lean innovation- a combination of innovative practices and lean management principles—is offered as a strategic approach to achieving these objectives. Despite its growing relevance, there have been limited efforts to examine how lean innovation achieves cost-effectiveness in relation to internal operating dynamics. The study bridges this gap by elaborating on the limitations of traditional cost-cutting approaches and highlighting the necessity of operational efficiency. The research attempts to analyze both the direct impact of lean innovation on cost reduction and the mediating effects of workforce efficiency and process standardization. Grounded in a comprehensive literature review, the study develops a conceptual framework linking these variables, drawing from theories in lean management, innovation, and organizational performance. Through a quantitative method, data were collected by using structured questionnaires for manufacturing companies' professionals. Statistical analysis confirms that lean innovation has a substantial influence on cost savings, both directly and indirectly. The results indicate that employee effectiveness and process standardization are partial mediators of the influence, with the implication that structured operations and quality human resources are necessary to maximally draw out the benefits of lean innovation. The findings contribute to the literature by describing internal mechanisms underlying cost efficiency and offering actionable insights to manufacturing managers. The study concludes that lean innovation, when supplemented with workforce development and operational standardization, is a viable and sustainable path to financial performance enhancement in manufacturing environments.

Keywords: Lean Innovation; Manufacturing Cost Reduction; Process Standardization; Labor Efficiency; Lean Management; Operational Efficiency

1. Introduction

1.1 Background of the Study

In today's fast-moving and swiftly changing industrial environment, manufacturers are under almost constant pressure -pressure that has been continuously upward in recent years -to reduce their operating costs while improving productivity and remaining competitive. The previous approaches to managing costs and innovating have been unsuccessful in achieving the necessary complexity, pace, and dynamics of the manufacturing world. Therefore, organisations are beginning to investigate lean innovation, a management approach that integrates the principles of lean manufacturing with a structured innovation process and seeks to eliminate waste, constrain operations, ensure continuous improvement, and optimize resources (Rabby et. al., 2025).

Building on TPS principles, lean innovation drastically focuses on eliminating waste (muda), standardizing processes, and being responsive to customer needs (Liker, 2004; Hossain et al., 2017). Lean innovation moves away from a focus on capital-intensive, large-scale innovation and fosters a culture of incremental improvement that redefines value creation and organizational flexibility (Sehested & Sonneberg, 2011). The degree of efficiency of lean innovation will rely heavily on the internal dynamics of the organization that relate to the standardization of processes and the organization's working with efficient employees. Standardized processes lead to a reduction in variation, improved predictability, and consistent quality (Dennis, 2007; Pawlak et al., 2023). When organizations empower employees through training, engagement, and problem-solving, employees become efficient actors that grease the wheels for the process of lean execution (De Medeiros et al., 2025; Sarnadi & Sulistyowati, 2024). While there has been a lot of research on lean, there has been little to no research on the concepts of lean innovation, specifically with regard to reducing costs through internal mechanisms, creating a need for empirical research.

1.2 Problem Statement

Manufacturers are experiencing increasing manufacturing costs, restrictions on resources, and greater global competition. In their attempts to preserve and enhance their profits as well as their sustainability in the long term, manufacturers will need to discover new, revolutionary means of realizing management costs that are more productive than is currently being done (Rabby et. al., 2025). Lean innovation is one promising approach for achieving cost reduction through waste reduction, flow streamlining, and adaptive innovation. However, observed and captured innovation outcomes of lean have varied greatly across organizations. Some manufacturers have observed significant cost savings and operational improvements, while others have had little or no improvements, indicating the presence of underlying mediating variables influencing the success of lean engendered initiatives.

Among these elements, the congruence between process standardization and employee efficiency has been identified as a key influence in lean performance outcomes. Companies with standardized processes and powerful and skilled employees are likely to be more successful in implementing lean innovation into tangible cost savings. However, it remains unclear how the relationship between process standardization and employee efficiency influences these lean performance outcomes, which presents a significant gap in the literature.

This is an important issue for manufacturing organizations like Grameenphone, which has rising costs to consider, and to understand better how to use lean innovation as a management strategy for creating value and sustaining cost savings. Thus, the study intends to examine these relations in the context of a manufacturing firm and in regard to cost savings.

Literature Review

2.1 Introduction

The global manufacturing sector is under increasing pressure to improve efficiency while lowering production costs in a very competitive environment (Panwar et al., 2018). While reducing costs is a vital strategic priority, businesses need to make reductions while not compromising product quality, safety, or customer satisfaction. Cost reduction measures taken using traditional methods like workforce reduction and pressure on suppliers often result in gains at the expense of long-term competitive advantage (6sigma.us, 2025). As such, manufacturers increasingly utilize integrated strategies containing the elements of lean innovation, standardization of processes, and the efficiency of employees as a means of achieving sustainable cost reductions. These companies do not consider these strategies to be independent of each other; they view them as related parts of a system designed to eliminate waste, improve predictability in processes, and maximize human resources. The ability of these organizations to synergistically employ these strategies results in simultaneous improvements in costs, quality, delivery performance, and flexibility (Nawanir et al., 2013). This literature review will synthesise empirical, case-based, and theoretical research extends to how operational procedures work together to influence manufacturing performance.

2.2 Lean Innovation

Lean innovation represents a strategic approach to combining lean thinking's philosophies with innovative management techniques. It is unlike older methodologies of innovation, which often relied on experimenting with an abundance of resources using trial-and-error principles. Instead, it implements a maximum value philosophy, an emphasis on speed through rapid experimentation, and the iterative enhancement of work processes with minimized use of resources (Rabby et. al., 2024). The origin of the concept is from the application of the principles of the Toyota Production System over decades in global manufacturing. Womack and Jones (1996) identified the five foundational lean principles—value definition, identification of value streams, flow creation, pull systems, and a quest for perfection—and established a theoretical framework for lean innovation. All of these five principles have at their core an emphasis on the continuous elimination of waste and an understanding that the success of an organization is dependent upon the application of lean thinking in totality and not just an isolated use of a lean tool (Lean.org, 2024).

Evidence suggests that lean practices support the creation of incremental innovation capabilities. This supports the concept put forth in Cuskic's (2024) qualitative case study, which found that lean manufacturing reduces waste, thereby enabling organizations to allocate resources towards proactive innovative activities. This research also highlighted the need for strong leadership and effective communication in order to maximize the benefits of implementing lean practices and minimize resistance to change. Together, these findings reinforce the perception of lean innovation as a strategic capability rather than simply an operational practice.

In addition to the capacity to create incremental innovation, lean innovation allows manufacturing companies' competitiveness to extend across multiple performance levels at once. Alshawabkeh (2021) identified that the mechanisms by which customer knowledge is transformed into competitive products are based on three variables - market orientation, new

product performance, and lean innovation. Likewise, Broichhausen (2013) established that lean innovation enhances the creation of value by eliminating wasteful behaviors throughout product development workflows. As a result, by shortening the time from product initiation to market and lowering the total amount of materials consumed without sacrificing quality, firms that utilize lean innovation are able to enter markets sooner and achieve lower overall costs than firms that utilize traditional methods of product innovation.

Lean innovation is supported by structured tools. Value Stream Mapping (VSM) gives a visual representation of what activities help to add value and what do not, allowing for the identification of bottlenecks and inefficiencies across production and innovative process lines (Kaizen.com, 2025). Another core tool for lean is Kaizen, which provides continuous improvement through small changes. Kareska (2024) identified statistically significant increases in productivity, efficiency, and reductions in defects and cycle time after implementing Kaizen in a manufacturing environment, underscoring that all levels within an organization must be involved.

The final example of a structured tool supporting lean innovation is the 5S system (Sort, Set in Order, Shine, Standardize, Sustain), which provides the foundation for a clean and organized workplace in support of lean innovation. Sangode (2018) found that implementing 5S yielded measurable results in workplace efficiency, organization, employee motivation, and working conditions, and provided evidence of a direct correlation between practicing 5S and operational performance.

2.3 Cost Reduction Mechanisms

Lean Innovation achieves reductions in manufacturing costs through many reflective processes of reduction based on a waste elimination process. Example: The elimination of waste (i.e., defective items) will create a reduction of the amount of material, labor, & facility resource consumption, which will result in a lower cost/per unit (Panwar et al., 2018). Example 2: With the implementation of lean methodologies, the total inventory will be reduced, therefore releasing funds previously tied up in inventory to be invested in cash flow in value-added activities (Kaizen.com, 2025). Example 3: Quality improvements established through lean methodologies will provide significant reductions in rework, scrap & warranty cost as well as reduced hidden cost associated with poor quality, which, based on the total revenue generated by manufacturing, could be as much as 15-40% (OrcaLean, 2025).

The cost savings achieved through lean practices are strongly confirmed through actual experience. In particular, Panwar et al. (2018) conducted a study in the Indian process industry and found positive relationships between lean practices and several performance metrics, including productivity, first-pass yield, waste reduction, inventory reduction, defect reduction, and total cost savings. According to the authors, lean practices need to be applied in a holistic manner and not just as separate, independent elements because applying them in a coordinated fashion creates multiplier effects for many different outcome areas. Organizations that adopt lean principles generally experience operational cost savings of 20–30% during the first year of implementation (6sigma.us, 2025). These savings result from systematic reductions in 3 major categories of costs: direct material costs (50–70%), direct labour costs (10–30%), and

manufacturing overhead costs (15–35%). Lean methodologies focus simultaneously on improvements to yield, productivity of labour, reductions in scrap, improved space utilization, and prevention of equipment failure (6sigma.us, 2025).

H3: There is a significant positive relationship between Lean Innovation and Cost Reduction.

A fundamental operational principle for how to reduce costs is known as Lean Innovation. Multiple studies have proven that Lean Innovation will achieve cost reductions by implementing many interconnected approaches, with the main approaches being: systematically removing waste, standardizing processes, and ongoing continuous improvement (Rabby et. al., 2024). Like standardizing processes, which allows tasks to be performed consistently and therefore improves the efficiency of performing tasks by eliminating variability costs associated with performing tasks, is an example of how “continuous improvement” is utilized to realize further reductions in resource usage per unit of output. Fadjarenie (2024) found that implementing MFCA and CPO Management can lead to significant improvements in reducing costs in the manufacturing sector and that this was further supported by the work Atta-Ankomah et al., 2022 who documented measurable improvements in the efficiency of Ghanaian manufacturing enterprises after implementing Kaizen through increases in the efficiency of manufacturing processes e.g.; as well as the improvement in WTV ratios and cost optimizations. (Ofoegbu and Efeh, 2023) provided additional evidence of a statistically significant positive correlation between lean production and operational performance, thereby linking the implementation of lean practices directly to achieving cost reductions (Guha et. al., 2025)..

Lean innovation's ability to reduce costs is supported primarily by means of employee efficiency, and it is an estimate of how well workers use time, skills, and resources to create value, comprising labour productivity, error rates, machine utilization, and adherence to standard processes. According to Yadav, D.K., & Rai, A.K. (2023) in their meta-analysis of the major reasons for loss of efficiency in manufacturing industries include: aged equipment, lack of training, lack of ambition, distractions in the workplace, and poorly designed production processes. These authors concluded that there are many factors that contribute to efficiency, and therefore, the solutions to increase it must be comprehensive, rather than one-dimensional.

The importance of training and skill development for enhancing employee efficiency is well-documented. Olasanmi et al. (2021) determined that both employee and organizational factors have a strong impact on productivity in manufacturing companies. Their study concluded that continuous training, action-learning programs, and on-the-job development enhance both performance and employee morale. The environment a worker is exposed to also has a significant influence on his/her level of efficiency (Rabby et. al., 2023). Motivation, satisfaction, and psychological safety are all moulded by the assignment the worker is in. Research has shown that supportive leadership, incentive systems that reward performance, and development of a positive work climate will produce improved efficiency and productivity (Deci et. al., 2001, Northouse, 2018).

Standardized processes also help to improve employee efficiency by providing an unambiguous framework for completing tasks. Standardization can help cut down on the time it takes to make decisions and minimize variations, which allows employees to dedicate more time to executing

quality work (MTI Systems, 2013). When standardized work practices are combined with training and performance feedback, they result in a high level of consistency in performance and help create a process for gradually improving the quality of performance through the use of learning and feedback (MTI Systems, 2013).

H4: There is a significant positive relationship between Employee Efficiency and Cost Reduction.

Employee efficiency is a contributor to the reduction of costs through decreased labour expenses per unit, reduced amounts of waste, and enhanced quality of the resulting product. Increased output will occur as a result of more efficient employees that do not require the proportionate number of additional employees needed during periods of non-product output, which allows more fixed labour costs to be spread across the total output of the employee population. Habib (2023) proved that the application of value stream mapping improved the productivity of employees by eliminating all activities that do not add value in a manufacturing company located in Bangladesh. Nwanyanwu (2023) provided similar results by proving a statistically significant correlation between the use of cost reduction strategies and financial performance. These studies suggest that sustained reductions in total costs can best be accomplished through integrated investments in employee efficiency, standardized processes and continued improvement rather than relying solely on short-term strategies such as reducing the workforce and/or salaries.

2.4 Employee Efficiency

Innovation based on Lean principles has become a viable method for improving manufacturing employee productivity. At its roots, Lean is based on the ideas of eliminating waste from the workplace and improving processes through continual improvement, and therefore is very supportive of both operational excellence and employee productivity since it allows for the simplification of tasks and more focus on activities that add value (Möldner, Garza-Reyes, & Kumar, 2020).

Continual improvement within a Lean culture occurs when employees are actively involved in solving problems and making decisions, which increases their morale, helps develop their skills, and provides a commitment to achieving efficiency objectives (Antonio, 2024). Lean Production, as used by Toyota, illustrates that when waste and employee empowerment are combined, sustained levels of productivity and excellent operational performance are possible (Antonio, 2024).

Innovation based upon Lean principles is taken even further with the use of advanced technology (Industry 4.0), which has the potential of dramatically increasing the productivity of employees. Real-time data collection and utilization, automation of tasks, and the availability of decision support tools (Möldner et al., 2020) have helped increase the efficiency of employees by allowing them to perform tasks more efficiently, have less fatigue from performing repetitive tasks, and make fewer errors. By linking lean and digital innovations, flexible work-flows can be developed and allow for faster response to changing production requirements.

There is evidence from empirical studies that Lean Innovation improves employee productivity. Möldner et al., (2020) found that both technical and human-centred lean approaches improve process innovation and overall operational performance. Case studies, including that of Horizon Addis Tire Manufacturing PLC, illustrate how implementing lean improves the relationship between workers and their roles, clarity of roles, and the ability to adapt to changing circumstances, which all contribute to employee productivity (Shrafat & Ismail, 2019). Leading manufacturers like Nike and Intel demonstrate that lean practices combined with process innovation can continue to deliver employee productivity and competitive advantages (Yen et al. 2023).

The literature consistently supports a strong positive relationship between Lean Innovation and employee productivity in manufacturing.

H1: *There is a significant positive relationship between Lean Innovation and Employee Efficiency*

2.5 Process standardization and cost reduction

The essential relationship between Lean Innovation is linked directly to Manufacturing and Process Standardization through their contributions toward operational efficiencies and continual improvement. Process Standardization establishes a stable foundation for an organization by creating consistent, repeatable work-flows, thus reducing variability and inefficiencies. Without Standardization, some of the consequences associated with introducing Innovative initiatives may be inconsistent or introduce instability into Processes. In turn, Lean Innovation systematically integrates Continual Improvements within Standardized Processes, thereby allowing for systematic refinement and improvement (Möldner, Garza-Reyes, & Kumar, 2020). Their interdependent relationship ensures that Innovations are applied according to best practices, rather than on a can be considered as Ad-hoc implementations.

There is a wealth of evidence attesting to the strong link between Process Standardization and Lean Environments. For example, by forming the foundation of the most efficient way to perform a task through identifying sequence, timing, and required tools, Standardized Work reduces Unnecessary Movement and Operational Variability (Oraclean, 2024). A study conducted by Ghatrha and Sharma (2022) revealed that implementing Standardized Work within a Manufacturing press facility resulted in a significant Reduction in Cycle Time and Labour Hours, thus providing increased Operational Efficiency and creating a safer and more predictable work environment.

Lean innovation takes consistent processes to the next level by incorporating state-of-the-art technologies, such as Industry 4.0, that enable real-time monitoring and quick updates on standardized processes (Möldner et al., 2020). With this updated standardization, flexibility is significantly increased while innovation will be spread quickly through all production systems, yet providing stable processes.

In addition to supporting cost reduction through standardization, process standardization directly reduces costs due to lower levels of defects, less rework, and less scrap, thus reducing

the cost of non-conformance (Oraclean, 2024). Higher labor utilization, accurate cycle times, and efficient material flow further lower the cost of inventory while increasing throughput. Empirical studies found that standardizing lean practices improves process reliability, resource utilization, and financial performance, making it clear that standardization is a vital component of achieving lean cost effectiveness and creating an advantage through lowering operational costs (Klein et al., 2022; Ghatorka & Sharma, 2022).

H2: There is a significant positive relationship between Lean Innovation and Process Standardization

H5: There is a significant positive relationship between Process Standardization and Cost Reduction

3. Conceptual Framework

3.1 Introduction

This chapter introduces the conceptual framework that informs this study. The study explores the effect of lean innovation on cost reduction in manufacturing firms with particular focus on process standardization and efficiency of workers as mediating functions. The framework is established to illustrate the interaction between variables and offer a systematic explanation of how lean innovation initiatives are translated into cost-advantage results through processes of operating and human efficiency.

3.2 Variables of the Study

This study involves four key contractors

Independent Variable:

- **Lean Innovation:** The deployment of innovative techniques, methods, and systems to eliminate waste, maximize resources, and provide value to the customer in production settings.

Dependent Variable:

- **Cost Reduction:** As a result of the firm's ability to decrease production and operation costs without compromising quality or performance.

Mediating Variables:

- **Process Standardization:** The level to which production processes are streamlined, integrated, and documented to standardize quality and efficiency.
- **Employee Efficiency:** The extent to which employees perform their duties efficiently and with minimal time and resource wastage, occasionally depending upon training, motivation, and process clarity.

3.3 Conceptual Framework

The conceptual framework of the study is illustrated in the figure below. It reflects both the direct and indirect relationships among the contractors. The arrows represent hypothesized casual pathways between the variables based on relevant literature and theoretical assumptions. The theoretical model illustrates that lean innovation has direct and positive impact on cost cutting for manufacturing firms. Besides the direct impact, lean innovation is also likely to have a positive impact on process standardization and employees' efficiency, both of which serve as mediating variables in the relationship between lean innovation and cost cutting. Process standardization assists in cost effectiveness via ensuring process stability and minimizing variations, thereby making production efficient and reducing wastage. Employee efficiency, on the other hand, enhances cost-saving outcomes through maximizing task implementation, decreasing downtime, and encouraging continuous improvement culture. The framework, therefore, suggests that lean innovation not just minimizes costs directly but indirectly as well by increasing the operating processes and productivity of human resources.

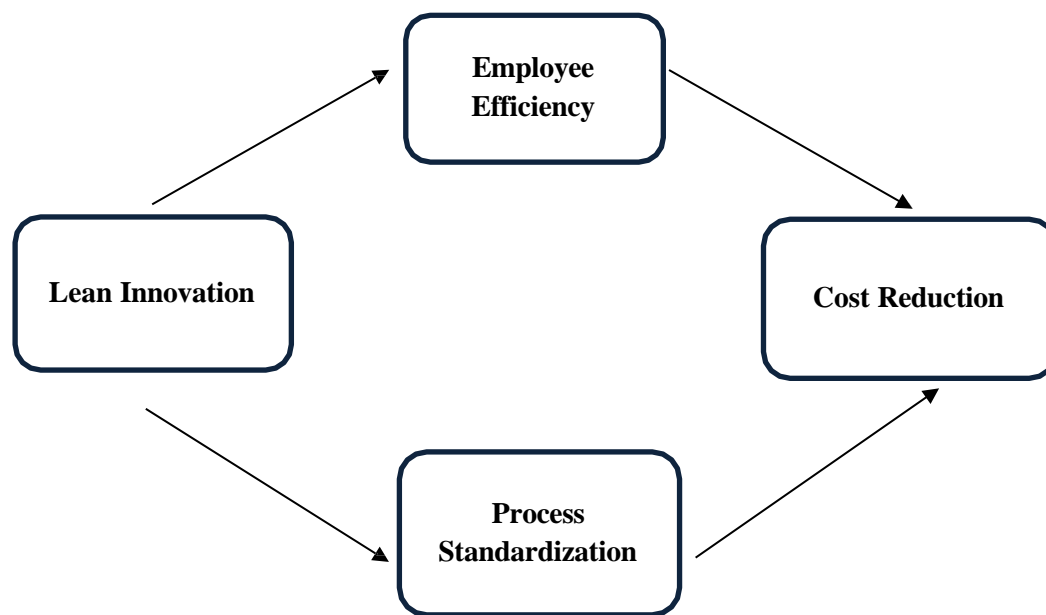


Figure 3.1: Conceptual Framework

4. Research Methodology

4.1 Research Design and Approach

The research employs a deductive and quantitative methodology that aims to investigate the effects of Lean Innovation on Cost Reduction for manufacturing companies, while recognizing the possible mediating influences of Process Standardization and Employee Efficiency. A deductive reasoning approach is appropriate to assess whether the theoretical propositions that have been inferred from the review of existing literature are validated, and provides an approach

to infer causal relationships around the theorized constructs that have been operationalized. A quantitative approach provides a structured means to assess relationships, enables an empirical assessment of the observations, and inference of statistically valid conclusions. The explanatory research enables the observation of how lean innovation strategies affect cost savings operating through operational procedures and employee matters.

For methodological rigor, multiple sources of primary and secondary data were used. Primary data were collected through a structured questionnaire survey developed to understand employee perspectives and practices of lean innovation, standardization, efficiency, and cost savings. Secondary data were gathered from reputable sources, such as peer-reviewed journals, industry reports, and organizational reports, with regard to lean management, operational efficiencies, and innovation-based efficiency. Multiple sources of data provided rigor and robustness in testing the conceptual model. Data were analyzed using IBM SPSS, then descriptive statistics, correlation, and hypothesis testing techniques to determine direct and mediation relationships among the study variables.

4.2 Population, Sampling, and Data Collection

The sample population of this research study included professionals working in the manufacturing and process-oriented industries in Bangladesh, with employees working for well-established organizations such as Grameenphone, Pran-RFL, Augmedix, and Daraz. These firms were selected for the diversity of their operations, as well as because each has formalized innovation practices within its production or service process. Each industry contained unique information and a wealth of knowledge to inform how lean innovation arrangements function in different contexts. The research adopted a non-probability purposive sampling approach, allowing for participants to be identified who were directly engaged with operational management, process improvement, and innovation initiatives. Out of approximately 520 potential respondents, 214 valid responses were collected through email solicitation, social media, and in-person (e.g., businesses; places with public access), resulting in an approx 41.15% response rate. This total is a sufficient number for developing quantitative data for the quantitative analyses (i.e., hypothesis testing) that are to be developed using the 214 valid respondents' responses.

The primary data collection used a structured survey based on validated constructs from prior studies. The survey contained four main variables - Lean Innovation, Process Standardization, Employee Efficiency, and Cost Reduction - that were assessed with items based on a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Academic scholars and professionals from the industry judged the questionnaire and survey for validity and reliability. Next, a pilot study was conducted with a finer population sample to gauge clarity and flow. Reliability was assessed using Cronbach's Alpha, gauging internal consistency across all the constructs within the assessments. The final survey was administered online and in-person to extend reach to respondents while reducing accessibility barriers. Secondary data was used to help complement and contextualize the primary data. In so doing, the research benefited from research validity and analysis richness.

4.3 Data Analysis and Ethical Considerations

The data collected were coded and organized in Microsoft Excel before exporting the data to IBM SPSS for statistical analysis. The first step in the statistical analysis included conducting descriptive statistics to summarize respondent demographic data and provide information on patterns in the overall data. Inferential analysis was then performed using Pearson's correlation coefficient to determine the strength and significance of the relationships between the constructs being studied. The second analysis was to test the hypotheses regarding the direct effects and the mediating effects of Lean Innovation, Process Standardization, Efficiency of Employees, and Cost Reduction, and this was consistent with the empirical framework that had been proposed. Based on the results of the analyses, the effect that lean practices have on both the operational performance and the financial performance of manufacturing companies was evaluated.

The study adhered to the ethical principles established for research involving human participants. Participants were informed of the study's purpose, the procedures to be conducted, and the possible risks before they agreed to participate, and they gave their consent to participate in the study. Participants were free to withdraw from the study, all data were collected confidentially, and no information that could be used to identify the respondents was collected. In addition, all data collected were maintained in a secure manner and were used only for academic research purposes following institutional ethical standards.

5. Analyses & Findings

5.1 Introduction

This chapter presents the findings from the correlation analysis conducted to examine the relationships among Lean Innovation (LI), Employee Efficiency (EE), Process Standardization (PS), and Cost Reduction (CR) in manufacturing firms. The primary objective of this study is to investigate the direct effect of Lean Innovation on Cost Reduction and the mediating roles of Process Standardization and Employee Efficiency in this relationship.

5.2 Descriptive Summary

The dataset consists of 214 valid responses out of 520 potential participants with a ratio of 41.15%. The correlation analysis was carried out using Pearson’s correlation coefficient to assess the strength and direction of linear relationships between variables. The significance level was set at $p < 0.01$ (2-tailed).

5.3 Hypothesis Testing and Correlation Analysis

H1: There is a significant positive relationship between Lean Innovation and Employee Efficiency

Correlations

		LI	EE
LI	Pearson Correlation	1	.657**
	Sig. (2-tailed)		<.001
	N	214	214
EE	Pearson Correlation	.657**	1
	Sig. (2-tailed)	<.001	
	N	214	214

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 5.1 Correlation between Lean Innovation & Employee Efficiency

As shown in Table 1, the Pearson correlation coefficient between Lean Innovation (LI) and Employee Efficiency (EE) is $r = 0.657$, $p < 0.001$, indicating a strong, statistically significant positive relationship. This supports **H1**, suggesting that improvements in Lean Innovation practices are associated with enhanced employee efficiency in manufacturing firms

H2: There is a significant positive relationship between Lean Innovation and Process Standardization

Correlations

		LI	PS
LI	Pearson Correlation	1	.285**
	Sig. (2-tailed)		<.001
	N	214	214
PS	Pearson Correlation	.285**	1
	Sig. (2-tailed)	<.001	
	N	214	214

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 5.2 Correlation between Lean Innovation & Process Standardization

Table 2 shows a Pearson correlation coefficient of $r = 0.285$, $p < 0.001$, between LI and PS. Although the correlation is weaker compared to other variables, it remains statistically significant. Thus, **H2 is supported**, indicating that Lean Innovation is positively associated with Process Standardization.

H3: There is a significant positive relationship between Lean Innovation and Cost Reduction

Correlations

		LI	CR
LI	Pearson Correlation	1	.718**
	Sig. (2-tailed)		<.001
	N	214	214
CR	Pearson Correlation	.718**	1
	Sig. (2-tailed)	<.001	
	N	214	214

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 5.3 Correlation between Lean Innovation & Cost Reduction

The results in Table 3 reveal a Pearson correlation coefficient of $r = 0.718$, $p < 0.001$, between LI and CR. This is a strong, positive, and statistically significant relationship, affirming **H3**. The findings imply that the implementation of Lean Innovation has a substantial direct effect on cost reduction efforts in manufacturing firms.

H4: There is a significant positive relationship between Employee Efficiency and Cost

Reduction

		EE	CR
EE	Pearson Correlation	1	.540**
	Sig. (2-tailed)		<.001
	N	214	214
CR	Pearson Correlation	.540**	1
	Sig. (2-tailed)	<.001	
	N	214	214

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 5.4 Correlation between Employee Efficiency & Cost Reduction

The correlation between EE and CR, shown in Table 4, is $r = 0.540$, $p < 0.001$. This moderate to strong positive correlation indicates that higher levels of employee efficiency are significantly associated with greater cost reduction. Therefore, **H4 is supported**.

H5: There is a significant positive relationship between Process Standardization and Cost Reduction

Correlations

		PS	CR
PS	Pearson Correlation	1	.224**
	Sig. (2-tailed)		<.001
	N	214	214
CR	Pearson Correlation	.224**	1
	Sig. (2-tailed)	<.001	
	N	214	214

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 5.5 Correlation between Process Standardization & Cost Reduction

As presented in Table 5, the Pearson correlation coefficient between PS and CR is $r = 0.224$, $p < 0.001$, indicating a statistically significant but relatively weak positive relationship. Nevertheless, the result is sufficient to support **H5**, suggesting that process standardization contributes positively, though moderately, to cost reduction.

5.4 Summary of Hypotheses Testing

Hypothesis	Relationship Tested	Pearson's r	Significance	Result
H1	LI → EE	0.657	p < 0.001	Supported
H2	LI → PS	0.285	p < 0.001	Supported
H3	LI → CR	0.718	p < 0.001	Supported
H4	EE → CR	0.540	p < 0.001	Supported
H5	PS → CR	0.224	p < 0.001	Supported

Table 5.1 Hypothesis Testing

5.5 Interpretation of Results

The results of the correlation analysis indicate that Lean Innovation plays a crucial role in reducing costs in manufacturing firms, both directly and indirectly. The strong correlation between LI and CR supports the foundational premise of the study. Furthermore, the mediating variables—Employee Efficiency and Process Standardization—also demonstrate significant positive relationships with Cost Reduction, validating their mediating potential in the conceptual model.

While Employee Efficiency exhibits a stronger mediating relationship than Process Standardization, both variables remain important channels through which Lean Innovation influences cost outcomes. This implies that interventions to improve Lean Innovation should simultaneously target operational standardization and workforce performance enhancement.

6. Discussion

The results of this research provide robust empirical evidence of the relationships among Lean Innovation (LI), Employee Efficiency (EE), Process Standardization (PS), and Cost Reduction (CR) in manufacturing organizations. The strong positive correlation between LI and CR ($r = 0.718$, $p < 0.001$) indicates that lean-focused innovation plays a key role in enhancing financial efficiency through process optimization and streamlining work-flows in addition to minimizing waste and increasing organizational responsiveness for the customer. The strong relationship of LI with EE ($r = 0.657$, $p < 0.001$) suggests lean-focused innovation also helps promote and empower the workforce to create engaged workers by facilitating increased accountability and behaviors for continuous improvement. This suggests that lean systems' success relies on the competence of human employees as much as it relies on effective processes. The relationship between LI and PS was positive but much weaker ($r = 0.285$, $p < 0.001$), leading us to believe the ability of LI to promote standardization is influenced by managerially deliberate efforts to embed standardized lean-level behaviours into the organization. Furthermore, the moderate to strong relationship between EE and CR ($r = .540$, $p < 0.001$) reinforces our prior observation that efficiency at the employee level results in measurable cost savings, as employees made fewer mistakes, completed tasks more quickly, and addressed operational problems in a proactive manner that led to cost savings for the organization. Meanwhile, PS shows a weaker, yet significant relationship with CR ($r = 0.224$, $p < 0.001$), which means that although PS means that the process is fairly stable, it is a less credible contributor to the cost reductions for the organization if employee behavior is not adaptive and innovative.

All together, these findings confirm the integrated model of intent in which Lean Innovation is the strongest contributor to reducing overall costs directly and indirectly through its mediators. In summary, the results indicate an important insight—Employee Efficiency has a greater mediating effect than Process Standardization, demonstrating that human flexibility and competencies will always be an important mechanism of how lean strategies become results. From a theoretical perspective, this research advances the lean management literature by arguing that lean success is heterogeneous and cannot be fully established and understood only as structural efficiency by itself. It further develops the argument that human-centred mechanisms have a comparatively greater role in the longevity of lean innovation outcomes and pushes forward a framework for calls to build on such LTD (lean leader, manager, and Ab) as behavioral Mediators and further TE (Team Efficiency) as structural mediators. These findings

are useful in balancing the lean implementation strategy for managers. Organizations that seek to reap ongoing cost efficiency should work in partnership with employees not only to eliminate wasteful activity and enact standard operating procedures, but also to develop employee engagement skills and innovative thinking skills. Dependably relying on standardization while not fostering employee 'agency' may inhibit flexibility and, in the long run, possibilities to increase performance. An employee-centered lean culture designed within consistent processes and measures seems to yield the best outcomes in gaining and maintaining competitiveness and cost reduction, especially in manufacturing systems.

In conclusion, the current research reinforces the notion that Lean Innovation (LI) serves both an enabling and a facilitating function for cost reduction, and the efficacy of LI is mediated by employees with capabilities and a process that is both structured and flexible. The interplay of

innovation, process control, and human efficiency demonstrates the multifaceted nature of competitiveness in contemporary manufacturing. Organizations like Grameenphone and other manufacturing companies in Bangladesh that apply lean innovation as an organizational idea beyond just a technical approach - demonstrating dedication to continual improvement, employee engagement/empowerment, and standardized discipline - will glean sustainable cost leadership and long-term operational excellence.

Conclusion

The study examined how manufacturing firms can be cost-effective by implementing Lean Innovation (LI), which is mediated by Process Standardization (PS) and Employee Efficiency (EE). The results confirm that Lean Innovation has a considerable effect of reducing costs by eliminating waste, simplifying work-flows, and amplifying value creation to its utmost. The impact of LI is maximized by the degree to which it is embedded within the structure and culture of a company. Process Standardization, as a weaker mediator, works to provide the assurance that innovative practices are consistently and dependably carried out. Conversely, Employee Efficiency was a stronger mediator, emphasizing the valuable role of an empowered, skilled workforce in powering lean outcomes. Trained and empowered employees help to interpret lean initiatives into cost-reduction action that is effective. The study emphasizes that Lean Innovation has to be a long-term organizational philosophy and not just a technical solution. When supported by capable people and standard processes, it delivers cost savings that are sustainable and scalable. This comprehensive approach offers the blueprint for manufacturing firms to acquire competitiveness in time-conscious and cost-sensitive markets. Lean Innovation—if aligned with operations systems and the abilities of employees—can transform manufacturing operations. This study has theoretical and practical implications, demonstrating the importance of aligning innovation, process discipline, and employee engagement in pursuit of sustainable cost-effectiveness.

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