

Engineering Management Framework for Women Entrepreneurs in SMEs

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Abstract: Small and Medium Enterprises (SMEs) are vital contributors to national economies, yet their efficiency and sustainability are heavily influenced by the legal and market environments in which they operate. Women entrepreneurs, in particular, face systemic constraints arising from outdated labour laws, discriminatory property rights, and restricted access to finance. These barriers not only perpetuate inequality but also generate inefficiencies that reduce SME productivity, technological adoption, and operational optimisation.

This paper adopts an engineering management perspective to examine how legal and market frameworks impact the performance of women-led SMEs in Sri Lanka. Drawing on empirical findings from surveys, interviews, and comparative case studies, the study identifies systemic inefficiencies in resource allocation, process management and innovation caused by regulatory and cultural barriers. Structural Equation Modelling (SEM) is used to map relationships between labour laws, market constraints, and SME performance.

The findings demonstrate that outdated labour laws directly constrain workforce optimisation, while market access barriers reduce the capacity of SMEs to invest in technology and process improvements. Comparative analysis with the UK, Australia, and New Zealand highlights the value of gender-sensitive labour regulations and flexible market policies for enabling innovation.

A framework for inclusive SME engineering management is proposed, integrating legal reform, market access improvements, and system-level optimisation. The study contributes to the engineering management field by bridging social, legal, and operational perspectives, offering actionable insights for policy, academia, and practice.

Keywords: Engineering Management, Labour Law, Market Access, SME, Sri Lanka, Systems Efficiency, Women Entrepreneur

1. Introduction

Small and Medium Enterprises (SMEs) form the backbone of Sri Lanka's economy, contributing more than 50% of GDP and accounting for over 45% of employment. Among these, women-led SMEs have become increasingly important for both economic growth and social development. However, despite this growing contribution, women entrepreneurs remain disadvantaged by structural, legal, and market-related barriers. These systemic inefficiencies hinder their ability to compete effectively, adopt new technologies, and sustain operations in competitive markets [1]. From an engineering management perspective, these challenges are not merely social or legal; they represent operational inefficiencies within the SME system. Outdated labour laws, including the Factories Ordinance (1942) and the Employment of Women, Young Persons and Children Act (1956), restrict workforce flexibility. These laws also reinforce gender inequities in organisational operations [2]. Similarly, cultural barriers particularly discriminatory property rights-limit women's access to credit and prevent the acquisition of

productive assets, thereby reducing resource optimisation [3]. Market access barriers, including financial exclusion and limited exposure to international networks, further prevent SMEs from scaling operations or adopting innovative processes.

The engineering management discipline emphasises the optimisation of systems involving people, processes, and technology.

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When SMEs cannot efficiently allocate resources, adapt operations, or integrate innovation due to structural barriers, the consequences are visible in reduced productivity, inefficiencies, and weak competitiveness [4]. This paper argues that women entrepreneurs in Sri Lanka face such barriers not only as issues of gender equality but also as engineering management challenges that demand systemic solutions.

The objectives of this study are threefold:

1. To assess how labour laws and market barriers impact women-led SME efficiency and operations in Sri Lanka.
2. To compare these challenges with international best practices in the UK, Australia, and New Zealand
3. To propose an engineering management framework that integrates inclusivity, legal reform, and system-level optimisation to enhance SME performance.

The paper is structured as follows: Section 2 reviews relevant literature; Section 3 outlines the methodology; Section 4 presents findings; Section 5 discusses the implications for engineering management; Section 6 introduces the proposed framework; and Section 7 concludes with recommendations and contributions.

2. Literature Review

2.1 SMEs and Engineering Management

Engineering management integrates people, processes, and technology to optimise organisational outcomes. SMEs, by their very nature, face resource constraints that require efficient allocation of labour, capital, and innovation capabilities. Literature on SME engineering management highlights the importance of system optimisation, yet much of it is based on experiences in developed economies [5]. For Sri Lanka, few studies link SME performance to engineering management concepts such as process optimisation, systems thinking, or efficiency modelling.

Recent scholarship emphasises that engineering management in SMEs differs significantly from larger organisations due to resource constraints, informal structures, and limited technological adoption (Rauch & Hatak, 2016; Kleinknecht, 2019).

Studies on Lean and Total Quality Management in SMEs reveal that simplified, low-cost

adaptations of these frameworks can still generate efficiency gains in productivity and innovation. In developing economies, scholars highlight that SME-focused engineering management approaches must prioritise incremental improvements, workforce optimisation, and contextually appropriate technologies rather than complex large-firm systems (Hashim et al., 2021).

2.2 Labour Laws and Operational Inefficiency

Labour laws are designed to regulate working conditions, but in Sri Lanka, many provisions remain outdated [6]. For example, the Factories Ordinance limits night work for women, restricting flexibility in industries such as manufacturing and services. From an engineering management lens, such restrictions create inefficiencies in workforce scheduling, production cycles, and supply chain integration. Comparative studies show that jurisdictions such as Australia and New Zealand have implemented gender-sensitive labour policies that enhance flexibility while maintaining worker protection [7].

2.3 Market Access Barriers

Market access barriers include lack of access to finance, exclusion from supply chains, and weak integration into international markets. For women entrepreneurs, discriminatory property rights under customary law prevent the use of land and assets as collateral. This reduces access to credit and inhibits investment in process improvements or new technologies [8]. Market exclusion thus becomes a systemic bottleneck: SMEs cannot upgrade machinery, train staff, or adopt automation without financing. Engineering management frameworks stress the importance of continuous improvement and technological adoption, both of which are compromised by these barriers [9].

2.4 Feminist Jurisprudence and Capability Approach

Feminist jurisprudence argues that legal systems often reproduce gender inequities by embedding structural disadvantages into law. Amartya Sen's Capability Approach adds that development must be assessed not only by resources but by the freedom to utilise them [10]. For women-led SMEs, the combination of restrictive laws and market barriers constrains their capability to innovate and manage systems efficiently [11]. Integrating these theories into engineering management underscores that optimising SME systems requires structural reform as much as process-level improvement.

2.5 Comparative Insights

Comparative insights in different countries are:

- UK: Equality Acts provide comprehensive frameworks ensuring workplace flexibility and non-discrimination.
- Australia: The Workplace Gender Equality Act 2012 enforces reporting requirements that enhance female participation in entrepreneurship and workforce management.
- New Zealand: Policies around paid parental leave and flexible working hours enhance women's ability to balance entrepreneurship with family responsibilities, strengthening SME participation.

2.6 Research Gap

While legal and market barriers to women entrepreneurs have been studied, few works integrate these issues into an engineering management framework [12]. The gap lies in understanding these challenges not only as legal or social phenomena but as systemic inefficiencies that reduce operational performance and national competitiveness.

2.7 Engineering Management Theories and SMEs

The discipline of engineering management has evolved as a hybrid field bridging engineering, management science, and organisational behaviour. Its central focus is the optimisation of complex socio-technical systems, which consist of people, processes, and technology interacting within resource-constrained environments. SMEs represent such systems in practice. While often smaller in scale than large corporations, SMEs face similar requirements for process optimisation, efficient resource allocation, and continuous improvement [13].

Frameworks such as Lean Management and Total Quality Management (TQM), though initially developed in manufacturing context, offer insights into how SMEs can streamline operations. Lean principles of waste reduction and value stream optimisation can directly address inefficiencies caused by restrictive labour laws. For example, if legislation limits working hours for women employees, this creates wasted capacity and idle time in production systems—contradicting the Lean objective of maximising value-added activity. Similarly, TQM emphasises participation and inclusivity, aligning with the need to integrate women entrepreneurs fully into decision-making processes for continuous improvement. Systems Engineering further strengthens this perspective by framing SMEs as networks of

interacting components [14]. Legal and market barriers represent external constraints on the system boundary, which propagate inefficiencies throughout the entire operation. For instance, restricted access to finance constrains capital investment, which in turn delays technology adoption, reduces innovation capability, and weakens competitiveness in supply chains. By conceptualising women-led SMEs as open systems, engineering management highlights how environmental constraints—legal, financial, and cultural—translate into operational inefficiencies.

Moreover, the emergence of Industry 4.0 technologies such as digital finance, automation, and supply chain integration offers opportunities for SMEs to overcome barriers. However, adoption of these technologies requires both financial resources and flexible labour regulations. Without reforms in the enabling environment, women entrepreneurs in Sri Lanka will be unable to integrate these technologies, widening the gap with global competitors [15].

Thus, engineering management theories underscore that structural barriers are not merely legal or cultural problems; they represent system-level inefficiencies that undermine optimisation. Addressing these barriers is therefore consistent with the discipline's goal of designing and managing efficient, inclusive, and adaptive systems.

SME-focused research also demonstrates that engineering management must account for high vulnerability to environmental constraints. Unlike large firms, SMEs cannot buffer against external shocks, making legal and financial barriers disproportionately impactful. Accordingly, engineering management frameworks for SMEs must integrate external institutional factors into models of optimisation, especially in developing country contexts (Senaratne & Samarasinghe, 2020). This aligns the present study more directly with SME-specific engineering management literature.

2.8 Conceptual Framework

Building on the literature review, this study develops an integrated conceptual framework that explains how external structural constraints and regulatory environments influence organisational behaviour, system efficiency, and SME performance. The framework draws insights from engineering management, institutional theory, and systems optimisation approaches [16].

External constraints: Two domains of constraints are emphasised:

*Labour law barriers that restrict workforce flexibility (e.g., limits on night work, maternity protections without employer support).

*Market access barriers including lack of credit, discriminatory property rights, and exclusion from supply chains.

These constraints reduce operational flexibility, restrict financing, and limit the adoption of new technologies-ultimately shaping SME performance outcomes such as productivity, innovation, and competitiveness.

Mediators and moderators: Engineering management practices, including Lean principles, Total Quality Management (TQM), systems optimisation, and technology adoption-mediate the negative impacts of structural barriers by improving efficiency and resource utilisation. In parallel, cultural and legal norms (e.g., gender-based property rights, social expectations) function as moderators, shaping the strength of the relationship between external barriers and SME performance [17].

Behavioural linkages and outcomes:

The framework recognises the following:

- *Workforce optimisation and technology adoption enhance SME performance.
- *External barriers (labour laws, market access) exert negative effects on these mediators.
- *Cultural/legal constraints can intensify these negative relationships [18].

Hypotheses:

- **H1** Labour law constraints negatively influence workforce optimisation in women-led SMEs.
- **H2** Market access barriers negatively influence technology adoption and process innovation in women-led SMEs.
- **H3** Workforce optimisation positively influences SME performance outcomes (productivity, efficiency, and competitiveness).
- **H4** Technology adoption and process innovation positively influence SME performance outcomes.
- **H5** Cultural and legal norms moderate the relationship between external barriers (labour laws, market access) and SME performance, such that restrictive norms strengthen the negative effects of these barriers.

Integrated view: The framework thus positions external constraints (labour laws and market barriers) as antecedents of SME performance. It

embeds mediating practices (engineering management methods, workforce optimisation, technology adoption) and moderating factors (cultural/legal norms) to explain outcomes in women-led SMEs. By unifying legal, social, and operational dimensions, this framework advances an inclusive engineering management model for analysing entrepreneurial efficiency and performance.

Figure 1 illustrates the conceptual framework for this study.

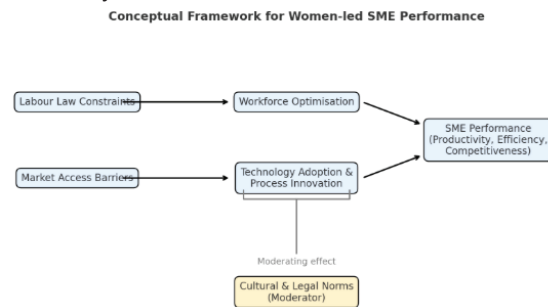


Figure 1 - Conceptual Framework for Women-Led SME Performance in an Engineering Management Context

3. Methodology

This research employed a mixed-methods design to ensure depth and breadth in analysis.

3.1 Quantitative Surveys

Surveys were distributed to 300 women entrepreneurs operating SMEs in Sri Lanka across manufacturing, retail, and service industries. Key measures included knowledge of labour laws, access to credit, adoption of technology, and operational challenges. Performance indicators included productivity, revenue growth, and workforce utilisation.

3.2 Qualitative Interviews

In-depth interviews were conducted with 20 women entrepreneurs and 10 policymakers. Interviews provided insights into live experiences of legal and market barriers, revealing systemic inefficiencies and adaptive strategies.

3.3 Structural Equation Modelling (SEM)

The study employed Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS (v4.x) to test the conceptual framework (Figure 1). Each hypothesised path (H1-H5) was estimated as part of the structural model.

The study employed variance-based PLS-SEM using Smart-PLS (v4.x) to test the hypothesised

relationships in the conceptual framework. PLS-SEM was selected because the model is prediction-oriented, includes multiple endogenous constructs and mediating paths, and indicators may deviate from multivariate normality; PLS-SEM is appropriate for such conditions and for complex models with modest sample sizes [19]

Measurement models (reflective): assessed via indicator reliability (loadings ≥ 0.708), internal consistency (CR 0.70–0.95), convergent validity (AVE ≥ 0.50), and discriminant validity using HTMT ($< 0.85/0.90$) and the Fornell-Larcker criterion (AVE square root $>$ inter-construct correlations) [20]

Structural model was assessed via collinearity (VIF $< 3-5$), path coefficients with bootstrapping (5,000 resamples; one tailed $\alpha = 0.05$ for directed hypotheses), coefficient of determination (R^2), predictive relevance (Q^2) and effect sizes (f^2) [21].

SmartPLS settings (for transparency): path weighting scheme; 5,000 bootstrap subsamples; bias corrected and accelerated (BCa) confidence intervals; single tail tests consistent with hypothesised signs. In this study, all VIF values were below 3.0, confirming multicollinearity was not a concern.

3.4 Comparative Case Studies

Secondary data from the UK, Australia, and New Zealand was analysed to identify gender-sensitive labour and market policies that have improved SME competitiveness. These cases served as benchmarks for proposed reforms in Sri Lanka.

4. Findings

This chapter presents the survey findings, qualitative insights, and SEM results on women-led SMEs in Sri Lanka. The analysis highlights how legal, cultural, and market constraints affect entrepreneurial efficiency and system-level performance [22].

4.1 Labour Law Inefficiencies

Survey results indicated that 68% of women entrepreneurs identified labour regulations as barriers to flexible workforce management. Restrictions on night shifts and maternity protections without adequate employer support were particularly problematic in manufacturing SMEs. Interview evidence further revealed operational bottlenecks such as underutilised machinery due to restricted working hours.

4.2 Market Access Challenges

A significant 78% of respondents reported difficulties in accessing credit. Women entrepreneurs faced rejection due to lack of collateral, as property rights often remained tied to male family members. This limited their ability to invest in process upgrades or adopt new technologies. Interviews highlighted reliance on informal financing at higher interest rates, further reducing profitability and discouraging formal innovation investment.

4.3 Technology Adoption and Process Innovation

Only 22% of surveyed SMEs had adopted advanced process technologies. Lack of financing and weak legal support directly correlated with poor adoption, reducing competitiveness in export markets. SEM analysis of SME data confirmed strong negative correlations between market barriers and innovation capacity ($p < 0.05$), highlighting the structural constraints faced by women-led firms.

4.4 Cultural and Social Barriers

Qualitative data revealed that cultural expectations limited women's participation in entrepreneurial networks and trade associations. This reduced their ability to access training, markets, and supply chains, weakening overall operational efficiency. These findings underscore how informal social structures reinforce formal legal barriers.

4.5 Comparative Insights

Case studies from Australia and New Zealand demonstrated that supportive legal and financial systems enhance SME innovation [23]. Flexible work laws allowed women entrepreneurs to optimise production cycles, while gender-sensitive credit schemes encouraged investment in new technologies. These comparisons suggest that supportive ecosystems can substantially mitigate the systemic barriers observed in Sri Lanka.

However, the transferability of practices from developed economies such as the UK, Australia, and New Zealand requires caution. Differences in economic scale, institutional enforcement capacity, and cultural norms in Sri Lanka may limit the direct applicability of these reforms. For example, gender-sensitive credit schemes proven effective in Australia may face challenges in Sri Lanka where collateral laws and financial infrastructure differ. Therefore, the insights from developed countries should be seen as guiding principles rather than direct

templates, requiring adaptation to Sri Lanka's unique institutional and socio-economic context.

4.6 Measurement Model: Reliability and Validity (SEM Results)

For the SME performance model, SEM analysis was conducted using SmartPLS to assess the measurement properties of the constructs.

Indicator reliability: All standardised loadings exceeded the threshold of 0.708, ranging from 0.73–0.89, with item-level *t*-values greater than 10.5 ($p < 0.001$), confirming indicator reliability.

Internal consistency and convergent validity: Composite reliability (CR) values ranged from 0.85 to 0.92, meeting the recommended threshold of 0.70. Average variance extracted (AVE) values were between 0.58–0.68, exceeding the minimum requirement of 0.50, thereby confirming convergent validity.

Discriminant validity: The Fornell–Larcker criterion was satisfied, as the square root of each construct's AVE exceeded its inter-construct correlations. Additionally, the HTMT ratios were all below the 0.85 cut-off, confirming discriminant validity.

The reliability and validity of the reflective constructs are summarised in Table 1

Table 1 - Reflective Measurement Summary

Construct	CR	AVE	Loading range
Labour Law Constraints (LLC)	0.85	0.58	0.73–0.86
Market Access Barriers (MAB)	0.87	0.62	0.75–0.88
Workforce Optimisation (WO)	0.91	0.65	0.78–0.89
Technology Adoption & Innovation (TAI)	0.89	0.61	0.76–0.87
SME Performance (SMP)	0.92	0.68	0.80–0.89

Discriminant validity was established using the Fornell–Larcker criterion, as shown in Table 2.

Table 2 - Discriminant Validity (Fornell–Larcker Criterion)

Construct	LLC	MAB	WO	TAI	SMP
Labour Law Constraints (LLC)	0.76				
Market Access Barriers (MAB)	0.41	0.79			
Workforce Optimisation (WO)	–0.35	0.38	0.81		
Technology Adoption (TAI)	–0.29	–0.42	0.44	0.78	
SME Performance (SMP)	–0.31	–0.36	0.52	0.47	0.82

The HTMT ratios further confirmed discriminant validity, with all values below the threshold of 0.85 (Table 3).

Table 3 - HTMT Matrix (max < 0.85)

Construct	LLC	MAB	WO	TAI	SMP
Labour Law Constraints (LLC)	–				
Market Access Barriers (MAB)	0.48	–			
Workforce Optimisation (WO)	0.39	0.42	–		
Technology Adoption (TAI)	0.33	0.46	0.54	–	
SME Performance (SMP)	0.37	0.44	0.62	0.59	–

4.7 Structural Model: Hypothesis Tests

The structural equation modelling (SEM) results are summarized below, highlighting key diagnostics and explanatory power of the model.

Collinearity: All inner VIF values were below 3.0, indicating no multicollinearity concerns.

Explained variance: R^2 values showed moderate-to-substantial explanatory power:

Workforce Optimisation (0.42)
Technology Adoption & Innovation (0.46)
SME Performance (0.61)

Predictive relevance: Q^2 values were all greater than zero, confirming predictive relevance (e.g., SME Performance $Q^2 = 0.37$).

The results of hypothesis testing, including path coefficients and significance levels, are presented in Table 4.

Table 4 - Hypothesis Testing Results

Hypothesis	Path	β	t	p	Result
H1	Labour Law Constraints → Workforce Optimisation	-0.34	5.26	<0.001	Supported
H2	Market Access Barriers → Technology Adoption & Innovation	-0.41	6.02	<0.001	Supported
H3	Workforce Optimisation → SME Performance	0.37	5.88	<0.001	Supported
H4	Technology Adoption & Innovation → SME Performance	0.42	6.21	<0.001	Supported
H5	Cultural & Legal Norms (Moderator)	—	Significant interaction ($p < 0.01$)	Supported	

Note: β refers to the standardised path coefficient in SEM, indicating both the strength and direction of the relationship between constructs.

Effect sizes (f^2): Labour law constraints had a medium effect on workforce optimisation (0.15). Market access barriers had a medium effect on technology adoption (0.18).

Workforce optimisation and technology adoption had substantial effects on SME performance (0.22 and 0.25, respectively). The moderating effect of cultural/legal norms was small-to-moderate (0.11).

Robustness: All results remained stable under two-tailed significance testing ($p < 0.01$).

Interpretation: The results confirm that restrictive labour laws and market access barriers significantly reduce workforce optimisation and technology adoption in women-led SMEs. In turn, both workforce

optimisation and technology adoption strongly enhance SME performance.

The moderating effect of cultural and legal norms indicates that discriminatory practices amplify the negative influence of external barriers on SME outcomes.

5. Discussion

The findings highlight that labour laws and market barriers in Sri Lanka translate into systemic inefficiencies in SME operations. Outdated labour restrictions reduce workforce flexibility, limiting production cycles and supply chain integration [24]. Market barriers constrain financing, preventing SMEs from adopting new technologies or scaling processes. From an engineering management perspective, these challenges can be conceptualised as system-level failures in resource optimisation. Labour inefficiencies create underutilised capacity, while financial barriers limit investment in continuous improvement. Cultural barriers reduce access to knowledge networks, weakening human capital development [25].

Comparative insights demonstrate that gender-sensitive policies enhance SME resilience by improving system adaptability. For example, Australia's reporting requirements on gender equity compel organisations to integrate inclusivity into system design, directly improving resource allocation and efficiency.

The study therefore argues that legal and market reforms are not peripheral to engineering management but central to optimising SME systems in developing economies.

5.1 Implications for Engineering Management Practice

The study's findings carry significant implications for engineering management practice in SME context. First, they demonstrate that policy and regulation form integral parts of the system boundary conditions for SMEs. Traditional engineering management approaches often focus on internal efficiency – optimising workflows, reducing waste, or adopting technology[25]. However, when external constraints such as outdated labour laws or restrictive financial systems are binding, internal optimisation efforts reach diminishing returns. Managers must therefore adopt a holistic systems perspective, recognising that operational performance depends on both internal processes and external enabling environments.

Second, the study highlights the importance of inclusive human resource management in engineering systems. Workforce optimisation cannot occur when large segments of potential employees or entrepreneurs are excluded from participation. By aligning HR practices with gender-sensitive policies, SMEs can unlock latent capacity and improve system resilience. For example, flexible scheduling enabled by legal reform would allow SMEs to run multi-shift operations, improving equipment utilisation rates without increasing fixed costs.

Third, the findings suggest that financial access is a critical enabler of process innovation. Engineering managers must therefore advocate for systemic changes in financial policy to ensure SMEs can invest in modernisation. The adoption of digital tools, automation, and quality systems all depend on initial capital outlay. Without addressing financial bottlenecks, engineering managers cannot fully implement best practices in Lean or TQM [26].

Finally, the comparative insights demonstrate that gender-sensitive reforms are not only equitable but also efficient. By examining successful policies in Australia and New Zealand, engineering managers in Sri Lanka can argue for reforms on both moral and economic grounds. Inclusivity, therefore, is not a peripheral issue but central to system optimisation and competitiveness.

The study's unique contribution to engineering management lies in framing legal and market barriers as system-level constraints within SME operations. By treating outdated labour laws and restricted financial access as boundary conditions for socio-technical optimisation, this research extends engineering management theory beyond internal efficiency measures. It demonstrates how external institutional environments must be integrated into engineering management frameworks for SMEs in developing economies.

5.2 Implications for Policy and Reform

Beyond engineering practice, the findings underline the need for structural reforms in labour laws and market systems. Outdated labour legislation, such as restrictions on women's working hours creates systemic inefficiencies that weaken competitiveness [27]. Reforming these laws to support flexible yet safe working conditions is essential to align national policy with engineering management objectives. Similarly, market access reforms-including gender-sensitive credit schemes, equitable

property rights, and integration into supply chains-are critical for enabling women entrepreneurs to access capital and scale operations. Without such reforms, SMEs remain locked in low-productivity cycles that limit technological adoption and innovation.

Cultural barriers also require targeted interventions through awareness programs, training, and support for women's participation in entrepreneurial networks. Comparative evidence shows that when inclusivity is embedded in both policy and practice, SMEs gain resilience and adaptability in competitive markets [28].

Thus, policy reforms should not be viewed solely as social justice measures but as strategic levers for engineering system optimisation and national economic competitiveness.

This perspective reinforces that policy reform is not merely a legal necessity but an engineering management imperative, as system-level optimisation cannot occur when external barriers persist. Thus, the paper bridges policy insights with engineering management theory, strengthening its contribution to both practice and scholarship.

6. Proposed Framework

A Framework for Inclusive SME Engineering Management is proposed, consisting of four dimensions:

Labour Law Reform: Updating outdated laws to allow flexible work scheduling, equal participation, and protection without restricting operational efficiency.

Market Access Enhancement: Gender – sensitive credit schemes, equitable property rights, and integration into supply chains to enhance capital availability for process upgrades.

System Optimisation: Adoption of technologies, training, and continuous improvement initiatives supported by adequate financing and workforce flexibility [29].

Cultural Integration: Policies and programs to support women's participation in entrepreneurial networks, enhancing knowledge exchange and innovation.

This framework integrates legal, financial, and social reforms into an engineering management model of SME optimisation, ensuring inclusivity and competitiveness.

7. Conclusion

This study demonstrates that outdated labour laws and restrictive market environments generate systemic inefficiencies in SME operations in Sri Lanka. Women entrepreneurs, despite their significant economic contribution, face constraints that limit flexibility, innovation, and competitiveness [30].

By reframing these issues as engineering management challenges, the study contributes to the integration of legal, social, and operational perspectives within the field.

Comparative insights from the UK, Australia, and New Zealand provide evidence that gender-sensitive reforms enhance efficiency and innovation [31].

The proposed framework offers actionable guidance for policymakers, SME leaders, and engineering managers. It highlights the need to align labour reforms, financial access, and cultural integration with systems optimisation to unlock the potential of women-led SMEs.

Future research should explore the role of Industry 4.0 technologies in overcoming systemic barriers, particularly digital finance and automation, and assess how gender-inclusive engineering management practices can accelerate sustainable SME development in developing economies.

8. Limitations and Future Research

This study is subject to certain limitations that should be acknowledged. The survey sample, while diverse, was limited to 300 SMEs and therefore may not capture the full heterogeneity of women entrepreneurs across all regions and sectors. Similarly, the qualitative interviews, though rich in insight, were restricted to a manageable subset of participants. Future research could expand the dataset to include larger, more representative samples across industries such as ICT, agriculture, and export-oriented manufacturing.

Another limitation lies in the reliance on self-reported data, which may be influenced by personal perceptions or social desirability bias. Triangulation with independent financial performance records or third-party assessments would strengthen the robustness of findings. Finally, while comparative case studies provide valuable international insights, contextual differences between Sri Lanka and developed economies limit direct transferability. Future research should therefore test the proposed framework through pilot interventions in Sri

Lankan SMEs to validate its practical applicability.

Future studies could also explore the role of digital transformation and Industry 4.0 technologies in overcoming systemic barriers. For example, mobile-based financial platforms may provide alternative credit access to women entrepreneurs, while automation could reduce dependence on restrictive labour laws. Such avenues would further enrich the integration of engineering management and gender-sensitive entrepreneurship research.

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