

Cultural Influence on Plant Maintenance Practices in the Tyre Industry of Sri Lanka

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Abstract

This research paper presents a qualitative investigation into the influence of organizational and national cultures on the implementation of maintenance practices, with a particular focus on the Sri Lankan tyre manufacturing industry. The study adopts a narrative literature review approach, supported by qualitative insights drawn from 10 companies within the Sri Lankan tyre industry, to explore how cultural factors shape maintenance strategies and performance within this sector. Relevant academic publications, industry reports, and case studies were systematically identified through databases such as Scopus, Web of Science, Google Scholar, and ScienceDirect, using keywords. The qualitative data collected from participating companies were analyzed using thematic analysis, allowing key patterns, themes, and relationships to emerge regarding the cultural influences on maintenance practices. The findings highlight notable disparities between maintenance practices in Sri Lanka and those in developed economies, primarily influenced by differences in national and organizational cultures, cultural theories, learning processes, and strategic planning approaches. The study further discusses the managerial implications of these cultural gaps. Although world-class frameworks such as Reliability-Centred Maintenance (RCM) and Total Productive Maintenance (TPM) provide structured methodologies for achieving strong maintenance performance, the research emphasizes that successful implementation requires alignment with the organization's evolving cultural context. This qualitative analysis, based on evidence from ten companies, underscores the critical role of culture in shaping effective and sustainable maintenance practices.

Keywords: Maintenance practices, maintenance culture, Sri Lankan tyre industry, Organisational culture, National culture.

Introduction

Maintenance is a critical function within manufacturing operations, essential for ensuring the continuous availability, reliability, and performance integrity of machinery and equipment. Defined by BS 3811 (1964) as the systematic and ongoing preservation of an organization's mechanical assets, maintenance ensures that production processes operate efficiently, safely, and without unexpected interruptions. However, effective maintenance is not solely the responsibility of a designated technical team. Instead, it must be embraced as a shared responsibility involving machine operators, engineers, planners, and all personnel who interact with production equipment. To develop a sustainable and effective maintenance culture, all relevant stakeholders must possess a clear, accurate understanding of the specific maintenance requirements of the equipment they work with. Furthermore, they must be properly trained, motivated, and empowered to take timely and appropriate actions that support equipment functionality and prevent premature failure. Creating such a culture requires a deliberate and strategic approach to maintenance planning and implementation. This review outlines the critical steps required to develop a robust maintenance strategy aligned with modern best practices and highlights the importance of adopting a proactive, collaborative, and technologically driven maintenance philosophy in today's competitive manufacturing environment.

Developing a Strategic Maintenance Framework as an Investment

Traditionally, maintenance has been perceived as a necessary cost; a reactive function aimed at restoring equipment after failure. However, this view has significantly evolved in recent decades. In asset-intensive industries, particularly manufacturing, maintenance is increasingly recognized as a strategic function that contributes directly to operational efficiency, product quality, safety, and long-term profitability. From this perspective, plant maintenance should be understood not merely as an operational expense, but as a form of investment; one that safeguards capital assets, enhances productivity, and supports sustainable competitive advantage. Viewing maintenance through an investment lens requires a shift in organizational mindset. Rather than minimizing maintenance costs, the objective becomes optimizing maintenance value; investing the right amount, at the right time, to maximize equipment availability and lifecycle performance. Preventive and predictive maintenance activities, when strategically planned, can reduce unplanned downtime, extend asset life, and improve return on assets (ROA). In this way, maintenance investments yield measurable financial and operational returns over time. The first step in building a comprehensive maintenance strategy is to identify and establish maintenance approaches tailored to each asset's operational needs. This process involves evaluating the criticality of each piece of equipment, its operating environment, and its failure history (Suwaibatul, 2012). Based on this assessment, the most suitable maintenance methodology should be adopted. For instance, Preventive Maintenance (PM) involves scheduled, time-based interventions designed to prevent equipment failures (Basri et al., 2017; Iwarue, 2025). Predictive Maintenance (PdM) leverages real-time condition monitoring technologies to forecast potential failures before they occur (Carvalho et al. 2019; Theissler et al., 2021; Tiddens, 2023). Reactive Maintenance, on the other hand, is appropriate for low-priority or non-critical assets where immediate intervention following a failure is acceptable (Marangis, et al., 2025; Al-Najjar et al., 2018; Naik and Kirkire, 2024). For high-risk systems, Reliability-Centred Maintenance (RCM) offers a rigorous framework for identifying failure modes and prioritizing maintenance tasks based on risk (Geisbush and Ariaratnam, 2023; Velmurugan and Dhingra, 2021). Regardless of the chosen approach, it is imperative to define clear maintenance tasks and inspection intervals to ensure consistency and reliability. Once an appropriate strategy is selected, the second priority is to allocate the necessary resources to support its execution. Effective implementation depends on having skilled personnel, spare parts, tools, and detailed maintenance procedures readily available (Zhu et al., 2019; Au-Yong et al., 2014). This includes recruiting and training qualified technicians, ensuring the availability of essential spare parts and consumables, equipping the maintenance team with the right tools and establishing job plans and standard operating procedures (Duffuaa et al., 1998). Without these foundational resources, even the most well-designed maintenance strategies are likely to fail. The third key element of a successful maintenance system is the adoption of appropriate management technologies. Central to this effort is the implementation of a Computerized Maintenance Management System (CMMS). A CMMS allows organizations to schedule work orders, track asset history, monitor inventory, generate performance reports, and integrate maintenance activities with production planning, procurement, and human resources (Shankar et al., 2021). Modern CMMS platforms also facilitate the use of Industrial Internet of Things (IIoT) technologies by sending automated alerts and enabling data-driven decision-making. The fourth step in the maintenance journey involves the practical implementation and continuous monitoring of maintenance activities. This includes carrying out planned maintenance tasks according to established schedules, monitoring key performance indicators such as equipment reliability and downtime, recording data from maintenance activities (e.g., time spent, parts used, error codes), and performing post-maintenance inspections and verification tests. Effective monitoring ensures that deviations from the plan are detected early and that maintenance processes remain aligned with operational goals. The final component of an effective maintenance system is the continuous review and improvement of the strategy. Maintenance is not a static function; it must evolve in response to operational performance data and organizational changes. Performance indicators such as Mean Time Between Failures (MTBF), Mean Time to Repair (MTTR), Overall Equipment Effectiveness (OEE), and maintenance costs versus budget must be regularly analyzed. Root cause analysis (RCA) should be conducted for significant failures, and cross-functional teams should review and refine the strategy periodically. To optimize equipment uptime while minimizing costs, a fundamental shift from a reactive to a proactive and profit-focused maintenance mindset is required. Manufacturing downtime, whether planned or unplanned, has a direct impact on plant capacity, resulting in lower output, higher operational costs, and disruptions in customer service. As organizations increasingly adopt lean manufacturing practices, just-in-time (JIT) production, and total quality management (TQM), the hidden costs of downtime become more significant (Swarnakar et al., 2021; Nayal et al., 2022). Consequently, the adoption of advanced maintenance models such as Reliability Centred Maintenance (RCM) and Total Productive Maintenance (TPM) is essential to achieving world-class manufacturing performance (Jayatilke and Fernando, 2024;

Muganyi and Mbohwa, 2017).TPM, in particular, emphasizes the involvement of both operators and maintenance personnel in the maintenance process. By enabling operators to carry out basic, routine maintenance tasks referred to as autonomous maintenance (AM), organizations can reduce machine idle time, improve product quality, and enhance equipment efficiency. This collaborative approach fosters ownership, accountability, and a shared commitment to continuous improvement. It also facilitates real-time responsiveness to emerging issues, allowing for faster resolutions and minimizing production disruptions. Maintenance accounts for a significant portion of operational costs in manufacturing, typically the second-largest expenditure after production. Estimates suggest that maintenance can consume between 35% and 40% of a manufacturing firm's total operational budget. However, there is considerable variation in maintenance effectiveness across different countries and regions. These disparities reflect differences in regional maintenance strategies, technological adoption, workforce skills, and policy environments (Satwaliya et al., 2023). Given its strategic importance, maintenance should not be viewed as a cost center, but rather as a critical investment in productivity, safety, and long-term operational sustainability. The future of maintenance lies in collaborative, data-driven, and technology-enabled systems that empower all employees, from shop-floor operators to senior managers, to contribute to equipment care and organizational excellence.

The Need for a Robust Maintenance Culture in Sri Lanka

The manufacturing sector is a cornerstone of Sri Lanka's economic development, contributing significantly to export earnings (68.9% in 2024), employment creation, and industrial growth (National Accounts SL, 2024). Despite its importance, a critical challenge threatening the sector's performance and sustainability is the widespread lack of a structured and proactive maintenance culture. Across various industries, including garments, food processing, rubber-based products, construction materials, and engineering workshops, many establishments suffer from frequent machinery breakdowns, low productivity, and poor product quality due to ineffective maintenance practices (Iwarue, 2025). Manufacturing capacity utilization in Sri Lanka increased to 62 % in 2024 from 60 % in 2023. It averaged 75% from 2008 until 2024 (CBSL, 2025). This indicates substantial idle capacity, much of which may be attributed to unplanned downtime or inefficiencies stemming from weak maintenance practices (Perera and De Silva, 2021; Janakpriyantha, 2021). In most Sri Lankan manufacturing facilities, maintenance is predominantly reactive. Equipment is typically repaired only after it fails, a "fix it when it breaks" approach (Mobley, 2004). This approach to corrective maintenance is the process of identifying and correcting equipment failures after they occur (Wang et al., 2014). This reactive strategy leads to unplanned downtime, production delays, and significant financial losses. It is not only inefficient but also far more costly than preventive maintenance, which involves regular servicing, lubrication, part replacements, and equipment inspections to avoid unexpected failures. In contrast, today, a computerized maintenance management system (CMMS) is a digital tool that uses integrated information systems to process maintenance data and generate key performance indicators related to maintenance activities (Lopes et al., 2016). Predictive maintenance, where advanced technologies like sensors and data analytics are used to monitor equipment health in real time, is almost absent in many small and medium-sized enterprises. This lack of technological integration leaves production lines vulnerable to sudden breakdowns and long-term equipment degradation (Mobley, 2002; Matyas et al., 2017; Bousdekis et al., 2021). Reducing maintenance costs and increasing productivity, but further advances in manufacturing will have a significant impact on future innovation and revolution (Okoro and Musonda, 2019). One of the root causes of this poor maintenance culture is the shortage of skilled technicians and maintenance engineers. Many companies rely on untrained labourers or production workers to carry out maintenance tasks, which compromises quality and safety. Technical and vocational institutions in Sri Lanka often prioritize production techniques over specialized maintenance education, leading to an ill-equipped workforce to implement modern maintenance strategies (Wijesundara et al., 2025). Moreover, maintenance departments are frequently under-resourced and excluded from strategic decision-making. Equipment is routinely used well beyond its serviceable life, while maintenance budgets are minimized rather than seen as critical investments in reliability and safety. This scarcity of funding results in inadequate access to spare parts, tools, and training, further reinforcing a reactive and inconsistent approach to equipment care (Dilanthi and Deegahawature, 2014). A further complication is the lack of proper documentation and data tracking. Many factories fail to maintain comprehensive records of maintenance schedules, equipment history, or failure patterns. This data gap makes it difficult to identify recurring problems, schedule preventive actions, or make informed decisions regarding equipment upgrades or replacements (Arsakulasooriya et al., 2023). Additionally, at the organizational level, maintenance is rarely treated as a core strategic function. Senior leadership often focuses solely on meeting production targets, with little regard for the essential role that effective maintenance plays in ensuring those targets are met. This top-down neglect filters through the organization, leaving maintenance tasks undervalued and frequently delayed (Garg and Deshmukh, 2006; Malalasekara, 2024). Neglecting maintenance not only affects operational efficiency but also poses serious safety risks. Malfunctioning equipment increases the likelihood of workplace injuries, fires, and environmental hazards. While safety regulations exist in Sri Lanka, enforcement is weak, and compliance is often superficial (Wedagedara and Dissanayake, 2024). As a result, many factories operate in unsafe conditions, exposing workers to avoidable risks. Moreover, inconsistent maintenance leads to process instability and poor-quality outputs. This undermines the international reputation of Sri Lankan exports, particularly in high-stakes industries such as apparel, rubber goods, food processing, and electronics. Without reliable maintenance practices, companies struggle to meet global quality standards and certifications, jeopardizing their long-term export potential (Wijesundara et al., 2025). As a result, the poor maintenance culture within Sri Lanka's manufacturing sector is a major obstacle to its progress. It is characterized by reactive approaches, a shortage of skilled personnel, underfunding, inadequate data systems, and weak compliance with safety standards. To overcome these challenges, a comprehensive shift is required (Sachitra and Gunasekara, 2023). Organizations must prioritize preventive and predictive maintenance, invest in the training and development of maintenance professionals, allocate sufficient resources, implement systems like Computerized Maintenance Management Systems (CMMS), and treat maintenance as a strategic function with full support from top management. Additionally, regulatory compliance and safety enforcement must be strengthened to ensure a secure and efficient production environment.

By adopting these reforms, Sri Lankan manufacturers can significantly improve equipment reliability, reduce production costs, ensure safer workplaces, and enhance their competitiveness in global markets.

Cultural Influence in the Sri Lankan Maintenance System: Focus on the Tyre Manufacturing Sector

In the journey toward national development, countries like Sri Lanka aim to enhance the quality of production and services. This effort necessarily includes improving maintenance systems to reduce repair costs, ensure operational safety, and optimize the longevity of equipment. Within this context, the role of maintenance personnel is indispensable. However, studies indicate that cultural factors, particularly individual attitudes and organizational mindsets, significantly influence the maintenance practices in Sri Lanka (Janakpriyantha, 2021). The development of a positive and proactive maintenance culture has emerged as a crucial element in extending the life of assets, improving plant efficiency, and enhancing the quality of output, especially in key sectors such as tyre manufacturing. Developing a rich maintenance culture consisting maintenance strategy that is appropriate for each asset involves determining what needs to be done to ensure asset reliability, safety, and performance (More et al., 2024; Suwaibatul, 2012). A maintenance culture refers to the collective values, behaviours, and attitudes that regard maintenance as a critical function in operations. According to Suwaibatul et al. (2012), maintenance culture manifests when individuals and organizations incorporate maintenance into their everyday routines, giving it due priority. Florence (2011) emphasizes that this culture is learned and passed on through the behaviour of dedicated maintenance workers who view upkeep as a natural part of their daily responsibilities. Unfortunately, in Sri Lanka, a

traditional mindset prevails, one that is resistant to change and heavily reliant on outdated practices. Many institutions, both public and private, prioritize reactive maintenance fixing equipment only after failure rather than investing in preventive or predictive strategies (Gholipour, 2025; Sivanuja and Sandanayake, 2022). This approach reflects a cultural legacy rooted in low awareness of modern maintenance methods and a reluctance to innovate. Sri Lankan workplace culture also tends to be hierarchical, discouraging open communication between technicians, engineers, and management. Maintenance staff often hesitate to report problems or suggest improvements due to fear of blame or disrespect from superiors (Manjaree and Shakyara, 2023). Instead of identifying root causes and addressing systemic issues, failures are frequently attributed to individual negligence, reinforcing a blame culture. For instance, machine operators might continue using faulty equipment or delay informing the maintenance department, leading to preventable breakdowns. This lack of transparency and accountability is a significant obstacle to establishing a reliable maintenance system (Hofstede, 2001; Hofstede Insights, 2023; Wickramasinghe and Gamage, 2012). Another cultural shortcoming lies in the overwhelming focus on production over maintenance. Within many organizations, maintenance is perceived as a cost centre rather than a value-adding function. Top management typically prioritizes immediate operational output, sidelining the long-term benefits of systematic equipment care. This disconnects between production and maintenance departments results in poor communication and collaboration, ultimately reducing workforce morale and undermining a sense of ownership among maintenance staff.

In addition to the organizational mindset, skill development and training represent another critical challenge. Technical education in Sri Lanka often undervalues vocational training and practical skill-building, which are essential for modern maintenance work. As a result, maintenance personnel frequently lack the knowledge required to implement advanced maintenance strategies such as Reliability-Centred Maintenance (RCM), Total Productive Maintenance (TPM), or Condition-Based Monitoring (CBM). Moreover, record-keeping and data analysis are often overlooked. Many organizations maintain poor documentation of maintenance activities, making it difficult to identify recurring issues, track performance, or plan preventive interventions effectively (Kalpage and Konara, 2014).

Resistance to modernization is another major issue. The adoption of technologies such as Computerized Maintenance Management Systems (CMMS) is limited, with organizations favoring traditional methods even when they prove inefficient (Gunathilaka et al., 2021). This is often driven by fear of change or lack of familiarity. Corruption and mismanagement further erode maintenance efforts, especially in the public sector, where contracts may be awarded to unqualified vendors, and funds allocated for maintenance are misused. In many cases, there is also a pronounced lack of ownership and accountability, an issue commonly seen across many developing countries. Employees may assume that maintenance is someone else's responsibility, resulting in systemic neglect and persistent equipment failures (Almotairi, 2023).

The absence of standardized performance criteria and best practices for delegating authority, motivating employees, and managing resources further complicates the situation (Seneviratne et al., 2021). Each organization tends to develop its own approach, leading to inconsistencies in human resource development and maintenance planning. Hofstede's cultural dimensions theory provides further insights into these issues. Sri Lanka's high power distance culture means that lower-level employees often refrain from offering feedback or making decisions independently. They may wait for instructions from superiors, which delays proactive maintenance actions. Moreover, centralized decision-making tends to exclude frontline workers from planning, leading to unrealistic or ineffective maintenance policies that fail to reflect on-ground realities.

Sri Lanka also displays a moderate degree of uncertainty avoidance, which means that while formal processes and checklists may exist, innovation is often discouraged. Maintenance technicians may adhere strictly to standard procedures, avoiding experimentation even when existing methods are inadequate. This stifles creativity and problem-solving capabilities. Cultural values rooted in religious and social traditions often encourage short-term thinking, emphasizing visible outcomes over long-term sustainability. Consequently, preventive and predictive maintenance practices are underutilized, even though they can significantly reduce long-term costs and operational disruptions (Hofstede, 2020). A comparative view across countries in Africa and South Asia reveals similar patterns. In Nigeria, Ghana, and Kenya, poor maintenance cultures have led to the deterioration of public assets due to neglect, lack of planning, and corruption. South Africa also grapples with similar issues, where insufficient funding and weak institutional oversight undermine maintenance efforts (Abankwa, D. A., and Rowlinson, S., 2021; Okereke, 2017). In countries like Bangladesh and Pakistan, the emphasis on building new infrastructure often overshadows the upkeep of existing facilities, resulting in rapid wear and tear (World Bank, 2020; Sanjay Kumar Singh, 2011). These examples highlight that maintenance culture is deeply influenced by societal values, governance practices, and institutional priorities.

The Sri Lankan tyre manufacturing industry offers a clear example of how these cultural issues affect plant maintenance. The sector is vital to the economy, contributing nearly 7.5% of the nation's total export earnings and employing over 300,000 individuals directly and indirectly. Sri Lanka is a global leader in solid tyre production, meeting roughly 25-30% of worldwide demand. Despite adopting some advanced technologies and practices, the industry still suffers from frequent breakdowns, with production losses estimated at 3% to 5% due to unplanned equipment failures. Maintenance costs in this sector can account for up to 40% of total production costs, underscoring the importance of effective maintenance systems (Piyatissa and Siriwardhana, 2023; Jayalath et al., 2017).

Companies such as CEAT Kelani Holdings and Michelin Lanka (formerly Camso Loadstar) have made notable strides in improving their maintenance strategies. CEAT Kelani, for example, has expanded production capacity and invested in efficiency improvements. Michelin Lanka has implemented Reliability Centred Maintenance (RCM) to optimize machine reliability and minimize downtime, reducing breakdowns from 11% to 3%. These efforts highlight the potential for improvement when modern maintenance practices are integrated with a supportive organizational culture. Nevertheless, broader cultural challenges remain. Hierarchical barriers, reactive mindsets, undervaluation of technical education, and resistance to innovation continue to hinder optimal maintenance performance. Addressing these issues requires a cultural shift at both the organizational and national levels. Companies must promote open communication, empower frontline workers, invest in training, and treat maintenance as a strategic function integral to business success. Furthermore, leadership development, performance-based rewards, and structured change management initiatives are essential for bridging the cultural gap and aligning maintenance practices with global industrial standards (Hofstede, 2001). In conclusion, transforming Sri Lanka's maintenance culture, particularly in critical sectors like tyre manufacturing, requires deep organizational introspection and commitment. By cultivating a maintenance-conscious culture that values learning, accountability, and innovation, the country can significantly enhance equipment reliability, reduce operational costs, and ensure sustainable industrial growth (Wickramasinghe and Gamage 2011).

Maintenance is influenced by Organizational and National Culture

At first glance, maintenance may seem purely technical; replacing parts, lubricating machinery, performing inspections, etc. However, in practice, the effectiveness, consistency, and strategic value of maintenance are shaped by human behaviour, cultural norms, and organizational priorities. This is why maintenance is not just a technical activity; it's deeply embedded in human, cultural, and organizational contexts. People are at the core of any maintenance system. Their attitudes, motivations, and perceptions significantly affect maintenance outcomes (Ogunbayo et al., 2022; Carcel-Carrasco et al., 2021). One of the most critical, yet often overlooked, aspects of effective maintenance is the role of human behaviour in shaping outcomes. While maintenance tasks may appear purely technical, they are deeply influenced by the perceptions, attitudes, and competencies of the people involved. Key human factors such as risk perception, responsibility and ownership, communication, and training and competence all play a significant role in determining how maintenance is carried out and how effective it. Firstly, risk perception significantly

influences maintenance prioritization. The degree to which workers and managers take equipment failure seriously often determines whether maintenance activities are treated as urgent and essential, or as optional and deferrable. When the risks associated with potential breakdowns are underestimated, there is a tendency to delay or skip necessary maintenance tasks, which can lead to equipment failure, costly downtime, and even safety incidents. (Bao, Y., Guo, C., Zhang, J. et al., 2018).

Closely tied to this is the sense of responsibility and ownership among maintenance personnel. When individuals feel a strong sense of accountability for the equipment they maintain, they are generally more proactive and attentive in their work (Iwarue, 2025). This sense of ownership encourages them to go beyond the minimum requirements, taking the initiative to identify early warning signs, perform additional checks, or suggest improvements to existing maintenance routines (Hsieh and Chiu, 2024; Wolska et al., 2019). Conversely, in environments where ownership is lacking, maintenance may become a box-ticking exercise with limited long-term impact. Effective communication is another crucial human factor in maintenance systems. Maintenance teams rely heavily on clear, timely, and accurate information to perform their work. The ability to report issues effectively depends not just on technical knowledge, but also on interpersonal skills and the degree of openness in the workplace culture. In organizations where communication is encouraged and valued, potential issues are more likely to be reported early, enabling preventive action. In contrast, poor communication can lead to misunderstandings, delayed repairs, and unaddressed hazards. Lastly, training and competence are foundational to maintenance effectiveness (Obiajunwa, 2013; Taylor et al., 2021). Technical training ensures that maintenance personnel know how to use tools, follow procedures, and understand the systems they are working on. However, competence in problem-solving, decision-making, and adaptability is equally important. Technicians who are empowered to think critically and respond to unexpected situations are better equipped to maintain complex systems in dynamic operational environments.

It is obvious that organizational culture refers to the shared values, beliefs, attitudes, and practices that shape how people in an organization interact, make decisions, and achieve goals (Romanovich et al., 2021; Cameron and Quinn, 2011; Schein, 2009). It acts as an invisible force that influences behaviour at every level of the organization. A strong, positive organizational culture can drive employee engagement, innovation, and performance, while a weak or toxic culture can lead to high turnover, low morale, and inefficiency. Organizational culture has a profound influence on maintenance culture, particularly in manufacturing and industrial settings. The values, norms, attitudes, and behaviours promoted within an organization directly shape how maintenance is perceived, prioritized, and executed. Organizations with a proactive and quality-driven culture tend to adopt preventive or predictive maintenance strategies, invest in staff training, and emphasize continuous improvement. In such settings, maintenance is seen as a strategic function that contributes to operational efficiency, safety, and long-term profitability (Mobley, 2004; Siyad and Khayal, 2025). This hampers proactive maintenance behaviour and contributes to a culture of blame rather than continuous improvement. Organizational cultures must continuously adapt to evolving external environments, which are shaped by factors such as rapid technological advancements, globalization, and shifting societal values. While culture tends to evolve gradually, external changes often occur at a much faster pace. When organizational cultures fail to keep up with these changes, especially in maintenance practices, they risk becoming obsolete or ineffective (Schein, 2010; Cameron and Quinn, 2011; Pathirana et al., 2020). This mismatch underscores the growing urgency to proactively align maintenance culture with external developments, such as digital transformation and sustainability demands, to ensure operational resilience and competitiveness (Moubray, 1997; Appio et al., 2021).

To remain internationally competitive, companies must maintain a high internal learning rate that improves upon existing culture-positive practices and embraces new ones. External benchmarking programs have become a popular way to identify effective practices, offering the advantage of demonstrating what can realistically be achieved. The learning associated with developing and implementing these programs also brings valuable benefits to participants. As noted by Amaral and Sousa (2009), while different types of benchmarking have led to significant successes, there are also potential barriers to consider. To remain competitive in a rapidly changing global environment, organizations must evolve into learning organizations (Srivastava and Rao, 2025). This transformation requires a strong foundation, including clear purpose, open communication, continuous training, flexible structures, and a culture that encourages innovation and risk-taking (Zhang et al. 2023). Equally important are practical tools such as systematic problem-solving, experimentation, knowledge transfer, and performance measurement (Eti et al. 2006; Cristache et al., 2025; Hameed et al., 2025). Cultural transformation is essential, as learning must be embedded in the organization's values. Trust, empowerment, and shared values form the foundation for this, creating an environment where continuous improvement thrives. In cultures like Japan's, learning is collective and deeply integrated into daily work (Faulks et al, 2021).

A key driver of learning organizations is "creative tension", the gap between current performance and vision, which fuels motivation for change. Although building such an organization may take more time than implementing quality programs, it fosters deeper systems thinking, shared vision, and collaborative problem-solving (Nonaka, 1991). However, success depends on effective leadership, strategic alignment, and the ability to integrate learning with strategic planning and innovation. Common barriers include weak strategies, poor management, and a lack of coordination. Continuous learning requires both internal and external focus, supported by tools like audits (e.g., OEE) and a strong knowledge management system (Prawiradilaga and Chaerumen, 2018). Finally, achieving excellence and sustainable change involves building organizational competence, the coordinated use of resources, people, and systems, to gain a long-term competitive advantage. Learning organizations foster this by enabling reflection, dialogue, and a culture of ongoing improvement.

Sri Lanka's national identity, predominantly shaped by Sinhala-Buddhist culture, influences various aspects of society, including organizational behaviours. The projection of a unified national culture often overlooks minority cultures, leading to a complex interplay between majority cultural norms and institutional practices. This dynamic can affect how maintenance cultures are developed and perceived within different organizational contexts. While direct studies linking national culture to maintenance culture in Sri Lanka are scarce, existing literature suggests that organizational culture, traditional craftsmanship, and national identity significantly influence maintenance practices. Understanding these cultural dimensions is crucial for developing effective maintenance strategies that align with Sri Lanka's unique cultural context. Chandrakumara and Sparrow (2004) examined how national culture, specifically work orientation, impacts human resource and organizational management practices in Sri Lanka. Fernando and Perera (2020) examined how organizational culture influences competitive advantage within Sri Lanka's Information and Communication Technology (ICT) sector. These studies highlight, to some extent, the importance of understanding national cultural influences when analyzing maintenance behaviour in Sri Lankan manufacturing contexts. Cultural factors such as communication styles, authority structures, and traditional craftsmanship play a critical role in shaping maintenance practices and organizational effectiveness.

Methodology

Understanding the subtleties of maintenance and culture has been a subjective study. Maintenance is often invisible unless it fails or has consequences. Culture is fluid, experienced differently across individuals and contexts. Therefore, studying their subtleties demands interpretation, empathy, and qualitative insight, making it a subjective endeavour. Thus, data collection is done primarily through qualitative methods. A qualitative focus group approach was utilized to stimulate discussion among the respondents regarding their perceptions, opinions and experiences about the maintenance culture. Previous literature has supported the validity of focus groups among maintenance managers, engineers and technicians (Naeem and Azam, 2017; Corbin, J. and Strauss, 2015). One complication in studying maintenance and culture is that cultural influences come not only from national culture but also from institutional and organizational culture. In this case, the impact of these

cultural attractions on maintenance in the Sri Lankan tyre manufacturing industry was investigated for the Sri Lankan manufacturing industries. These are solid and pneumatic plants, respectively, most of which are located in the capital city of Sri Lanka. In-depth interviews were conducted to obtain maximum value for these locations, including facilities, personnel skills and organizational structures. Current literature on organizational and organizational cultures, learning, TPM and RCM maintenance strategies was reviewed. This paper, therefore, argues that when maintenance is managed in a structured manner and involves everyone in the organization, a sense of ownership is developed within the operator by introducing independent teams consisting of operators, maintainers, engineers and managers to improve the performance of people and equipment. Therefore, this paper aims to find and determine the impact of culture on the organization's maintenance systems, comparing what is achieved in developed countries using business excellence models and ISO 9000:2001 standards.

This study is limited to 10 tyre manufacturing plants in Sri Lanka. The participants are managers, engineers, maintenance technicians and maintenance beneficiaries who develop or implement maintenance strategies in their companies. These are production managers, production engineers or supervisors, and production operators. Tyre companies are large and medium-sized companies located in Sri Lanka and present their similarities and differences. These companies have been in operation for more than 10 years (most of the companies are multinational companies with collaboration in Europe or India). The life span of the companies' equipment varies from 10 to 40 years, and their businesses operate in a competitive environment. Their work environment is seen to be risky. This study qualitatively explores how organizational and national culture influences maintenance practices, behaviours, and attitudes of maintainers in the workplace. The main objective of this study is to examine the collective mindset, values, and practices related to maintenance activities in an organization, such as preventive maintenance, safety practices, and equipment care, by referring to "maintenance culture." The perceived status of maintenance management within the organization, as well as the barriers and challenges hindering the implementation of an optimal maintenance management strategy. To collect information, we conducted face-to-face interviews with the participants, and also communicated via e-mail and conference calls while analyzing the results. During the interview, 1) we presented the purpose and benefits of the study to them and asked the respondent to provide information about the company, its activities, the products or services it provides to its clients, the maintenance processes, the technology and equipment used, and the organizational chart. 2) The participant answered questions that included the influence of organizational culture and the constraints and difficulties that managers face in implementing the maintenance strategy.

Conceptual Framework and Variables

The conceptual framework proposes that organizational culture and national culture play a fundamental role in shaping maintenance attitudes and behaviours within industrial environments. These cultural dimensions influence how maintenance is perceived, prioritized, and practiced across the organization. Specifically, organizational and national culture affect key maintenance enablers, including leadership commitment, accountability, and collaboration among management, operations, and maintenance and production personnel. Strong leadership commitment ensures that maintenance is strategically prioritized, accountability clarifies roles and responsibilities for asset care, and collaboration promotes effective communication and coordination. Together, these factors determine whether maintenance practices are predominantly proactive, such as preventive and predictive maintenance or reactive, where actions are taken mainly after equipment failure.

The relationship between culture and maintenance practices is influenced by several mediating barriers. Constraints such as limited financial resources, shortages of skilled personnel, and resistance to organizational change can hinder the effective implementation of proactive maintenance strategies, even in culturally supportive environments. Ultimately, the effectiveness and perceived importance of maintenance management determine key organizational outcomes. Effective maintenance management leads to improved plant performance, enhanced operational safety, reduced downtime, and increased reliability of industrial assets. Conversely, weak maintenance management negatively impacts productivity, safety, and overall operational efficiency. This framework highlights the interconnected role of cultural factors, organizational capabilities, and structural constraints in shaping maintenance practices and their impact on industrial performance.

Data Collection

Maintenance staff, including supervisors, managers, engineers, and technicians, participated in entrance (N = 60) and exit (N = 57) focus group interviews conducted within four weeks of programme commencement and during the final course meeting, respectively. Each session lasted about 45 minutes. All of the discussions were audio-recorded and transcribed verbatim. A qualitative focus group approach was utilized to generate discussion among the respondents regarding their perceptions, opinions and experiences about the topics. Previous literature has supported the validity of focus groups among maintenance staff (Maxwell, 1992; Alwis and Kaluarachchi, 2013). Each focus group was guided by a collection of key questions to explore areas of interest. The focus group guide for entrance interviews (see Table 1) explored maintenance staff's perceptions. The focus group guide for the exit interview (see Table 2) explored maintenance staff's perceptions and opinions about the study; acquired experiences regarding plant maintenance.

Table 1. Semi-structured entrance interview guide

Nbr	Questions
1	How would you describe leadership's role in supporting maintenance at your plant?
1.1	Are maintenance issues taken seriously by management?
1.2	Can you give an example of leadership supporting (or not supporting) a maintenance initiative?
2	Who is responsible for equipment care and maintenance in your plant?
2.1	Do you feel a sense of ownership over the equipment you use?
2.2	How do staff typically respond when a fault or breakdown occurs?
3	What values are promoted in your organization regarding safety and maintenance quality?
3.1	Are there regular safety and quality checks or meetings?
3.2	How do employees typically react to safety and quality protocols?
4	How would you describe your organization's approach to maintenance?
4.1	Do you mostly fix things after a breakdown or plan preventive maintenance?
4.2	What influences whether maintenance is planned or delayed?
5	How are decisions related to maintenance typically made in your plant?
5.1	Is it easy for junior staff to raise concerns or suggest improvements?
5.2	Who has the final say in maintenance matters?
6	How do team members collaborate on maintenance tasks?
6.1	Do people work more independently or in close-knit teams?
6.2	How is information or responsibility shared across team members?
7	Is there a focus on short-term fixes or long-term maintenance planning?
7.1	Are future risks discussed in team meetings or reviews?
7.2	What drives your team's priorities: immediate output or sustained performance?
8	How well do different departments (e.g., production, engineering) collaborate on maintenance?
8.1	Are there regular meetings or shared planning between departments?
8.2	What challenges exist in cross-department maintenance coordination?
9	How do financial considerations impact maintenance decisions in your plant?
9.1	Are maintenance budgets adequate and flexible?
9.2	Have you experienced delays due to a lack of funds?

- 10 Are staff adequately trained for maintenance tasks?
- 10.1 Are there regular training sessions?
- 10.2 What gaps in knowledge or skill have you noticed?
- 11 How does your organization respond to changes in maintenance practices or technologies?
- 11.1 Are people open to trying new tools or methods?
- 11.2 What makes it hard to introduce changes?
- 12 How has your team adapted to modern or digital maintenance tools?
- 12.1 Have new systems or machines been introduced recently?
- 12.2 What challenges have come with using them?
- 13 How important is maintenance to the overall performance of your plant?
- 13.1 Is maintenance linked to productivity targets or KPIs?
- 13.2 Do people see it as a core part of operations?
- 14 How is maintenance viewed financially in your organization?
- 14.1 Is it seen as a cost to be minimized or as a way to save money long-term?
- 14.2 Have you seen examples where good maintenance led to major cost savings?
- 15 In your opinion, how does maintenance influence safety and product quality?
- 15.1 Are breakdowns or faults linked to safety risks or quality issues?
- 15.2 Is this discussed in safety meetings or performance reviews?
- 16 How involved is management in monitoring maintenance activities?
- 16.1 Are there audits, reports, or KPIs reviewed by leadership?
- 16.2 Is feedback provided or action taken when issues are identified?
- 17 Do you have anything else you would like to share about maintenance practices at your plant?
- 17.1 Are there any stories or examples you'd like to share?
- 17.2 What changes would you like to see in the current system?

Table 2. Semi-structured exit interview guide

Nbr	Questions
1	How would you now describe the level of leadership support for maintenance in your organization?
1.1	Have there been improvements or setbacks in management commitment?
1.2	Can you share any examples of leadership involvement during this period?
2	Has your sense of accountability or ownership over equipment changed?
2.1	Do you feel more responsible for the condition of the machines?
2.2	Have your colleagues' attitudes changed as well?
3	What values around safety and quality are most evident in your workplace now?
3.1	Are safety procedures followed more rigorously now?
3.2	Do you think the team shares similar views on maintenance quality?
4	Would you say your organization is shifting toward more proactive maintenance?
4.1	What changes (if any) have been made in how maintenance is planned and performed?
4.2	Are there more preventive actions compared to earlier?
5	Have traditional hierarchies affected your ability to make maintenance-related decisions or suggestions?
5.1	Has there been more openness across levels of authority?
5.2	Are junior staff more comfortable expressing concerns now?
6	How do team dynamics influence your maintenance work now?
6.1	Is there more or less collaboration across individuals and teams?
6.2	Do people work together more collectively or individually?
7	Have you noticed any shift in long-term vs. short-term thinking in your team's maintenance mindset?
7.1	Are future risks considered more now than before?
7.2	Is maintenance planning becoming more strategic?
8	How effective has cross-departmental collaboration been in your maintenance work?
8.1	Are other departments (like production or quality) more involved now?
8.2	Are joint meetings or planning sessions occurring more often?
9	What are the biggest barriers you still face in implementing effective maintenance?
9.1	Are budget limitations still a challenge?
9.2	Has resource allocation improved or worsened?
10	Has there been any improvement in training or skill development for maintenance staff?
10.1	Have you or others received relevant training recently?
10.2	Do you feel more capable in using new tools or techniques?
11	How has your team responded to new maintenance processes or technologies?
11.1	Are there still challenges with adoption?
11.2	Have people become more open to innovation?
12	Are there still difficulties in adapting to new technologies?
12.1	What technologies have been introduced, and how well have they been adopted?
12.2	What kind of support or training was provided?
13	Has your perception of maintenance's role in plant performance changed?
13.1	Is maintenance more clearly connected to productivity or output now?
13.2	Do you think others in the plant recognize its importance?
14	How is maintenance financially viewed in your organization at this point?
14.1	Is it still treated as a cost, or is it seen as adding value?
14.2	Has there been any shift in budgeting priorities?
15	Has awareness increased about how maintenance affects safety and product quality?
15.1	Have there been incidents or discussions linking maintenance with safety?
15.2	Do people talk about these links more openly now?
16	How would you describe management involvement in monitoring and evaluating maintenance now?
16.1	Are performance metrics used more regularly?
16.2	Is there more communication between workers and management about maintenance issues?
17	If you could change anything in your plant's maintenance system or culture, what would it be?
17.1	What do you think would improve maintenance efficiency or safety?
17.2	Are there any practices from other industries or companies you wish were adopted here?

Data Analysis

This study employed thematic analysis following the approach outlined by Braun and Clarke (2006). The process began with focus group interviews, including the transcription of audio recordings and written notes, followed by a systematic coding procedure. Initially, the researcher engaged in repeated reading of the transcripts to become familiar with the data and to identify potential initial codes. In the second level of analysis, these initial codes were reviewed and refined, with particular attention given to preserving the diversity of core codes and constructing meaningful higher-level sub-themes. The main research questions the impact of cultural influence on plant maintenance practices, guided the thematic development throughout the process (Boyatzis,1998). Subsequently, relevant participant quotes were identified and mapped to the emerging themes. The themes were then reviewed for coherence and distinction before being clearly defined and named. Once finalized, the themes formed the foundation for the writing of the findings and analysis.

Results

In thematic analysis, the goal is to identify, analyze, and report patterns (themes) within qualitative data. When applied to entrance and exit interviews, this process helps organizations move from anecdotal feedback to systematic insights that can inform decision-making.

Entrance Interview Themes: There were four primary themes that emerged from the focus groups that were conducted. Each theme is next described in detail (see Table 3). Additional example quotes are included in Table 4.

Table 3. Definition of Theme and Sub-themes

Theme 1: Influence of Organizational Culture on Maintenance

Theme / Sub-theme	Definition	Statement Focus
1. Influence of Organizational Culture on Maintenance	Statements that describe how shared values, beliefs, and behaviors within the organization impact maintenance attitudes, decisions, and practices.	Emphasis on how organizational norms, employee engagement, communication patterns, and cultural priorities shape maintenance effectiveness and compliance.
1.1 Leadership support and management commitment	Statements that highlight the role of leadership in fostering a culture of maintenance	Emphasis on managerial support, policies, and initiatives that encourage maintenance practices.
1.2 Accountability and ownership of equipment	Comments on the responsibility of individuals or teams in maintaining equipment	Discussions about clear roles, ownership of equipment, and how individuals or departments hold themselves accountable.
1.3 Shared values about safety and care	Statements about how the organization collectively values safety and proper equipment care	Reflections on collective attitudes toward safety, equipment care, and ensuring proper maintenance culture.
1.4 Reactive vs. proactive maintenance mindsets	Comments contrasting reactive vs. proactive approaches to maintenance	Focus on whether maintenance is seen as a necessary emergency response or part of an ongoing, forward-thinking strategy.

Theme 2: Role of National Culture in Shaping Attitudes

Theme / Sub-theme	Definition	Statement Focus
2. Role of National Culture in Shaping Attitudes	Statements that explore how broader cultural values, traditions, and societal norms at the national level influence individual and collective attitudes toward maintenance and workplace practices.	Emphasis on how cultural dimensions such as power distance, uncertainty avoidance, collectivism vs. individualism influence perceptions of responsibility, adherence to procedures, and openness to maintenance-related initiatives.
2.1 Hierarchical decision-making (power distance)	Statements referring to the influence of hierarchy on decision-making processes	Discusses whether decision-making is centralized or decentralized based on power distance, and how it affects maintenance decisions.
2.2 Influence of collectivism/individualism on teamwork	Statements on how cultural orientations (collectivism vs. individualism) impact collaboration	Reflections on how cultural values regarding teamwork, individual responsibility, and group collaboration shape maintenance work.
2.3 Short-term orientation and lack of proactive culture	Statements referring to the tendency to prioritize immediate outcomes over long-term planning, and a reactive rather than proactive approach to maintenance.	Explores how cultural emphasis on short-term gains and crisis-based management undermines proactive maintenance planning, investment in reliability, and long-term asset performance.
2.4 cross-functional teamwork and integration	Comments on the collaboration between different departments or teams for effective maintenance	Examines how the degree of integration between maintenance, production, and other departments influences information flow, problem-solving, and coordinated maintenance efforts.

Theme 3: Barriers to Effective Maintenance Implementation

Theme / Sub-theme	Definition	Statement Focus
3. Barriers to Effective Maintenance Implementation	Statements that identify challenges, obstacles, or limitations that hinder the successful execution of maintenance strategies, programs, or practices.	Emphasis on factors such as resource constraints, lack of training, resistance to change, poor communication, inadequate planning, or organizational inertia that impede maintenance effectiveness.
3.1 Financial and budgetary constraints	Statements about the lack of financial resources for maintenance	Discusses the impact of limited budgets or financial resources on maintenance practices.
3.2 Lack of skilled labour or training	Comments about a shortage of qualified personnel or inadequate training	Focus on how lack of technical skills or insufficient training affects the quality of maintenance work.
3.3 Resistance to change	Statements about organizational or individual resistance to adopting new maintenance strategies	Discusses how change resistance, whether due to tradition, fear of technology, or other factors, impacts maintenance culture.
3.4 Difficulty in adapting to new technologies	Comments on the challenges of integrating new technologies in maintenance	Focuses on the barriers organizations face when trying to implement modern technology in their maintenance processes.

Theme 4: Perceived Importance of Maintenance Management

Theme / Sub-theme	Definition	Statement Focus
4. Perceived Importance of Maintenance Management	Statements that reflect individual or organizational perceptions regarding the value, priority, and strategic significance of maintenance management within the overall operations.	Emphasis on how maintenance is viewed in terms of its contribution to safety, efficiency, productivity, cost reduction, and long-term asset reliability.
4.1 Strategic role of maintenance in plant performance	Statements referring to how maintenance activities contribute to achieving long-term operational efficiency, reliability, and competitiveness.	Investigates the extent to which maintenance is viewed as a strategic function that supports overall plant performance, productivity, and asset longevity.
4.2 Maintenance as a cost centre vs value creator	Statements reflecting whether maintenance is perceived primarily as an operational expense or as a function that adds value through reliability, efficiency, and asset longevity.	Explores organizational perceptions of maintenance—whether it is viewed merely as a cost to be minimized or as a strategic investment that enhances productivity and long-term value.
4.3 Awareness of maintenance importance on safety and quality	Statements referring to how maintenance practices are linked to ensuring workplace safety and product or service quality.	Examines the extent to which organizations recognize the role of maintenance in preventing accidents, ensuring compliance, and maintaining high standards of operational quality.
4.4 Management involvement and monitoring	Statements referring to the degree of engagement by management in overseeing, supporting, and evaluating maintenance activities.	Explores how actively management participates in maintenance planning, resource allocation, performance monitoring, and how this involvement influences maintenance effectiveness and accountability.

Exit Interview Themes: Four key themes that were initially identified during the entrance interviews continued to be relevant during the exit interviews. These recurring themes provide insight into how participants' perceptions evolved over the course of the programme, and how underlying cultural and organizational factors continued to influence workplace maintenance practices. Each theme is described in detail below (Table 4), highlighting both continuity and change in participants' perspectives. Supporting participant quotes are also provided in Table 4.

Table 4. Entrance Themes and Exit Themes

Theme 1: Influence of Organizational Culture on Maintenance

Sub-theme	Entrance Theme	Exit Theme
1.1 Leadership support and management commitment	"Our supervisor really emphasizes the importance of keeping our equipment in top shape."	"Leadership always makes sure we have the resources we need for maintenance."
1.2 Accountability and ownership of equipment	"Usually the maintenance team waits for things to break before acting."	"Now, operators feel more responsible for reporting issues early."
1.3 Shared values about safety and care	"People know safety is important, but it's not always followed strictly."	"There's more discussion now about safety, and people are taking it seriously."
1.4 Reactive vs. proactive maintenance mindsets	"We mostly fix things after they stop working."	"We've started planning more preventive maintenance schedules."

Theme 2: Role of National Culture in Shaping Attitudes

Sub-theme	Entrance Theme	Exit Theme
2.1 Hierarchical decision-making (power distance)	"Technicians rarely question managers, even when they see a problem."	"There's a bit more openness now, but senior staff still make the final calls."
2.2 Influence of collectivism/individualism on teamwork	"People prefer to work in their own groups and don't often share ideas across teams."	"We've had more cross-team meetings lately, and people are starting to collaborate more."
2.3 Short-term orientation and lack of proactive culture	"We focus on fixing today's issues, not future problems."	"There's more awareness now about long-term planning, though old habits are hard to change."
2.4 Cross-functional teamwork and integration	"Production and maintenance work separately with little coordination."	"There's better communication now between departments during maintenance planning."

Theme 3: Barriers to Effective Maintenance Implementation

Sub-theme	Entrance Theme	Exit Theme
3.1 Financial and budgetary constraints	"Budget is always a problem—maintenance gets pushed back due to costs."	"We still have limitations, but leadership is trying to allocate more funds."
3.2 Lack of skilled labour or training	"Some workers don't know how to handle the newer machines."	"After the training, people are more confident using modern tools."
3.3 Resistance to change	"People are used to the old ways and don't want to change."	"There's still resistance, but some are slowly adapting to new systems."
3.4 Difficulty in adapting to new technologies	"We have the equipment, but no one knows how to use it fully."	"We've started learning how to use the newer systems more effectively."

Theme 4: Perceived Importance of Maintenance Management

Sub-theme	Entrance Theme	Exit Theme
4.1 Strategic role of maintenance in plant performance	"Maintenance is seen as necessary, but not really strategic."	"Now we talk about how proper maintenance improves overall efficiency."
4.2 Maintenance as a cost centre vs value creator	"It's often treated as a cost, something to be reduced."	"There's a growing view that maintenance prevents bigger losses."
4.3 Awareness of maintenance importance on safety and quality	"We know it affects quality, but it's not always top priority."	"Now it's clearer that safety and quality depend on good maintenance."
4.4 Management involvement and monitoring	"Management doesn't usually follow up after maintenance activities."	"Managers are now more involved and ask for regular updates."

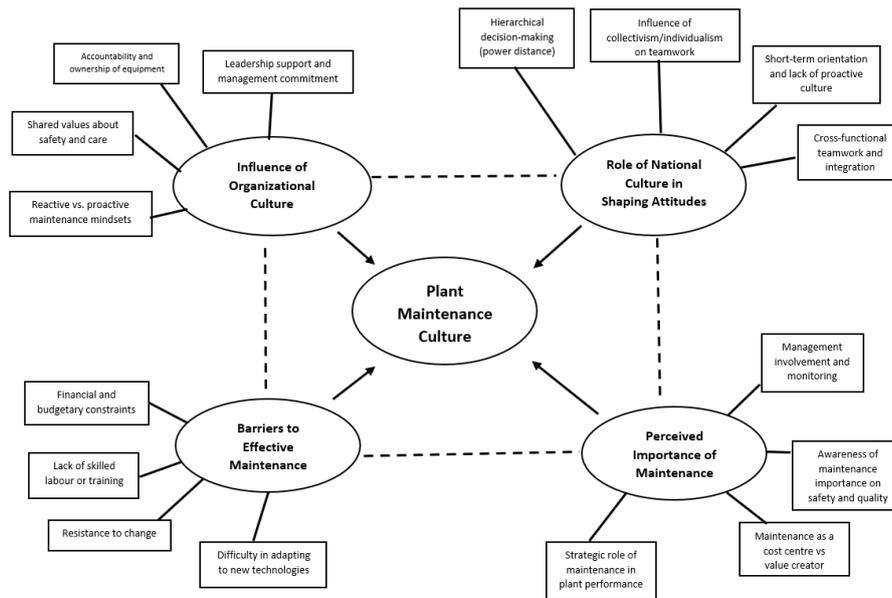


Figure 1. Finalized thematic map demonstrating four themes

According to Figure 1, the finalized thematic map illustrates that maintenance practices in Sri Lanka's tyre manufacturing industry are strongly influenced by both organizational and national culture. Organizations characterized by supportive leadership and strategic cultural alignment foster equipment ownership and proactive maintenance approaches, including preventive and safety-oriented practices. In contrast, weak or cost-focused organizational cultures are associated with predominantly reactive maintenance behaviours. Furthermore, high power distance and hierarchical decision-making norms constrain employee participation and hinder effective strategy implementation. The analysis also identifies common barriers across firms, including budgetary constraints, resistance to change, and skills shortages. Overall, the findings indicate that mature maintenance cultures enhance the strategic status of maintenance, contributing to improved operational performance, safety outcomes, and long-term organizational resilience.

Discussion

This discussion interprets the findings of the study by examining how organizational and national cultural factors influence maintenance practices within Sri Lanka's tyre manufacturing industry. Four themes collectively highlight how leadership orientation, cultural norms, resource allocation, and organizational maturity shape maintenance behaviours, strategic alignment, and the perceived status of maintenance management. By integrating participant insights with existing literature, this section explains the mechanisms through which cultural and structural factors either enable or constrain the development of effective, proactive, and strategically valued maintenance systems.

Theme 1: The Influence of Organizational Culture on Maintenance Practices

The findings of this study indicate that organizational culture plays a central and defining role in shaping the way maintenance is understood, prioritized, and practiced within tyre manufacturing plants in Sri Lanka. Through thematic analysis of the interview data, it became evident that supportive and strategically aligned organizational cultures foster a more proactive, preventive, and safety-conscious maintenance environment. In organizations (plants A, B, C, and D) where leadership visibly endorsed maintenance as a strategic priority, employees at all levels, particularly engineers and technicians, demonstrated a strong commitment to preventive maintenance (PM), regular inspections, and adherence to standard operating procedures. Respondents from such companies described maintenance as part of the DNA of their operations, with senior management regularly monitoring maintenance KPIs, allocating adequate budgets, and encouraging cross-functional communication. However, about 60% of respondents from the organizations surveyed, reported that traditional reactive maintenance was performed outside of standard activities at all levels. In those companies where they viewed maintenance as a cost centre or non-strategic function, participants reported a reactive culture marked by last-minute repairs, equipment breakdowns, and low investment in talent development. In these environments, there was no clear maintenance strategy, and front-line staff expressed frustration with the lack of long-term planning and support. One Maintenance Manager stated that maintenance is not just an afterthought. It is part of our daily planning meetings, and we track it like we track production. An engineer at one such company (plant J) said, "we only fix it when it breaks, and that's the norm. There is no vision for preventive maintenance here".

The Sri Lankan context further revealed the influence of top-down decision-making hierarchies, where, although the attitudes of senior leadership significantly shaped the maintenance culture, and middle and front-line managers, as well as in several multinational companies, Indian or European corporate partners influenced policies, local leadership commitment was the critical factor in effective implementation. Some participants highlighted that despite access to modern technologies such as CMMS (Computerized Maintenance Management Systems), a lack of cultural alignment within the organization undermined their use. In addition, maintenance technicians emphasized that trust and empowerment are critical cultural elements. In factories where technicians feel valued and are asked to contribute to maintenance planning, they are more likely to take ownership of equipment and demonstrate preventive maintenance behaviours. But in the other 60% of companies, the situation is completely different. Trust and empowerment or machine ownership taking is moderate. This quality of self-determination about their machinery and equipment is not developed by machine operators or production supervisors. "In these plants, neither the operators nor the supervisors are acting responsibly. They do not clean and inspect their machines daily, and there is no clear understanding of concepts such as CLIT (cleaning, lubrication, inspection, and tightening)," explained one production supervisor in plant I. These findings support claims that nearly 40% of companies have a strong organizational culture characterized by leadership support, shared values, accountability, and open communication that leads to better alignment of maintenance practices with strategic business goals. In contrast, weak or indifferent cultures tend to result in a short-term, breakdown-oriented approach, with detrimental effects on safety, efficiency, and equipment lifespan.

Theme 2: The Role of National Culture in Shaping Attitudes

The analysis revealed that national cultural values, particularly those common in Sri Lankan workplaces, significantly influence the way maintenance strategies are communicated, managed, and implemented within tyre manufacturing companies. These cultural undercurrents shape managerial style, employee engagement, and decision-making structures, which in turn affect the success or failure of maintenance initiatives. A recurring pattern across interviews was the presence of high power distance, a national cultural trait identified by

Hofstede's dimensions of culture (Mohamed Irfan, 2016). This was especially evident in hierarchical organizational structures, where decision-making authority is concentrated at the top, and lower-level employees, including maintenance technicians and supervisors, are often excluded from strategic discussions. A Maintenance Technician at Plant G emphasized that "We usually wait for the manager's instructions. We don't make decisions on our own, even if the situation is urgent?" This top-down approach, while culturally accepted and expected, creates a disconnect between strategy and execution. Participants expressed that maintenance strategies are often designed by top management, sometimes in consultation with foreign partners, without adequate input from those who perform day-to-day maintenance tasks. This leads to a lack of ownership and reduced buy-in from the workforce. Engineer, from Plant E, expressed that sometimes we are told to follow a new procedure, but no one explains the reason. It is just an order from above. Moreover, communication styles influenced by national culture also played a critical role. Many participants highlighted that direct feedback or raising concerns, especially upward to management, is generally avoided due to cultural norms around respect for authority and avoiding confrontation. As a result, potential maintenance issues go unreported, and opportunities for improvement are missed. A Technician at Plant D mentioned that "we don't usually challenge the system or ask questions, even if we see a problem". It may be seen as disrespectful.

Interestingly, companies with multinational affiliations, particularly with European or Indian partners, demonstrated some degree of cultural blending. In these environments, there was often an intentional effort to reduce hierarchical barriers, encourage open dialogue, and involve operational staff in decision-making. However, even in these cases, the prevailing Sri Lankan workplace culture sometimes hindered full engagement. Maintenance strategies often created implementation gaps, and formal strategies remained on paper but were not effectively translated into everyday practice. In companies where the Sri Lankan cultural focus was dominant, there was little implementation of maintenance strategies and minimal adaptation at the operational level. This often led to implementation gaps, and formal strategies, while existing on paper, were not effectively translated into day-to-day practice.

Theme 3: Common Barriers to Effective Maintenance Across Organizations

Despite variation in company size, ownership (local vs. multinational), and operational scale, the study identified consistent and recurring barriers to the successful implementation of effective maintenance strategies across tyre manufacturing plants in Sri Lanka. These barriers emerged as a dominant theme during the thematic analysis of participant interviews, indicating a shared set of systemic and cultural challenges that cut across organizational boundaries.

A key concern expressed by participants was the insufficient allocation of financial resources for maintenance systems, tools, training, and technology. While senior managers (at plant J) often acknowledged the importance of maintenance, budget priorities were skewed towards production, with maintenance seen as a secondary or support function. Maintenance Managers of Plant G and H stated that "we talk about preventive maintenance, but when it comes to budget matters, production priorities always win. Maintenance gets whatever is left" This underinvestment was more pronounced in locally-owned firms, but even in multinational plants, maintenance departments struggled to justify expenditures unless tied directly to production losses or compliance mandates.

Another frequently cited barrier was resistance to change at multiple organizational levels. Technicians and engineers spoke about longstanding practices, routines, and informal systems that were difficult to alter, even when new strategies or technologies were introduced. "The older staff prefer the old ways. Even when we show them better systems, they feel it's unnecessary or risky," said the engineer at Plant C. This resistance often stemmed from a fear of the unknown, lack of training, or distrust of new technologies such as CMMS (Computerized Maintenance Management Systems). In some cases, middle managers also acted as gatekeepers, blocking innovation due to uncertainty or perceived threats to their control.

A skills gap, particularly in technical diagnostics, electrical systems, automation, and preventive maintenance techniques, was another widespread issue. Although many workers had long tenures in the company, upskilling and formal training programs were rare, especially in local firms. Maintenance Supervisor at Plant B said that "we have experienced staff, but they haven't been trained on the new systems. So, even if we buy technology, it is not used properly" Participants noted that while some multinational companies had internal training programs (sometimes delivered by Indian or European partners), these were limited in scope and frequency. Moreover, the national vocational training infrastructure was viewed as outdated and mismatched to modern industrial needs.

What is particularly striking is that these barriers, including budget constraints, resistance to change, and skills shortages, persisted regardless of company size, ownership type, or technological maturity. Whether the company had been operating for decades or was part of a large international group, the same constraints were echoed across interviews. Even though we are part of a multinational group, we face the same issues. "Training is limited, and upgrades are slow unless they directly affect production", Operations Manager, Plant E, said.

A strong maintenance culture has not been consistently sustained within the Sri Lankan tyre manufacturing industry. Such a culture is defined by key attributes, including proactive maintenance practices, heightened safety awareness, long-term asset stewardship, and robust organizational support. These elements are inherently interrelated, and their presence or absence directly influences plant effectiveness in reducing downtime, optimizing operational performance, and ensuring safe working conditions. Organizations that invest in the systematic development of a strong maintenance culture tend to demonstrate greater operational resilience, improved efficiency, and enhanced long-term competitiveness.

In particular, within highly structured and often Sri Lankan multinational manufacturing environments, organizations exhibiting a mature maintenance culture have undergone a strategic transition from reactive, breakdown-driven maintenance toward preventive and predictive maintenance approaches. This shift reflects an increased emphasis on reliability, risk mitigation, and sustainable asset management.

Participants emphasized that this evolution should not simply be about systems or schedules, but about a shift in mindset and attitudes. As an engineering manager at Plant A described that, "Preventive maintenance is not just a task, it is a philosophy". When teams believe in keeping machines healthy rather than fixing them only when they fail, the whole plant becomes more stable. Regular equipment audits, root cause analyses, and predictive diagnostics (such as vibration and thermal monitoring) were standard practices in such environments. In contrast, in less mature setups, maintenance was still largely reactive, often driven by urgency and constrained budgets. Technicians in these contexts reported being in "firefighting mode," only called upon when equipment failed. Organizations with preventive-focused cultures reported lower unplanned downtime, more efficient use of spare parts, and improved trust between production and maintenance teams. Importantly, preventive culture was reinforced through data-driven decision-making, where maintenance logs, failure patterns, and performance metrics were used not to assign blame, but to anticipate and solve recurring issues. As one maintenance engineer at a Colombo-based tyre plant (plant C) noted, "if you wait for the machine to fail, you've already lost productivity. Our approach now is to look at trends, vibration, temperature, noise and act before damage occurs".

A strong commitment to safety was seen as both a driver and an indicator of a healthy maintenance culture. In mature organizations, safety wasn't treated as an external compliance obligation; it was deeply embedded in day-to-day operations. Maintenance teams had clear protocols, such as lockout/tagout (LOTO), confined space entry procedures, and mandatory PPE compliance. Safety was also regularly reviewed through toolbox talks, joint safety committees, and safety KPIs. As noted by a senior technician in Plant A, "if we don't feel safe doing a job, we don't start it

simply as that. And the management backs us up every time. That kind of support changes how you work". This culture of safety led to greater confidence among technicians, reduced accident rates, and increased job satisfaction. In contrast, in less formalized environments, safety was often treated reactively after an incident. Workers reported that under production pressure, safety procedures were sometimes bypassed. In such cases, accidents or near misses were more frequent, and maintenance staff felt less protected and less valued. In one Sri Lankan tyre company, a maintenance supervisor reported that "We have stopped jobs midway if something looks unsafe. Management supports us fully, even if it causes a short delay. Safety always comes first".

In environments with mature maintenance practices, long-term care of assets was viewed as a strategic priority. Maintenance was not merely about fixing what is broken today, but preserving and enhancing the life cycle of critical equipment. This involved structured planning, use of computerized maintenance management systems (CMMS), timely part replacements, lubrication schedules, and periodic condition assessments. A reliability engineer from Plant A emphasized that "we treat our machines like investments. We track every downtime, every repair, and we ask, 'What can we do now that saves cost two years from now?'. By contrast, in less mature organizations, equipment was often operated until failure. Maintenance decisions were short-term, cost-driven, and influenced by the availability of parts or downtime tolerance. Equipment documentation was often outdated or missing, and upgrades were rare due to capital constraints. This reactive mindset led to higher operating costs, more frequent disruptions, and reduced asset life. A reliability engineer at a leading tyre manufacturer (plant B) explained that "our machines are decades old, but still run smoothly. That is because we have tracked every fault, replaced parts on schedule, and never ignored the signs".

Perhaps the most defining characteristic of a strong maintenance culture was the level of organizational support and accountability for the maintenance function. In high-maturity environments, maintenance was not a background role it was central to business success. Maintenance departments had dedicated budgets, strategic visibility, and direct involvement in operational planning. A plant manager from a leading Sri Lankan tyre manufacturer (plant B) noted that "We have stopped seeing maintenance as a cost centre. It is a core enabler of everything from safety to quality to delivery". That shift in mindset came from the top. Conversely, in firms where maintenance was treated as a support function or secondary priority, staff often felt undervalued. Technicians reported unclear expectations, inconsistent feedback, and minimal involvement in decision-making. Breakdowns were seen as isolated incidents rather than systemic signals. The absence of clear accountability often led to a "blame culture," where maintenance was faulted for failures without understanding underlying causes, be it poor design, rushed production, or operator error. In contrast, supportive organizations promoted a "shared responsibility" model, where success and failure were collective, not departmental. As a plant manager (at plant A) shared, "when breakdowns happen, we don't point fingers". Production, maintenance, and quality all sit together to solve it. That unity comes from leadership.

Theme 4: Mature Maintenance Culture and Its Link to Perceived Importance of Maintenance Management Status

Thematic analysis of the data revealed a strong association between a mature maintenance culture and the perceived effectiveness and strategic status of maintenance management within tyre manufacturing companies in Sri Lanka. Participants across roles including managers, engineers, and technicians consistently described mature maintenance cultures as those characterized by structured processes, proactive practices, and cross-functional collaboration. In such environments, maintenance was not only operationally embedded but also strategically valued.

In companies where participants reported high levels of maintenance planning, documentation, and review mechanisms, maintenance was perceived as being more strategically integrated into broader business operations. These organizations commonly employed Computerized Maintenance Management Systems (CMMS) or other digital tools to monitor equipment health, track preventive maintenance schedules, and log maintenance history. Here is what Engineer at Plant D said about the positive situation, "We have a system where every maintenance task is tracked and reported. Nothing is missed, and we can plan well ahead". This structured approach was seen as indicative of a professionalized and mature maintenance function, which in turn elevated its status in the company hierarchy. Maintenance managers in these settings were often involved in strategic meetings, budget planning, and operational reviews.

Mature maintenance cultures in mostly multinational companies also demonstrated strong cross-departmental collaboration, particularly between maintenance, production, and quality teams. Participants described how problems were jointly diagnosed, preventive actions planned together, and operational priorities aligned through regular coordination meetings. Evidently, according to the maintenance supervisor at plant A, when the maintenance, production, and quality teams work together, we avoid many breakdowns. Everyone sees it as a shared responsibility. This sense of shared ownership led to higher motivation, reduced blame culture, and quicker resolution of issues. Importantly, such collaboration was viewed as a sign of respect and recognition for the maintenance function, enhancing its perceived legitimacy within the organization.

In companies with mature maintenance cultures, participants highlighted that maintenance objectives were aligned with broader business goals, such as reducing downtime, ensuring safety compliance, and improving overall equipment effectiveness (OEE). Senior leaders in these firms were seen to champion maintenance initiatives, allocate appropriate resources, and involve maintenance teams in strategic planning. Our top management sees maintenance as a long-term investment, not just a cost. That mindset changes everything, said a Plant Manager at Plant B. The status of maintenance management in these companies was notably higher, evidenced by regular performance reviews, key performance indicators (KPIs), and recognition programs for maintainers. Technicians reported feeling valued and included, which further contributed to a positive maintenance mindset and behaviour.

In contrast, companies where maintenance was reactive, under-resourced, or isolated from decision-making reported a lower perceived status of the maintenance function. Participants in such environments (plants G, H, and I) described maintenance as ignored until something breaks, with little integration into production planning or organizational learning processes. A Technician at Plant F noted that "no one talks about maintenance until a machine fails. We are not part of any strategic decisions". These kinds of companies lacked the systems, routines, and recognition that define mature maintenance cultures. As a result, maintenance staff often felt disconnected from the organization's mission and undervalued by leadership.

Conclusions

The findings of this study strongly affirm that the effectiveness of maintenance practices in Sri Lanka's tyre manufacturing sector is deeply influenced by both organizational and national cultural dimensions, alongside structural, strategic, and operational factors. A well-established maintenance culture characterized by preventive practices, safety commitment, long-term asset stewardship, and organizational support emerges as the most critical differentiator between high-performing and underperforming plants. The study reveals a clear divide: approximately 40% of the companies demonstrate mature, strategically aligned maintenance environments where leadership support, cross-functional collaboration, and trust-based empowerment drive continuous improvement. In these firms, maintenance is treated not as a cost centre but as a value-adding function critical to productivity, safety, and competitiveness. In contrast, the other 60% continue to operate with reactive, breakdown-focused mindsets, constrained by limited investment, resistance to change, and lack of accountability, often exacerbated by hierarchical structures and national cultural norms that discourage bottom-up communication.

Importantly, the link between organizational culture and maintenance maturity is undeniable. Firms with strong leadership commitment, open communication, and participatory decision-making tend to build high-performing maintenance cultures that align with long-term business goals. Meanwhile, national cultural traits such as high power distance and respect for hierarchy present both constraints and opportunities. While they

can limit frontline initiative, they also offer pathways for change if senior leadership models and supports a culture of openness, safety, and continuous learning. Finally, systemic barriers such as skills shortages, underinvestment, resistance to change and limited training capacity remain prevalent across both local and multinational firms. Addressing these challenges through capacity building, cultural transformation, and strategic alignment is essential for Sri Lankan tyre manufacturers aiming to elevate maintenance from a reactive necessity to a strategic advantage. On the other hand, employees tend to think positively about equipment ownership, recognize the value of preventing breakdowns, and are more diligent, thorough and proactive. Maintenance managers in the manufacturing sector in Sri Lanka should be encouraged to adopt best practices from globally benchmarked maintenance strategies and apply them to their specific areas of weakness. However, implementing these changes will be challenging, as many managers are reluctant to move away from traditional beliefs shaped by deeply ingrained cultural norms. The study urges leaders to be willing to critically examine these cultural frameworks and step out of their comfort zones. Embracing this uncertain but potentially innovative path requires re-evaluating and, when necessary, abandoning outdated management practices that no longer support organizational growth or competitiveness.

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