Proceedings of the 35th European Safety and Reliability & the 33rd Society for Risk Analysis Europe Conference
Edited by Eirik Bjorheim Abrahamsen, Terje Aven, Frederic Bouder, Roger Flage, Marja Ylönen
 Published by Research Publishing, Singapore.
doi: 10.3850/978-981-94-3281-3_ESREL-SRA-E2025-P7986-cd

Factors Influencing the Performance of Railway Track Maintenance Teams

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Team functionality plays an important role in employees' performance that drives organisational objectives. Optimal performance within the railway industry requires management systems to be created and implemented to achieve team efficiency to enhance productivity. Various factors linked to High Performance Work Systems (HPWS) relating to human behaviour and function are investigated to determine key factors that influence the performance of maintenance teams, specifically focusing on activities linked to the railway industry. A questionnaire was presented to 180 sample population, out of which 131 questionnaire data were used for analysis. The respondents were responsible for perway (track) related maintenance tasks, the quantitative results presented by respondents ranked factors of this study and how they viewed each item using a four-point scale methodology. Collaborating the results through descriptive, frequency, reliability and validity statistics, the outcomes of the analysis have shown the following factors as valued the most to the least: rewards and recognition (most valued), effective communication, motivation, trust, teamwork, effective leadership, skills, supervisor support, co-operation and co-ordination, adaptation, performance monitoring, shared responsibility and diversity (least valued). Although every factor is indicated to be relevant in this study, they are valued differently in the railway industry; by leveraging the top items, railway organisations can ensure and maintain high performance. Furthermore, by investigating and implementing the least valued factors, organisations can improve the intrinsic motivation of teams, which will ultimately have a positive influence on team performance.

Keywords: High Performance Work System (HPWS), railway, performance productivity, human resource.

1. Introduction

History has shown a growing interest in redirecting bulk commodities from road to rail, which includes passengers and resources from mines. This is evident as South Africa hauls up to 1.8 billion tonnes of freight over an average section of 246km, providing 432 billion tonne-km to the economy. The popularity of rail freight is its high bearing capacity and the ability of infrastructure to be designed with a reasonable lengthy life span. Increasing organisational revenue and the delivery of economic growth, as well as the reliability and availability of rail networks, is sought out and can be achieved with efficient and effective asset management practices (Too, Betts and Kumar, 2006). In many aspects, maintenance management becomes valuable in driving track stability and reliability (IHHA, 2009).

Typical perway track maintenance teams consist of sixteen employees, including a Track Inspector, Track Master, two flagmen, and twelve labourers. They are responsible for various forms of maintenance, which include routine and preventative maintenance, as well as emergency work. These activities are labour-intensive and improve the condition of rails, sleepers (tie) and track geometry. Several standards and guidelines are used to ensure quality maintenance for optimal asset functionality. Considering the high levels of dynamic forces applied by rolling stock (trains), maintenance teams require regular and timeous maintenance. The level of maintenance intensity is dependent on section classification, the network is classified under N1, N2, N3 and S line classification, of which the criteria is affected by the type of infrastructure and the

total tonnages of resources hauled over a particular corridor. Maintenance of these assets by the perway track maintenance teams' performance is essential.

The research gap lies in the lack of a targeted framework linking High-Performance Work Systems (HPWS) to railway maintenance team performance. While HPWS benefits are well-documented, existing studies do not sufficiently address industry-specific challenges such as leadership effectiveness, motivation, adaptability, and team cohesion in railway maintenance. The absence of an integrated model limits the ability to systematically enhance team performance and rail network reliability

To address this research gap, the study aimed to investigate factors that influence the performance of maintenance teams in the railway industry. To achieve this, the following objectives were developed for this study:

- What are the primary factors which influence the performance of maintenance teams?
- What strategies can be adopted to improve maintenance team performance?

2. Literature Review or Theoretical Framework

In an industry reliant on maintenance to achieve business objectives, efficient and effective maintenance becomes fundamental and desirable (Too et al., 2006). Moreover, organisations research several means to increase productivity and performance, which directly influences the bottom line. In many cases, human resources, tools, and equipment are needed to execute maintenance, which is in line with HPWS functionality (Shih, Chaiang and Hsu, 2013). This chapter will review the literature to study and understand existing factors that influence the performance of teams to determine which of these items are prominent and which can be used in the railway industry.

2.1. *Human Elements Influencing Team Behaviour*

Katzenbach and Smith (1993) define a team as "a small group of people with complementary skills who are committed to a common purpose, performance goals and approach for which they are mutually accountable". Dutra, Prikladnicki and Conte (2015) investigated effective communication, coordination, teamwork, team diversity, leadership, team cohesion and motivation parameters, they established that these factors correlated with team performance. Effective communication is essential to understanding requirements, and it enables employees to share information to build team cognition. In essence, the complexity of maintenance tasks can decrease productivity, and the results are exaggerated when poor communication is incorporated into the process (Kerr and Tindale, 2004).

Similarly, preferred outcomes are achieved when there is effective team coordination, this is evident in various activities as most cannot be done alone (Espinosa, Lerch and Kraut, 2004). Team coordination is a behavioural process, and it links to how tasks are planned and where roles and responsibilities are clearly defined (Espinosa, et al., 2004). When successful, it enables employees to predict team member needs through shared mental models (Hoeft, Jentsch, Smith-Jentsch and Bowers, 2005). Next, Buzamat's (2014) study shows the value of teamwork, he established that if the function is incorporated into activities, high performance is realised.

An influential factor like diversity is known to increase the performance and resilience of teams, it creates a condition efficient to develop a competitive advantage, which incorporates cognitive decision-making (Aidman, 2017). Pieterse et al., (2010) discuss how team performance is directly proportional to how diverse a team is, this is evident in a reflexive type of group while indirectly proportional to a non-reflexive group. The effects of leadership on team performance were researched by Zaccaro, Rittman and Marks (2001), and they established that leadership is significantly influential owing to its ability to impact cognitive, motivational, affective and co-ordination attributes of a team. Essentially, a cohesive team does have a greater influence on team behaviour to deliver milestones, it further affects the level of stress when their focus is to achieve high performance (Schachter, Ellertson, McBridge and Gregory, 1951).

Obtaining commitment from maintenance teams has been shown to correlate with the principle of motivation, and the framework relates to a discussion by Johnson, Chang and Yang (2010). Furthermore, Cho and Perry (2012) also

indicated that managerial trustworthiness and goal-directedness increase intrinsic motivation, while extrinsic reward expectancy reduces it.

2.2. *High Performance Work Systems (HPWS)*

The delivery of high performance can be challenging in an agile and complex environment, it does affect the bottom line of an organisation. Sourchi and Jianqiao (2015) conducted research using a web-based survey, and they demonstrated that respective structures have a constructive impact on employees, which can include influencing creativity, pro-activeness, attitude, and adaptability. A positive outcome can be achieved if job infrastructure, training, information sharing and employee incentives are inclusive in an organisation (Shih, Chiang and Hsu, 2013). Similarly, Salas, Cooke and Rosen, (2008) have observed that by leveraging commitment and an empowered team environment, high productivity is evident (Salas et al., 2008). In contradiction, creating an environment where competitive advantages are promoted is believed to be done at the expense of employees (Gulzar, Moon, Attiq and Rauf, 2014). Gulzar et al., (2014) state that HPWS is associated with psychological outcomes such as anxiety, job burnout and role overload. These are some of the dynamics of HPWS that should be taken into consideration when developing strategies that are responsible for performance improvement.

2.2.1. *Framework of HPWS and Organisational Performance*

Research linking HPWS to internal social structure and organisational performance has been conducted by Evans and Davis (2005). They indicated that positive outcomes are dependent on human resources, finances and labour, which can be optimised once the characteristics of shared mental models are understood (Evans and Davis, 2005).

Organisations incorporating appropriate investment in training, mentorship, internal and individual development programmes will create an employment pool which encourages teams to be effective and will ensure reliable and continuous performance. Similarly, education and training investment of people, people focus, inclusiveness and measurable performance an underpinning concepts discussed by Armitage and Keble-Allen (2007), which ultimately provide productivity.

Therefore, talent management strategies do help employees make decisions to meet current and future organisational objectives. Key components developed by Salas, Sims and Burke (2005), namely, team leadership, mutual performance monitoring, backup behaviour, adaptability, and team orientation, were studied and labelled as the 'Big Five'. The elements were shown to contribute to team effectiveness in line with co-ordinating mechanisms.

3. Conceptual Method

3.1. *Proposed framework*

The proposed research framework is demonstrated in Figure 1, where the relations of core factors affecting the performance of maintenance teams are presented. Salas, et al., (2005) argued that team leadership, mutual performance monitoring, backup behaviour, adaptability and team orientation are the core components of team performance. Their theory forms the basis of the framework developed for this research, and it links to the complexity of team effectiveness and productivity. Literature has shown a link between HPWS and its subsequent effects on factors that influence the performance of teams. Based on the above, hypotheses were developed and discussed further, and the findings can create opportunities for improving team performance in the railway industry.

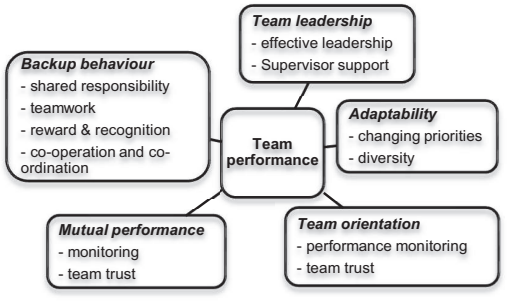

Fig. 1.Framework of railway organisational performance

3.2. *Performance related factors*

Although there are several parameters examined in literature with respect to their impact on team performance, this study focuses on the five elements and their supporting factors because there is strong evidence of its relation to the

developed model. The parameters are elaborated and the associated hypotheses are listed subsequently.

3.2.1. *Team leadership*

Effective and efficient leadership is known to ensure sound management of activities, development of solutions and implementation of actions to meet maintenance objectives (Eduardo, 2005). Facilitating and co-ordinating employees generates responsibilities conducive to encourage adaptability which promotes continuous productivity. Fundamentally, leaders and supervisors can generate shared mental models among team members, which provide clear understanding throughout the lifespan of an activity (Salas, et al., 2005). Furthermore, tracking quality assurance becomes critical in such instances where efficient maintenance is required and relied upon (Eduardo, 2005).

3.2.2. *Mutual Performance Monitoring*

Eduardo (2005) has observed that when teams hold each other accountable, they are likely to maintain team effectiveness. This includes their strength and limitations, collaborating and co-ordinating activities among themselves encourages efficient use of tools and equipment when conducting maintenance. Roles and responsibilities are clear up front, and feedback outcomes are inconsequential. When respect and dignity are maintained, trust, loyalty, and cohesive team conditions will be norms that support team performance (Salas et al., 2005). It should be noted, though that conditions of tracking each other continuously may have a consequential impact, which may result in the loss of trust, therefore, leveraging intrinsic motivation can generate the required level of trust (Eduardo, 2005).

3.2.3.*Backup Behaviour*

Team members providing backup behaviour relates to providing feedback and training to improve performance, assisting team members in executing maintenance activities and supporting each other in completing tasks based on time and work limitations (Zaccaro et al., 2001). This parameter is consequential to its relationship to the mutual performance monitoring factor; co-operation and co-ordination among team members are known to have a positive influence on team effectiveness and, ultimately performance. (Eduardo, 2005). Leveraging the consequential effect of reward and recognition can be linked to increasing employee motivation, though it may be for a short period (Appelbaum, et al., 2000).

3.2.4. *Adaptability*

In the railway industry, adaptability becomes critical as the primary objective of the organisation is to ensure the safe passage of rolling stock (trains). This relates to when actions and functions would require adjustments as the environmental condition changes, the ability to do that effectively becomes critical (Salas, et al., 2005). Adaptable teams are known to be effective with flexible groups and there is a positive correlation seen based on the diversity of a team (Eduardo, 2005). As such, emergency work becomes manageable, as identifying solutions and assigning meaning to change becomes understandable (Eduardo, 2005).

3.2.5. *Team Orientation*

This parameter refers to how team members place themselves when maintenance activities are executed. This includes how they coordinate and communicate with themselves so that instructions are clear for execution. Johnson et al. (2010) have specified that the commitment and motivation that employees have towards an organisation is an essential work approach. Employees equipped with appropriate skills are known to have a positive influence on intrinsic motivation, which adds value to how effective maintenance is executed (Johnson, et al., 2010). Combs, et al. (2006) showed that HPWS practices produce fruitful outcomes when team members have correct skills, when employees are empowered and when they are motivated.

4. Research Methodology

4.1. *Research Design*

The appropriate research design should be followed to best achieve the objectives of this study, whereby it effectively answers the research questions. Methods such as frequency and descriptive analysis provide relevant information for the above questions. This study used a qualitative approach towards descriptive and explanatory research design. The relationship with dependent variables and the impact of the factors on the performance of maintenance teams are empirically tested.

Essentially, hypothesis testing will be aligned with the research model.

4.2. *Population and Sample*

The population of the study is individuals from the railway engineering sector, particularly, employees in maintenance teams were considered in the research. The survey targeted railway maintenance personnel, with a sample size determined using the Krejcie and Morgan (1970) formula for statistical accuracy. Of 180 invited participants, 131 completed the questionnaire (73% response rate). Respondents included maintenance workers (81.7%), supervisors (11.5%), and planners/coordinators (6.1%), ensuring diverse representation. Ethical approvals were obtained before data collection

4.3. *Instrumentation*

Primary sources of data for this study was gained from questionnaires. They were presented to employees to collect information for this research, they were from the railway sector and worked in teams responsible for perway track maintenance. A series of sixteen questions were in the questionnaire, which consists of two parts, the first requested respondents to rank factors influencing the performance of maintenance teams from the most important to the least important based on their perception. The second part used a four-point scale method, asking respondents to rate statements from one to four and relating them to strongly disagree to strongly agree, respectively. The analysis was completed using SPSS, in which frequency, descriptive, reliability and validity statistics were used to analyse the data.

4.4. *Analysis of Data*

Data collected from respondents who completed the questionnaire was used for the analysis. Reliability and validity were achieved by obtaining Cronbach's alpha. Descriptive and frequency statistics were used for developing the outcome. The results of the statistical test are presented in the next section, along with explanations.

5. Results

5.1. *Respondent Characteristics*

The majority of the sample consists of 81.7% of those executing maintenance, while traditional team supervisors consist of 11.5% of the population and 6.1% of the sample were those responsible for maintenance planning and coordination.

5.2. *Data Analysis*

Respondents ranked several variables to establish how they viewed the most critical factor over the others, which influences their performance, this was ranked from one to eleven, representing the most valued to the least valued, respectively.

Effective communication was identified as the most influential factor affecting team productivity, with a mean of 2.21. Items such as team coordination and teamwork are shown to be similarly valued, with a mean of 3.55. Although these factors are not mutually exclusive, though subjective, good leadership can influence team coordination when manoeuvring maintenance activities. Team behaviour was identified as the least valued factor and was determined to have the least impact, with a mean of 5.75, on respondents' performance output. It is argued that team members may be struggling to understand each other's needs and capabilities.

Table 1 shows the descriptive analysis of ranking factors that influence performance.

Table 1. Descriptive analysis of ranking factors that influence performance.

Performance Factor	Ranking Mean
Effective communication	2.21
Teamwork	3.17
Team coordination	3.55
Leadership	3.55
Motivation	3.63
Team cohesion	4.62
Performance monitoring	5.22
Adaptability	5.51
Team diversity	5.53
Team orientation	5.73
Backup behaviour	5.75

A combination of the factors from Table 1 was also tested with additional factors using a four-point scale. The majority of the scores lean towards three and four, which represent 'agree' and 'mostly agree', respectively. Therefore, all the factors were viewed as valued, though categorised differently. Reward and recognition were viewed as the most critical and significantly influential, with a mean of 3.67 and a standard deviation of 0.601. The least

influential parameter was identified as performance monitoring, with a mean value of 3.15 and a standard deviation of 0.769.

Table 2 shows the descriptive analysis of the second-ranking factors that influence performance.

Table 2. Second descriptive analysis of ranking factors that influence performance

Factor	Four-point scale mean
Reward and recognition	3.67
Motivation	3.66
Trust	3.66
Effective communication	3.63
Effective leadership	3.6
Skills	3.6
Teamwork	3.54
Shared responsibility	3.52
Co-operation and co-ordination	3.52
Supervisor support	3.5
Adaptability	3.33
Diversity	3.21
Performance monitoring	3.15

A strong relationship was observed between rewards, recognition, motivation, and trust, highlighting the role of intrinsic motivation in organisational performance. While rewards and recognition drive motivation, their effect may be short-lived without continuous implementation (Combs et al., 2006). Team behaviour is similarly influenced by performance monitoring, where excessive supervision can undermine trust and affect attitudes. The railway industry is transitioning from pseudo-groups to more cohesive teams, improving performance as members better understand each other's capabilities (Katzenbach and Smith, 1993). Given the limited maintenance windows, efficient teamwork is crucial to minimise train delays and revenue losses.

The analysis further supports that team leadership, mutual performance monitoring, backup behaviour, adaptability, and team orientation significantly influence performance, aligning with Salas et al. (2005). However, performance monitoring was perceived as less critical, with respondents finding excessive oversight counterproductive. This suggests a lack of mechanisms to foster accountability and peer support. Prior studies confirm that motivation and skills positively impact performance (Appelbaum et al., 2000), which was also evident in this research, as these factors ranked among the most critical. Understanding both intrinsic and extrinsic motivation is key to sustaining high performance (Cho and Perry, 2012). While rewards and recognition enhance motivation, other long-term strategies should be considered for sustained improvement (Appelbaum et al., 2000).

5.3. *Implications of the Findings*

This study has added value to existing research on HPWS and its influence on impacting performance of railway track teams. There is a correlation between how team behaviour can be improved and how it can be leveraged for the benefit of a railway organisation. Without increasing fixed expenses, such practices can be used to improve skills, empower employees and improve motivation (Combs, et al., 2006). The result provides insight into the relationship between rewards and recognition, communication, diversity, and mutual performance monitoring. Visibly, reward and recognition, which are associated with motivation, are valued the most. Diversity is viewed as the least valued parameter influencing team performance. Once these factors are leveraged and managed appropriately, team performance can be increased.

Frequent motivation and skills development programmes and effective communication can guarantee that the required quality of output is gained from teams and may ensure better railway network reliability and availability. Additionally, the integration of HR systems, policies, and strategies, similar to those of Arulrajah (2017), can be taken advantage of to deliver a quality and productive culture within an organisation. Moreover, by increasing team output, performance, job satisfaction and lesser occupational pressure, an organisation can gain similar effectiveness as mentioned by Sourchi and Jianqiao (2015), whereby they emphasised employee commitment, which is linked to similar items argued in this research. In principle, this study emphasised the value of HPWS and its influence on performance and its application in affecting the cognitive states of employees in a team. Leaders and managers should familiarise themselves with these parameters and implement actions on

maintenance teams to improve performance when executing maintenance.

6. Conclusions and Recommendations

The results of this study provide a structured approach to linking questionnaire responses with performance-related factors, ensuring that the ranking and prioritisation of these factors are grounded in empirical data. Each questionnaire item was systematically mapped to specific performance drivers, such as rewards and recognition, teamwork, leadership, communication, and motivation. The four-point Likert scale responses were analysed using descriptive statistics, frequency analysis, and reliability testing (Cronbach's Alpha) to validate internal consistency. This approach allowed for the quantification of perceived importance, enabling a direct estimation of how each factor contributes to overall maintenance team performance. The ranking system derived from respondents' inputs was consolidated to provide a clear representation of the most and least valued factors, aligning with established High-Performance Work Systems (HPWS) frameworks.

Based on this study, there is a clear indication of which factors are more valued within the railway industry, with maintenance team performance being directly influenced by these elements. While there is room for improvement, leveraging the studied parameters can enhance performance within the organisation and support more effective decision-making processes. Respondents ranked the factors influencing their performance from most to least impactful, with rewards and recognition, effective communication, motivation, trust, teamwork, and effective leadership identified as the most valued. Skills, supervisor support, co-operation and co-ordination, adaptation, performance monitoring, shared responsibility, and diversity were ranked lower in terms of influence. Notably, reward and recognition, along with communication, were shown to further influence several other parameters, such as team behaviour and motivation, though their long-term effectiveness depends on sustained implementation. Conversely, diversity and performance monitoring were identified as the least influential factors. Without significant changes in mental models and organisational culture, their impact on performance may remain limited. Employees may feel intimidated by constant supervision, which could hinder optimal performance due to fear or resentment. Although diversity was ranked low, its role in fostering inclusivity and equality should not be overlooked, as proper time, management strategies, and training can create conditions that improve team performance.

Leveraging these parameters or conducting targeted workshops and training initiatives can support organisational objectives. Further research is required to unpack the reasoning behind respondents' perceptions of these factors and to develop strategies that effectively address performance constraints.

For future research, the study can incorporate human reliability aspects from IEC 62508: Guidance on Human Aspects of Dependability. While HPWS factors like cohesion, communication, and leadership are key, human reliability is crucial for minimising errors and optimising maintenance efficiency. IEC 62508 provides methodologies for assessing human error probability, workload, and risk mitigation, which can complement HPWS in developing a more comprehensive performance model.

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