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Factors affecting workforce productivity in road construction projects: A statistical analysis from Nepal

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ABSTRACT

The purpose of this study is to investigate the key factors affecting labor productivity in road construction projects and to identify strategies for improving workforce performance in the construction industry. A mixed-methods research approach was adopted, integrating quantitative and qualitative analyses. Primary data were collected through structured questionnaires using a five-point Likert scale to assess construction professionals' perceptions of productivity-related factors. The analysis identified five major factors significantly influencing labor productivity: labor experience, remuneration, material availability, quality of supervision, and weather conditions. The findings further revealed distinct differences in productivity between skilled and unskilled labor, underscoring the need for differentiated management practices and workforce development strategies. The study also demonstrated that inadequate planning, poor material management, and insufficient supervision adversely affect project performance and labor efficiency. Based on the findings, several practical measures are recommended, including providing competitive remuneration, improving project scheduling, ensuring efficient resource allocation, implementing effective inventory control systems, adopting standardized design practices, and establishing sound financial planning mechanisms. In addition, the study highlights the importance of adequate break periods in reducing worker fatigue and enhancing productivity. Finally, the research emphasizes the lack of universally accepted criteria for measuring labor productivity in construction projects and recommends developing standardized productivity measurement frameworks to improve consistency, benchmarking, and overall project performance across the industry.

Contribution/Originality: This study identifies and empirically prioritizes the critical factors affecting labor productivity in road construction. It provides practical management insights and highlights the need for standardized productivity indicators to improve performance evaluation and decision-making in construction projects.

1. INTRODUCTION

In developing countries like Nepal, where the construction sector largely relies on manual labor, it is critical to comprehend and manage workers' output. Construction productivity on site affects the ability to finish construction within a stipulated time and budget constraints, thereby affecting the success of each project (Montaser, Mahdi, Mahdi, & Rashid, 2018). By accurately quantifying and tracking labor productivity as per the schedule, construction companies can maximise their resources and finish their projects within the desired output (Alaloul, Musarat, Mehmood, & Altaf, 2021). To achieve anticipated profits from the completed construction project, it is crucial to

properly manage human resources, tools, machines, and finances (Mengistu, Quezon, & Kebede, 2016). Managing resources in the most effective means for construction purposes promotes increased output and completes the project within the stipulated time and cost (Ghate, More, & Minde, 2016). Labor productivity, driven by effective work conditions, strong management quality, and advanced technology, stands as a decisive pillar for the successful delivery of construction projects (Rathor, Singh, & Sangal, 2024). Specific initiatives in the identified key areas will maximise success by improving efficiencies and providing timely completion (Soekiman, Pribadi, Soemardi, & Wirahadikusumah, 2011). Skilled workers give projects a competitive edge through higher performance (Mtotywa & Mdlalose, 2023). Therefore, increasing worker productivity requires improved efficiency and effectiveness of workers.

Labor productivity operates in a complex and unpredictable environment, surpassing the challenges of the translation process itself. Multiple unknown or complex variables can disrupt both the time and cost of a construction project (Katta, Kumari, & Devi, 2019). Measuring productivity in construction is unlike measuring productivity in other (non-construction) industries because of the qualitative nature of labor productivity (Alina & Wilfred, 2016). Critical Learning Pathway (CLP) parameters must be prioritized to develop an accurate model that takes into consideration both subjective and objective elements (Arnaud, 2019). Therefore, as the primary variable of the economy, productivity is a fundamental driver of the efficiency of production activities. Businesses are trying to improve their level of productivity by using efficient methods of converting labor and material resources into acceptable products to maximize profitability (Goel, Agrawal, & Sharma, 2017; Karimi & Gidado, 2012).

There are currently very few or no empirical research studies available that examine or provide evidence regarding labor productivity for construction workers in Nepal. Potentially, this research identifies and ranks key factors affecting labor productivity in construction projects and ways to enhance overall labor productivity. Contributions were made in the form of a theoretical model and empirical evidence to support improved project outcomes for construction projects.

2. LITERATURE REVIEW

Productivity is the ratio of output to input, and this is known as efficiency, such as how well we are using resources in production, including all the machinery and tools (Hussain, Xuetong, & Hussain, 2020). When there is more output with the same inputs as before, productivity has increased. Also, productivity has been maintained when there is the same amount of output for less input than before. Essentially, if you increase output while also increasing inputs proportionally, your productivity is unchanged. In the construction industry, no matter the size of the company, labor productivity is critical. Organizations must assess and understand those factors that affect their organization's productivity, and take action to improve productivity (Rahman, Memon, Memon, Shaikh, & Siddiqui, 2019; Shehata & El-Gohary, 2011). To prevent these types of problems from occurring and to ensure the success of the projects, an analysis of the factors affecting an organization's productivity and the implementation of proactive measures is necessary.

At present, infrastructure investment globally is critical to the global economy because it provides growth, connection, job creation, trade enhancements, higher living conditions, and building resilience against future difficulties (Wang et al., 2023). However, there are also problems with the construction industry on how to improve productivity to the desired level. In the construction industry, productivity is often calculated based on labor productivity, which is defined as the number of units of work performed by each employee per hour worked (Abdel-Hamid & Mohamed Abdelhaleem, 2022). Project failures are primarily attributed to productivity issues, which are often associated with the performance of the workers (Latief, Anditiaman, Rahim, Arifuddin, & Tumpu, 2023). Enhancing productivity is seen as the key to addressing industry challenges and driving national prosperity (Huynh, Le-Hoai, & Do, 2025; Rane, Lopes, Raval, Rumao, & Thakur, 2017).

Continuous improvement in construction productivity is crucial for contributing meaningfully to national economies (Giri, Pahari, & Lamichhane, 2025). Labor productivity is an indicator of construction industry

productivity and can be improved through identifying and managing items that contribute to a lack of efficiency (Almamlook, Bzizi, Al-Kbisbeh, Ali, & Almajiri, 2020; Ghate et al., 2016). By implementing methods to minimize inefficiencies and improve the management of construction workers, construction firms can improve their performance and competitiveness of construction firms and increase the likelihood of construction firms being successful in a highly competitive environment (Ibrahim, Zayed, & Lafhaj, 2024; Nor, Subramaniam, & Sahudin, 2023).

Numerous studies have been conducted over several years on factors affecting productivity in construction (Alaghbari, Al-Sakkaf, & Sultan, 2019). Mahamid (2013) reported that rework, poor communication, financial problems, lack of labor experience, and lack of materials adversely affected productivity in Palestine (Mahamid, 2013). Project managers' perspectives (Jarkas, Radosavljevic, & Wuyi, 2014) highlighted financial incentives, decision-making delays, remuneration, information response, and labor shortages in Qatar. Similarly, Ghoddousi, Poorafshar, Chileshe, and Hosseini (2015) found that remediation, job satisfaction, promptness of payment, management ethics, and opportunities are significant factors impacting productivity in Iran (Ghoddousi et al., 2015).

To improve labor productivity in construction, a multi-dimensional approach is needed. This includes improving the skills of the workforce, enhancing the motivation of employees, and increasing the competency of managers (Giri & Chhimal, 2025). Continuous training programs for construction laborers that provide on-the-job training and hands-on experience should be emphasized by multiple studies (Alaghbari et al., 2019). Stakeholders should also create workshops/training sessions for the construction laborers, as well as for managers, to enhance the managers' skillset and improve decision-making abilities (Mahamid, 2014).

The productivity improvements depend heavily on motivation. Research shows that having motivated and rewarded workers has a positive connection with their satisfaction, loyalty, and performance (Ghoddousi, Bahrami, Chileshe, & Hosseini, 2014). By providing incentives, organizations can recognize the contributions of their employees and, as such, show appreciation from the management for the employee's contribution to help create a culture of dedication among employees toward the organization's goals (Charles, Francis, & Zirra, 2021). Additionally, contractors need to invest time and resources into training managers so they can effectively supervise, schedule materials, and allocate other resources. Creating an appropriate material management system and designing supply schedules for each project will help reduce delays and provide greater ease in obtaining resources when needed (Aguda, 2024).

Productivity improvements result in shared benefits for both the employers and employees. Increased productivity rates lead to increased earnings, improved workplace conditions, and higher levels of job satisfaction and motivation (Defri, Indrawati, & Kurniawati, 2024). Productivity improvement plays an important role in construction planning and directly affects the three major project constraints (time, cost, quality) (Iqbal, Nawaz, Ali, Osman, & Hamza, 2024). Productivity is the core element of construction project cost estimates and provides a basis for assessing actual project performance against planned performance (Hatamleh, Hiyassat, Sweis, & Sweis, 2018). Construction projects that are completed on time, within budget, meet quality standards, and ensure safety consistently achieve planned productivity levels. Despite the success of many completed construction projects, the construction industry continues to be plagued by low levels of productivity (Radman, Jelodar, Lovreglio, Ghazizadeh, & Wilkinson, 2025). Considering the importance of productivity growth to the long-term viability of construction companies, there is a pressing need to improve productivity in the construction industry (Justina, Emmanuel, & Samuel, 2022). The construction industry in developing countries, such as Nepal, faces several significant barriers to improving productivity; therefore, this study evaluates labor productivity in road construction projects in Nepal.

Past studies have shown that labor skills, motivation, management practices, financial incentives, and availability of resources are all important factors affecting productivity in construction. There is also a need for more context-specific empirical research on labor productivity. This research answers that gap. It combines quantitative and qualitative evaluations of labor productivity in Nepal's road construction and provides practical insights and advances knowledge in developing-country contexts.

3. METHODOLOGY

This study employed a comprehensive research approach, including site visits, structured questionnaires, and Key Informant Interviews (KIIs). The study collected both quantitative and qualitative data to provide an overall understanding of the influencers of labor productivity on road construction projects. The quantitative approach used data collection through systematically collecting numerical data via direct observations and questionnaires, while also using qualitative data from literature review and the collection of data from several sources of KIIs. The research was conducted in Tanahun District, covering 1,546 km², where 13 road construction sites were selected to analyze factors affecting labor productivity and recommend improvements.

The construction sites involved a wide range of stakeholders such as consultants, engineers, workers, and contractors. In addition, eighty-three individuals who had significant experience (>5 years) in road construction projects were surveyed using a structured questionnaire (engineers n=25; contractors n=13; consultants n=6; workers n=39).

With a sample of 83 respondents from 13 locations representing a range of significant stakeholders and project variances, there is enough data to proceed with conducting the exploratory research as planned. Five percent of respondents pilot-tested the questionnaire, which was done to determine clarity, relevance, and reliability. Some minor word changes were made, some unclear items were removed, and the structure of the instrument improved as a result of the feedback from the pilot testing. Cronbach's alpha has indicated an appropriate level of reliability for the main survey. Data that was collected from the research questionnaire was assessed statistically through the use of statistical tools, including the Relative Importance Index (RII).

4. RESULT

The study's goal is to examine the factors that influence workforce productivity in Nepal's construction sector. Cronbach's Alpha, on a scale from 0 to 1, assesses a questionnaire's internal consistency, with higher values indicating greater reliability. It is deemed excellent if more than 0.9, good between 0.8 and 0.9, acceptable from 0.7 to 0.8, and questionable within 0.6 to 0.7. Poor reliability falls between 0.5 and 0.6, while values below 0.5 are considered unacceptable (Sharma, 2016).

Table 1 presents the Coefficient of Cronbach's Alpha. Cronbach's Alpha values for assessing the manpower factor affecting labor productivity in this study indicate a good level of internal consistency with a Cronbach's Alpha value of 0.844. The indicators, attitude, age of labor, personal problems of labor, alcoholism, absenteeism, labor experience, and skill have Cronbach alpha values of 0.797, 0.804, 0.844, 0.794, 0.813, and 0.845 with internal consistency of acceptable, good, good, acceptable, good, and good, respectively. The motivation factor affecting labor productivity has a Cronbach's Alpha of 0.863; this factor is considered good in terms of internal consistency. Its indicators, timeliness of remuneration, reward/punishment, amount of remuneration, training facilities/sessions, recognition, and appreciation have a Cronbach alpha value of 0.861, 0.805, 0.829, 0.827, 0.846, and 0.846, respectively, with the internal consistency of all indicators being good.

The resource factor affecting labor productivity has a Cronbach's Alpha value of 0.845, which falls within a good range of internal consistency. When examining individual indicators, an increase in the price of material, a lack of construction material, an unsuitability of materials storage location, a lack of construction tools and equipment, and poor access within the construction site have Cronbach alpha values of 0.791, 0.839, 0.816, 0.826, and 0.792, with the internal consistency of acceptable, good, good, good, acceptable, respectively. The project factor affecting labor productivity demonstrates a good range of inconsistency, with an overall Cronbach's Alpha value of 0.848. When looking at specific factors, multiple sources of commanding, project location, project manager's leadership, lack of supervision, client intervention, and structural design complexity have the internal consistency of good, good, acceptable, good, good, and good with Cronbach alpha values of 0.807, 0.828, 0.798, 0.878, 0.812, and 0.799, respectively. The miscellaneous factor affecting labor productivity has a Cronbach's Alpha of 0.920; this factor is

considered excellent in terms of internal consistency. The indicators of weather condition, working overtime, break time, social culture, and economic condition have Cronbach alpha values of 0.924, 0.887, 0.889, 0.914, and 0.837, with the internal consistency of excellent, good, good, excellent, and good, respectively.

Table 1. Coefficient of Cronbach's Alpha.

S.N	Description	Cronbach's Alpha	Internal consistency
A.	Human resource factor	0.844	Good
1	Attitude	0.797	Acceptable
2	Age of labor	0.804	Good
3	Personal problems of labor	0.844	Good
4	Alcoholism	0.794	Acceptable
5	Absenteeism	0.813	Good
6	Labor experience and skills	0.845	Good
B.	Motivation factor	0.863	Good
1	Timeliness of remuneration	0.861	Good
2	Reward/punishment	0.805	Good
3	Amount of remuneration	0.829	Good
4	Training facilities/session	0.827	Good
5	Recognition and Appreciation	0.846	Good
C.	Resource factor	0.845	Good
1	Increase in the price of the material	0.791	Acceptable
2	Lack of construction material	0.839	Good
3	Unsuitability of the materials storage location	0.816	Good
4	Lack of construction tools and equipment	0.826	Good
5	Poor access within the construction site	0.792	Acceptable
D.	Project factor	0.848	Good
1	Multiple sources of commanding	0.807	Good
2	Project location	0.828	Good
3	Project manager's leadership	0.798	Acceptable
4	Lack of supervision	0.878	Good
5	Client intervention	0.812	Good
6	Structural design complexity	0.799	Good
E.	Miscellaneous factor	0.920	Excellent
1	Weather condition	0.924	Excellent
2	Working overtime	0.887	Good
3	Break time	0.889	Good
4	Social culture	0.914	Excellent
5	Economic condition	0.837	Good

4.1. Factors Affecting Labor Productivity

4.1.1. Manpower/Human Resource Factor

Figure 1 depicts the overall responses from the respondents. It provides that the experience/skill sets of the labor force are the main variable impacting labor productivity. Labor experience/skill sets ranked highest, with an RII of 0.915, while absenteeism was in second place with an RII of 0.877.

Attitude was rated third with an RII of 0.843. Additionally, alcoholism is identified as the fourth-ranking factor with an RII value of 0.807.

Similarly, ranked fifth and sixth, the age of labor with RII 0.771 and personal problems of labor with RII 0.722 are significant. Insights from KII with construction experts affirm that labor experience and skills play a key role in road construction labor productivity.

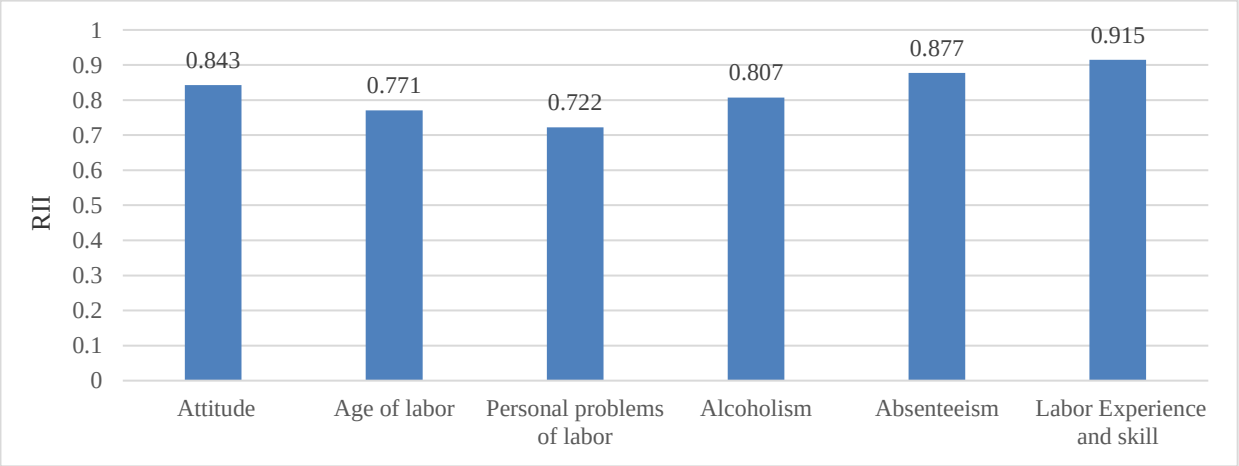

Figure 1. Manpower factor affecting labor productivity.

4.1.2. Motivation Factor

As shown in Figure 2, the collective response of respondents regarding motivation factors influencing labor productivity in road construction is depicted. Notably, the amount of remuneration secures the top rank with a significant RII value of 0.838. Following closely, the timeliness of remuneration claims the second position with an RII value of 0.824, while reward/punishment takes the third spot with an RII value of 0.802. The motivation factors ranked fourth and fifth, with RII values of 0.775 and 0.746, are training facilities/sessions and recognition and appreciation, respectively. KII with construction experts further validates that the amount of remuneration stands out as the major motivational factor influencing labor productivity in road construction projects. It suggests that offering competitive and satisfactory compensation packages can potentially boost labor productivity.

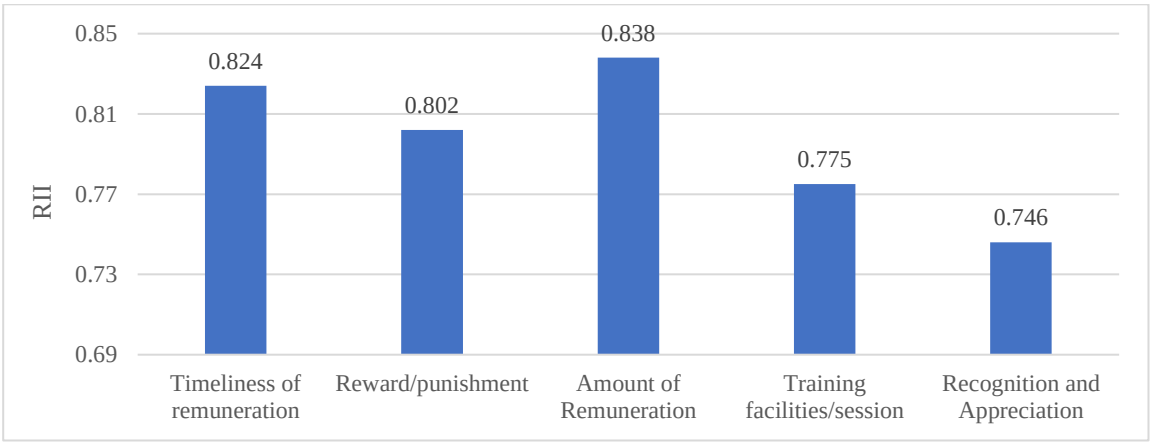

Figure 2. Motivation factor affecting labor productivity.

4.1.3. Resource Factor

Figure 3 shows the overall results for all respondents regarding the resource factors affecting labor productivity in road construction projects. It reveals that respondents ranked a lack of construction materials as a major resource factor affecting labor productivity, with an RII of 0.819. Lack of construction tools and equipment has been ranked as the second resource factor with an RII value of 0.802. Poor access within the construction site has been ranked as third with an RII value of 0.778. The resource factors that have been ranked fourth and fifth, with RII values of 0.751 and 0.730, are an increase in the price of material and the unsuitability of the materials storage location, respectively. During the KII with experts in construction projects, it was found that a Lack of construction material was the main resource factor affecting labor productivity in road construction projects.

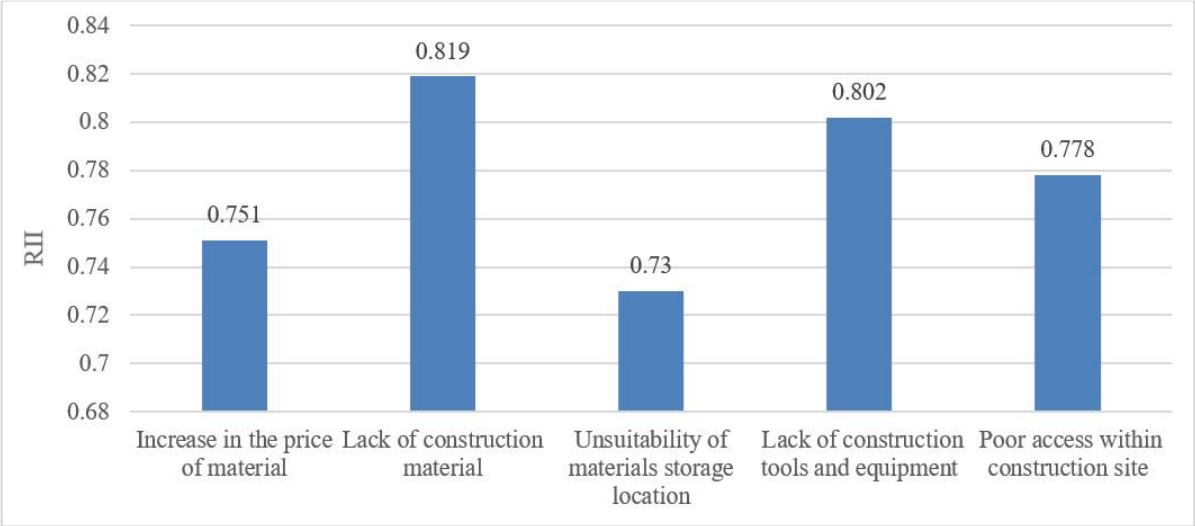

Figure 3. Resource factor affecting labor productivity.

4.1.4. Project Factor

As shown in Figure 4, the collective response from respondents regarding project factors impacting labor productivity is presented. The lack of supervision claims the top rank as a major project factor with a substantial RII value of 0.908. Following closely, client intervention secures the second position with an RII value of 0.893. Multiple sources of commanding are ranked third with an RII value of 0.850, while structural design complexity takes the fourth spot with an RII value of 0.807. Project factors occupying the fifth and sixth positions, with RII values of 0.761 and 0.720, respectively, are the project manager's leadership and project location. KII, with construction experts confirming that the lack of supervision stands out as the primary project factor influencing labor productivity in road construction projects.

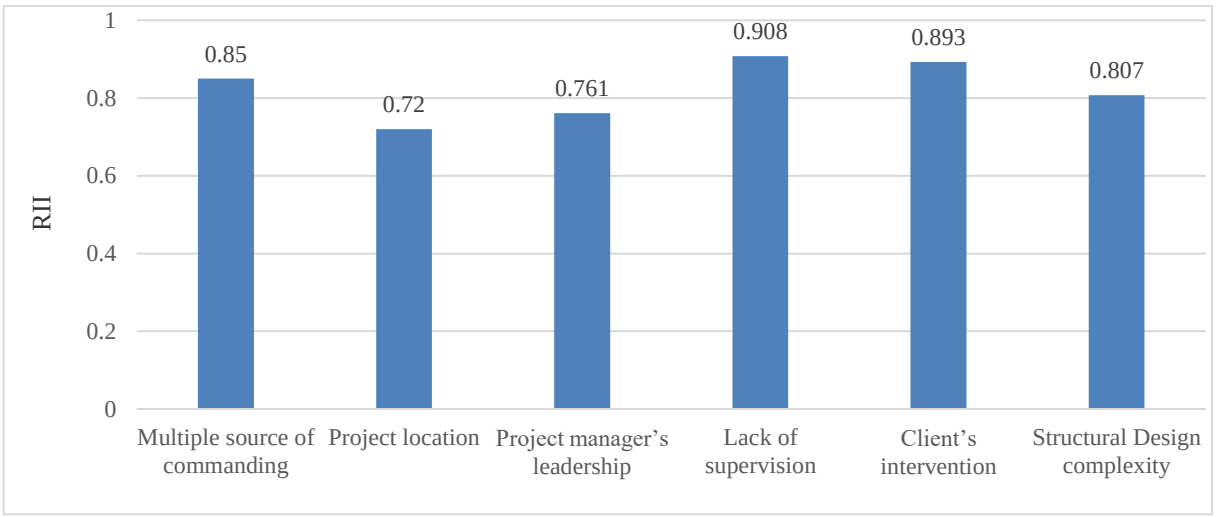

Figure 4. Project factors affecting labor productivity.

4.1.5. Miscellaneous Factor

Figure 5 presents the overall results of the total respondents regarding miscellaneous factors affecting labor productivity in road construction projects. It reveals that weather conditions have been ranked as a major miscellaneous factor affecting labor productivity by the respondents, with an RII value of 0.848. Economic condition has been ranked as the second resource factor with an RII value of 0.821, and break time has been ranked third with an RII value of 0.785. The miscellaneous factors ranked fourth and fifth, with RII values of 0.761 and 0.732, are working overtime and social culture, respectively. During the Key Information Interview (KII) with experts in

construction projects, it was found that weather conditions were the main miscellaneous factor affecting labor productivity in road construction projects.

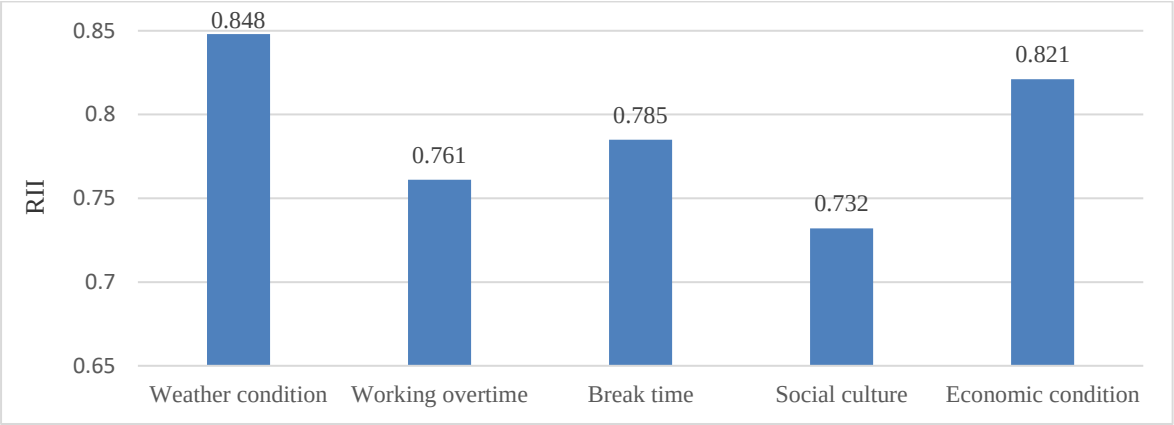

Figure 5. Miscellaneous factors affecting labor productivity.

4.1.6. Labor Productivity

Labor productivity in construction projects is a global concern with factors impacting efficiency across diverse contexts. In projects with high density, the allocation of labor hours becomes crucial, and the emergence of resource limitations often necessitates the implementation of overtime work, impacting budgets and completion schedules (Chaturvedi, Thakkar, & Shankar, 2018; Qi, Owusu, Siu, & Chan, 2024). Insights from Pakistan highlight unskilled workforce issues, payment delays, tool shortages, communication challenges, and financial constraints as factors affecting labor productivity (Alaloul et al., 2021). Similarly, research in the USA identifies a lack of labor supervision, experience, and skill, construction technology, design errors, and delays in responding to information requests as key productivity influencers (Almamlook et al., 2020). In India, research underscores the significance of skilled labor, material/tool availability, project manager's leadership, site management communication, and safety conditions in shaping labor productivity (Ghate et al., 2016). These global findings emphasize the multifaceted nature of labor productivity challenges, urging tailored strategies for effective project management worldwide.

5. CONCLUSION

The primary aim of this research was to explore influencing factors for labor productivity in the road construction projects and potential improvements. Primary data were gathered through a questionnaire survey, field observations, and KII. The study unveiled the significant manpower factors affecting labor productivity, such as experience and skill, absenteeism, attitude, alcoholism, age of labor, and personal problems of labor. Motivation factors influencing productivity were ranked as amount of remuneration, timeliness of remuneration, reward/punishment, training facilities, and recognition and appreciation. Resource factors were identified as a lack of construction material, a lack of construction tools and equipment, poor access within the construction site, an increase in the price of material, and the unsuitability of the material storage location. Project factors affecting labor productivity included lack of supervision, client intervention, multiple sources of commanding, structural design complexity, project manager's leadership, and project location. Lastly, miscellaneous factors influencing labor productivity were weather conditions, economic conditions, break time, working overtime, and social culture. The study proposed several strategies for improving labor productivity, encompassing competitive and timely payment, proper resource allocation, efficient scheduling, availability of necessary tools and equipment, inventory management, standardized design processes, financial planning, and adequate break time, offering practical insights for enhancing the road performance of construction efficiency. Future research can take place, including more influencing factors, longitudinal studies, larger sample sizes, and a broader range of leading variables across various geographic locations. Thus, the findings of this

study can be useful to academic institutions, researchers, HR analytics, regulatory institutions, project designers, and other related stakeholders. This study is limited by sample size, geographic scope, and self-reported data. Future research should include regional comparisons, additional variables, and advanced methods such as regression modeling to improve accuracy and generalizability.

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Institutional Review Board Statement: The study involved minimal risk and followed ethical guidelines for social science fieldwork. Formal approval from an Institutional Review Board was not required under the policies of Institute for Research Ethics Committee of the Pokhara University, School of Engineering, Nepal. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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