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A Qualitative Productivity Model in Small-scale Building Construction Management for Tabriz City Projects

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***Abstract*:** This study proposes a qualitative productivity model tailored for small-scale building construction projects in Tabriz city, addressing the unique challenges and characteristics of the region. By integrating quantitative and qualitative analyses, the model identifies key productivity factors, including workforce efficiency, material management, and project scheduling. A survey of local construction managers and workers was conducted, supplemented by on-site observations to validate the model's applicability. Results indicate a significant correlation between structured management practices and enhanced productivity levels. The proposed model provides practical recommendations for optimizing resource allocation, reducing delays, and improving project outcomes, contributing to the sustainable growth of the building constructions in Tabriz city.

Keywords: Construction productivity, Small-scale projects, Building management, Tabriz City, Resource optimization.

I. INTRODUCTION

Small-scale building construction projects are vital to urban development, especially in rapidly growing cities like Tabriz. These projects, often characterized by limited budgets and shorter timelines, face distinct challenges that hinder productivity, such as inefficient resource utilization, workforce limitations, and inadequate project planning. Despite their scale, these projects significantly influence local economies and the overall quality of urban infrastructure. Indeed; small-scale construction management focuses on planning, coordinating, and supervising smaller construction projects, such as residential buildings, small commercial spaces, or local infrastructure developments. This discipline ensures that projects are completed efficiently, cost-effectively, and within their designated timelines (Lyons, 2009). Proper management is vital for addressing challenges such as limited budgets, resource allocation, and compliance with local regulations. It also helps in maintaining quality and ensuring that the project aligns with the specific needs of the community or stakeholders (Kurtzer et al., 2020). Productivity in construction management is a multidimensional concept, encompassing the efficient use of labor, materials, and time (Daly et al., 2018). For small-scale projects in Tabriz, understanding and addressing the unique factors affecting productivity is essential for achieving timely and cost-effective project delivery (Kelly & Ilozor, 2019). The city's construction sector, while diverse and dynamic, often lacks standardized practices tailored to the needs of smaller projects (Demian & Walters, 2014).

In Tabriz, a historic and rapidly urbanizing city, small-scale construction plays a significant role in meeting housing demands, revitalizing older neighborhoods, and supporting the local economy (Nahaei et al., 2021). The city's unique architectural heritage and diverse urban landscape make effective management essential for preserving cultural identity while accommodating modern needs. Many small construction projects in Tabriz involve renovating traditional homes or developing affordable housing, both of which require specialized oversight to balance tradition and progress (Jafarimand, 2018). Tabriz faces various urban challenges, such as population growth, infrastructure maintenance, and earthquake resilience due to its location in a seismically active region. Small-scale construction projects often act as solutions to these challenges, providing flexible and tailored responses to local needs. Proper management ensures the incorporation of safety measures, sustainable materials, and efficient designs that align with the city's broader urban development goals. It also minimizes disruptions to the city's daily activities and promotes a smoother integration of new developments into the urban fabric (Nahaei & Naziri-Oskuei, 2021).

Investing in small-scale construction management in Tabriz is crucial to fostering sustainable urban growth and improving living conditions for its residents. It ensures that limited resources are used effectively, that projects contribute to long-term resilience, and that they align with the city's architectural and cultural values. Additionally, proper management attracts skilled labor and small contractors, creating local job opportunities and boosting the economy. By prioritizing small-scale construction management, Tabriz can achieve balanced development that respects its rich heritage while addressing modern urban demands (Mostafavi & Soranj, 2019).

This paper aims to develop a productivity model that accounts for the specific conditions of Tabriz City's construction environment. By focusing on workforce dynamics, material supply chains, and scheduling practices, the study seeks to offer actionable insights for improving project outcomes. Through surveys, case studies, and observational data, the research identifies key productivity determinants and proposes strategies for their optimization. The subsequent sections outline the methodology, present the results and discussions, and conclude with practical recommendations for stakeholders in Tabriz's construction industry. This study not only fills a gap in the literature on small-scale construction productivity but also provides a framework for enhancing efficiency and sustainability in urban development projects.

II. Background

The Project Management Institute (2013) describes a project as a 'temporary endeavor undertaken to create a unique product, service, or result'. This temporary nature reflects its defined start and end points, distinguishing it from routine operations. A project is characterized by its uniqueness, meaning it produces outputs that differ from existing products, services, or results. Common examples of projects include the development of a new product, the design of innovative machinery, or the construction of a shopping mall. Projects involve the strategic organization of financial resources, personnel, and materials to achieve specific objectives within the constraints of time, budget, and scope. Turner (1992) emphasizes that these constraints require meticulous planning and execution to ensure the successful delivery of the intended outcomes.

Small-scale building construction projects play a vital role in urban development, especially in emerging economies and rapidly urbanizing cities (Zavadskas et al., 2010). They cater to essential housing needs, local infrastructure, and community-oriented developments (Hart, 1970). Despite their significance, these projects often face unique challenges related to resource allocation, management strategies, and sustainability (Eyiah & Cook, 2003). This review explores the existing body of knowledge on small-scale construction projects, highlighting key themes such as management practices, resource constraints, stakeholder involvement, and sustainability considerations (Nair & Garimella, 2010). Small-scale construction projects are typically defined by their limited scope, budget, and complexity. These projects often involve residential buildings, small commercial spaces, or minor infrastructure works (Amoah et al., 2011). Unlike large-scale projects, small-scale initiatives rely on fewer resources, simpler designs, and shorter timelines (Lévy, 2011). Studies, such as those by Yang & Chen (2015), emphasize that their unique characteristics require tailored management approaches to ensure efficiency and success.

Managing small-scale construction projects presents distinct challenges, including tight budgets, limited access to skilled labor, and inadequate project planning (Gambo et al., 2017). According to research by Khahro et al. (2019), small-scale projects often suffer from resource constraints that can lead to delays, cost overruns, and compromised quality. Effective project management practices, including detailed planning, risk assessment, and stakeholder coordination, are essential to overcoming these challenges (Memon et al., 2018). Stakeholder involvement is one of the factors in the success of small-scale projects. These projects often involve local communities, small contractors, and individual investors, whose active participation can significantly impact outcomes. Studies, such as those by Martinez-Avila et al. (2016), highlight the importance of clear communication and engagement strategies to align stakeholders' expectations and ensure project success.

In recent years, there has been a growing emphasis on incorporating sustainability into small-scale construction. Researchers like Kibwami & Tutesigensi, (2016) argue that adopting green building practices, such as energy-efficient designs and sustainable materials, can enhance the long-term viability of these projects (Alwan et al., 2017). However, limited budgets and a lack of technical expertise often hinder the widespread adoption of sustainable practices in small-scale construction (Yu et al., 2018). Efficient resource management is crucial for the success of small-scale projects (Altieri & Toledo, 2005). This includes optimizing the use of financial resources, materials, and labor (Pomeroy et al., 2009). Studies by Thomas et al. (2018) reveal that resource allocation strategies, such as just-in-time delivery and local sourcing, can significantly reduce costs and improve project efficiency. However, the lack of standardized practices in small-scale projects often leads to resource wastage and inefficiencies.

The integration of technology in small-scale construction is an emerging area of interest. Tools such as building information modeling (BIM) and project management software have been shown to improve planning, coordination, and execution. According to Lévy (2011), these technologies are underutilized in small-scale projects due to cost and complexity, but their adoption can enhance efficiency and quality. Small-scale construction projects often face challenges related to regulatory compliance (Kim et al., 2018). Ensuring adherence to building codes, safety standards, and environmental regulations can be difficult for smaller contractors with limited resources. Research by Fadzil (2021) underscores the need for simplified regulatory frameworks and training programs to help small-scale builders meet compliance requirements. While there is a growing body of research on small-scale construction projects, several gaps remain. For instance, more studies are needed to explore innovative financing mechanisms, the role of digital technologies, and the integration of sustainability in low-budget projects. Future research should also examine the long-term impacts of small-scale construction on urban development and resilience.

III. Studied Case

Tabriz, located in northwestern Iran, is one of the oldest continuously inhabited cities in the world. Renowned for its rich cultural heritage and strategic geographical position, it has served as a significant hub for trade, politics, and culture throughout history. Location of Tabriz city is provided in Figure 1. The city's historical importance is reflected in landmarks such as the Blue Mosque, the Tabriz Bazaar (a UNESCO World Heritage Site), and the El Goli Park. These historical treasures not only attract tourists but also symbolize the city's enduring legacy as a center of architectural and cultural excellence.

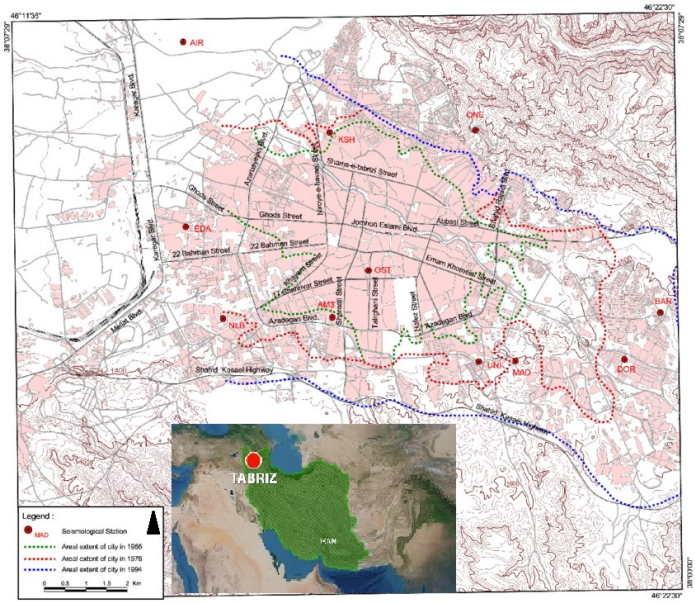

Fig. 1 Location of studied area

In recent decades, Tabriz has undergone substantial construction and urban transformation to accommodate its growing population and economic aspirations (Taghipour et al., 2019). Modern residential complexes, commercial centers, and industrial zones have been developed to enhance urban living standards. Infrastructure projects, including the expansion of highways and the introduction of metro systems, have improved connectivity and mobility within the city (Karami et al., 2022). The focus has been on integrating traditional designs with modern architecture, ensuring that Tabriz's identity is preserved amidst rapid urbanization (Alizadeh & Zamani, 2021). Environmental sustainability has emerged as a key focus in Tabriz's development plans. The city has invested in green spaces and urban parks, with initiatives aimed at improving air quality and promoting sustainable lifestyles (Feizizadeh et al., 2021). Projects such as the expansion of El Goli Park and the establishment of community gardens are part of the city's efforts to combat urban sprawl and enhance quality of life. Furthermore, renewable energy solutions, including solar and wind energy projects, are being implemented to reduce reliance on fossil fuels (Mahmoodzadeh & Herischiyan, 2018).

Despite significant progress, Tabriz faces challenges in balancing development with heritage preservation. Uncontrolled urban sprawl and inadequate housing for low-income groups highlight the need for more inclusive planning. The risk of natural disasters, such as earthquakes, also poses a threat to the city's development, necessitating stricter building codes and disaster preparedness measures. Addressing these challenges requires a cohesive approach involving local government, private sectors, and community stakeholders. Construction in Tabriz reflects a blend of cultural heritage and modern technology. Traditional craftsmanship, such as intricate tile work and stone masonry, is often integrated into contemporary buildings, preserving the city's unique aesthetic appeal. Meanwhile, advanced construction techniques and materials are being adopted to enhance the resilience and energy efficiency of buildings. The city has also embraced smart technologies, with projects aimed at creating intelligent transportation systems and automated building management solutions. Looking ahead, Tabriz aspires to become a leading regional hub for innovation and sustainable development. Investments in education and research facilities are fostering a new generation of engineers and urban planners who prioritize human-centered design and environmental stewardship. By aligning its growth strategies with global trends in smart and sustainable urban development, Tabriz is poised to maintain its historical significance while embracing the opportunities of the 21st century.

IV. Materials and Methods

The study focused on small-scale building construction projects in Tabriz, a city characterized by its rapid urbanization and unique socio-economic conditions. These projects, typically involving modest budgets and limited resources, represent a significant portion of the local construction industry. Preliminary investigations identified key characteristics of these projects, such as workforce composition, resource utilization, workforce efficiency, material management, project scheduling and project timelines, to ensure the model was tailored to the city's specific construction environment.

Data collection methods: A robust data collection strategy was employed, combining qualitative and participatory approaches. Semi-structured interviews were conducted with 25 stakeholders, including project managers, site supervisors, contractors, and laborers, to identify productivity challenges and best practices. Additionally, two focus group discussions, each involving 8-10 participants with diverse roles, were held to gather collective insights. A comprehensive review of project reports, schedules, and financial records from various Tabriz projects further supplemented the primary data.

Qualitative data analysis: The data collected through interviews, focus groups, and document reviews were analyzed thematically using qualitative analysis. This analysis identified critical productivity factors; including workforce skills, material supply chains, equipment availability, and site organization. Local socio-cultural and environmental factors were also integrated into the analysis to account for their impact on construction practices in Tabriz.

Development of the productivity model: Based on the thematic analysis, a conceptual productivity model was developed to address the unique dynamics of small-scale construction projects in Tabriz. The model is structured around three primary components: input factors (e.g., workforce skills and material availability), process factors (e.g., communication and site coordination), and output factors (e.g., project timelines and quality of work). It highlights the interconnections between these components and incorporates qualitative indicators for measuring and improving productivity.

Validation and pilot testing: The model was reviewed by a panel of 10 construction management experts, including academics and industry practitioners familiar with Tabriz's construction landscape. Their feedback was used to refine the model further. To evaluate its practicality, the refined model was pilot-tested on three active small-scale construction projects in Tabriz. This testing phase provided valuable insights into the model's effectiveness and areas for improvement.

Materials utilized in the study: The study relied on various materials, including customized interview and focus group guides, project documentation (e.g., blueprints, schedules, and financial records), and qualitative analysis tools. These resources ensured a comprehensive understanding of the local construction industry. By integrating data from diverse sources, the study successfully developed a qualitative productivity model that is both practical and context-specific, addressing the unique challenges of small-scale construction management in Tabriz. Below tables are summarizing the identified factors categorized into input, process, and output components. The input parameters, encompassing workforce skills, material availability, and equipment efficiency, form the foundation of project productivity in small-scale construction. Workforce factors, such as skill levels and motivation, directly impact project quality, while reliable material supply chains and well-maintained equipment minimize delays and inefficiencies. These factors are interconnected; for instance, unskilled labor may underutilize high-quality materials or advanced machinery, highlighting the need for a balanced approach. Effective integration of these inputs into key processes, such as site coordination and communication, is essential to achieve desired outcomes like timely completion, cost-effectiveness, and quality assurance in construction projects.

Table 1 Overview of productivity factors

Category	Factors	Description
Input Factors	Workforce skills, material availability, equipment efficiency	Resources needed to initiate and sustain construction activities.
Process Factors	Communication, site coordination, adherence to schedules	Activities and management practices that ensure efficient workflow.
Output Factors	Timelines, cost-effectiveness, quality of work	Final outcomes that measure project success and align with set goals.

Table 2 Input parameters - workforce factors

Category	Factors	Description
Workforce Skills	Technical abilities, experience, and training	Skilled workers ensure higher productivity and better quality outcomes.
Availability of Labor	Number of workers available for projects	Adequate workforce prevents delays and ensures project continuity.
Motivation Levels	Workers' willingness and commitment	High motivation boosts efficiency and reduces errors.

Table 3 Input parameters - material factors

Category	Factors	Description
Material Quality	Durability, strength, and compliance with standards	High-quality materials improve construction longevity and reduce rework.
Supply Chain Reliability	Timeliness and consistency in material delivery	Reliable supply chains minimize delays and ensure smooth project execution.
Cost of Materials	Affordability and budget alignment	Cost-effective procurement enhances financial efficiency.

Table 4 Input parameters - equipment factors

Category	Factors	Description
Equipment Availability	Number and type of tools/machinery on-site	Ensures efficient execution of tasks requiring specialized machinery.
Maintenance Status	Operational readiness and condition of equipment	Well-maintained equipment reduces downtime and operational inefficiencies.
Technology Adoption	Use of modern tools and automation	Advanced technology enhances precision, speed, and overall productivity.

V. Results and Discussion

The qualitative analysis of small-scale building construction projects in Tabriz revealed key productivity drivers, challenges, and potential interventions. The developed model captures critical interdependencies among input, process, and output factors, offering a comprehensive framework for addressing productivity issues unique to the local context. The results highlighted the significance of workforce skills as a primary determinant of productivity. Projects employing skilled labor demonstrated higher quality outputs and faster completion times compared to those relying on untrained workers. Stakeholders emphasized that skill gaps in areas like masonry, carpentry, and plumbing often led to inefficiencies and rework.

Labor availability emerged as a consistent challenge, particularly during peak construction seasons. Many contractors cited difficulties in securing a stable workforce, leading to frequent disruptions. Furthermore, motivation levels among workers were found to correlate with productivity; projects with strong supervisory practices and fair compensation observed higher commitment and efficiency among laborers. Material supply chain reliability was identified as a critical bottleneck. Delayed or inconsistent material deliveries often stalled progress, particularly for time-sensitive projects. Additionally, while locally sourced materials were cost-effective, they occasionally lacked the desired quality, necessitating adjustments or replacements that impacted project schedules and budgets.

The role of equipment in enhancing productivity was underscored by the analysis. Projects with access to modern, well-maintained machinery experienced smoother operations and reduced manual labor dependency. However, smaller contractors often struggled with the high cost of equipment, leading to reliance on outdated or rented tools, which compromised efficiency. Process factors, especially communication and coordination, played a pivotal role in project performance. Poor communication between stakeholders, including clients, contractors, and workers, frequently led to misunderstandings and delays. Effective site coordination, on the other hand, was associated with streamlined workflows and fewer conflicts.

Adherence to schedules was a recurring concern, with many projects experiencing delays due to mismanagement of resources or unforeseen challenges. The study found that proactive scheduling practices, such as regular progress reviews and contingency planning, significantly improved adherence to timelines. The quality of work emerged as a key output factor, directly influenced by input and process components. Projects with skilled labor, high-quality materials, and effective

coordination consistently achieved better results. Conversely, substandard materials or poor supervision led to structural deficiencies and client dissatisfaction. Tabriz's unique cultural and environmental context also shaped construction productivity. Traditional practices, while preserving local heritage, sometimes conflicted with modern methods, leading to inefficiencies. Additionally, environmental factors, such as weather conditions, often disrupted project timelines, particularly during winter months. Interviews and focus groups revealed differing perspectives among stakeholders. Contractors prioritized cost control and resource availability, while laborers emphasized fair wages and safe working conditions. These varying priorities underscore the need for inclusive decision-making to balance competing interests. The pilot testing of the productivity model demonstrated its practicality in real-world scenarios. The model's emphasis on interlinked factors enabled project managers to identify weaknesses and implement targeted improvements. Feedback from the validation phase highlighted its adaptability to projects of varying scales.

One of the most actionable insights was the need for vocational training programs tailored to the local workforce. Such initiatives could bridge skill gaps, reduce dependency on external labor, and improve overall productivity. Collaborations with educational institutions and industry bodies could support this effort. Improving material supply chain efficiency was another critical area. Establishing partnerships with reliable suppliers, implementing just-in-time delivery practices, and leveraging technology for inventory management were proposed as effective strategies to mitigate supply-related disruptions. Sustainability emerged as a secondary, yet significant, concern. Incorporating eco-friendly materials and practices into small-scale projects could enhance long-term viability while aligning with global sustainability goals. This approach would also appeal to environmentally conscious clients. The findings underscore the importance of a holistic approach to productivity in small-scale construction. By addressing workforce training, material supply chain optimization, and effective process management, stakeholders can significantly enhance project outcomes. The proposed model offers a flexible and practical framework for improving productivity while accommodating Tabriz's unique cultural and economic landscape.

VI. Conclusion

This study developed and validated a qualitative productivity model tailored to the unique dynamics of small-scale building construction projects in Tabriz. Through a comprehensive analysis of input, process, and output factors, the research identified key drivers and challenges affecting construction productivity in the region. Workforce skills, material availability, and equipment efficiency emerged as critical input parameters, while communication, coordination, and schedule adherence were vital process factors influencing project outcomes. The findings highlighted the importance of addressing skill gaps through targeted vocational training programs and improving supply chain reliability to ensure timely and cost-effective material delivery. The study also emphasized the need for better communication and coordination among stakeholders to minimize delays and enhance workflow efficiency. Furthermore, incorporating sustainable practices and eco-friendly materials into construction projects was identified as a promising approach to align local construction activities with global environmental goals. The validated productivity model offers a practical framework for project managers and contractors to assess and improve performance in real-world scenarios. By integrating stakeholder perspectives and considering cultural and environmental influences, the model ensures its relevance to the specific needs of Tabriz's construction sector. Future efforts should focus on refining this model further by incorporating quantitative metrics and expanding its applicability to other urban contexts. This research provides a foundation for fostering sustainable and efficient construction practices, contributing to the broader development goals of Tabriz and similar urban centers.

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Authors' contributions

Hossein Hasanvand conducted the main data analysis, contributed to the data collection, preprocessing, and interpretation, and was responsible for drafting the initial manuscript. Javad Majrouhi Sardroud assisted in the development of the methodology and performed validation checks, provided supervision, conceptual guidance, and critical revision of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors have not disclosed any competing interests.

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