International Journal of Architectural Engineering & Urban Planning, Volume 36, Number 2, 2026
***DOI:* 10.22068/ijaup.720**

Research Paper

Factors Affecting the Application of Prefabrication in Construction Projects: A Sustainability Approach in Iran

Mohammad Ali Nemati [1], Javid Ghanbari [2*], Mohammad Hossein Zare [2]

[1] *Department of Architecture, Firouzabad Higher Education Center, Shiraz University of Technology, Shiraz, Iran*

[2] *Department of Architecture, Shiraz University, Shiraz, Iran*

Received: February 2025, **Revised:** March 2026, **Accepted:** May 2026, **Publish Online:** June 2026

Abstract
Prefabrication, as an off-site construction approach, relocates key production processes from construction sites to controlled factory environments, offering significant advantages in efficiency, quality, and sustainability. Despite its growing global adoption, the criteria and prerequisites for its effective implementation remain insufficiently explored within the context of Iran. This study aims to identify and evaluate the critical factors influencing the application of prefabrication in Iran's construction industry, with particular emphasis on sustainability considerations. A total of 26 criteria were identified through a comprehensive literature review and expert input. Data were collected via a structured survey administered to construction industry experts in Tehran. Exploratory factor analysis (EFA) was employed to determine the underlying factor structure, followed by confirmatory factor analysis (CFA) to validate the relationships between the identified factors and their influence on prefabrication adoption. The results indicate that five principal factors—construction and operational costs, constructability, external context, societal aspects, and environmental considerations—significantly influence the adoption of prefabrication. The first-order model demonstrates strong intercorrelations among these factors, highlighting their collective importance for stakeholders. Furthermore, the second-order model confirms that prefabrication adoption is closely associated with broader dimensions of Iran's economy, society, environment, and construction culture. The findings contribute to the existing body of knowledge by contextualizing prefabrication adoption within a developing construction market and provide a structured framework to guide decision-making toward more sustainable construction practices in Iran.

Keywords: *Sustainable construction, Prefabrication, Construction project, Iran.*

INTRODUCTION

On-site construction practices are often associated with low environmental performance due to their labor-intensive nature and high consumption of non-recyclable resources (Shen et al., 2010). In response, many countries have increasingly adopted prefabrication as an

---

[*] *Corresponding author: J.Ghanbari@shirazu.ac.ir*

alternative construction approach to mitigate environmental impacts and improve efficiency (Ghanbari et al., 2025; Hosseini et al., 2018).

Despite these global advancements, prefabricated construction in Iran has not developed in proportion to the rapid growth of the construction sector, particularly in residential projects, which have expanded significantly in recent decades (Abbaszadeh, 2016; Ghanbari & Zare, 2021). At the same time, the Iranian public sector has emphasized the provision of sustainable and habitable housing as a central objective in urban development policies (Hessari et al., 2018; Sadeghian et al., 2021). However, the continued reliance on conventional construction methods and uniform design practices has contributed to increased environmental degradation and inefficiencies within the industry (Dastgheibifard, 2016; Ghoddousi & Hosseini, 2012; Hashemi, 2015). These challenges pose significant barriers to achieving long-term sustainable development in the construction sector.

Prefabrication presents a viable solution for addressing these challenges; however, its ineffective or unstructured implementation may lead to adverse outcomes, including construction defects, project delays, increased costs, and reduced quality (Kamali & Hewage, 2015). Although previous studies have explored various aspects of prefabrication, existing research remains fragmented and often focuses on isolated factors without providing a comprehensive, multi-dimensional evaluation framework, particularly within the context of developing countries such as Iran. Furthermore, decision-making processes in practice are frequently based on limited criteria—primarily cost-related factors—or subjective judgments rather than systematic and data-driven approaches (Nemati et al., 2018).

Accordingly, there is a critical need for a structured and empirically validated framework that identifies and evaluates the key factors influencing the adoption of prefabrication in Iran, while simultaneously incorporating sustainability considerations.

This study aims to address this gap by identifying and analyzing the critical factors affecting the application of prefabrication based on expert perspectives within Iran’s construction industry. Using a combined exploratory and confirmatory analytical approach, the research develops a hierarchical factor model to evaluate the interrelationships among economic, technical, environmental, and socio-cultural dimensions. Unlike previous studies, this research develops and empirically validates a second-order structural model integrating economic, technical, environmental, and social dimensions of prefabrication specifically within the Iranian construction context. The contribution of this study is threefold:

1) It provides a comprehensive and context-specific evaluation framework for prefabrication adoption in Iran.
2) It integrates sustainability dimensions into decision-making criteria; and
3) It offers empirically validated insights to support stakeholders in adopting more efficient and sustainable construction practices.

LITERATURE REVIEW

A Sustainability Approach to Prefabrication in Construction Projects

Environmental Sustainability

Prefabrication has been widely recognized as an effective approach to improving environmental sustainability in construction projects. By shifting construction activities from on-site to controlled factory environments, this method significantly reduces material waste, energy consumption, and environmental pollution (Hong et al., 2018; Jiang et al., 2018; Nemati et al., 2018; W. Zhang et al., 2018). For instance, Zhang et al., (2018) report that prefabrication can reduce construction and demolition waste by up to 52%, highlighting its substantial potential for waste minimization (Zhang et al., 2018).

In addition to waste reduction, prefabricated construction contributes to lower greenhouse gas (GHG) emissions and reduced dust generation compared to conventional on-site practices (Pan & Teng, 2021). These environmental benefits are further enhanced through the integration of emerging digital technologies. The adoption of Building Information Modelling (BIM) and the Internet of Things (IoT) in prefabricated construction enables more efficient design coordination, resource optimization, and lifecycle management, thereby supporting sustainability objectives across the entire construction process (Liu & Zou, 2021; Shen et al., 2021).

Despite these advantages, most existing studies focus primarily on isolated environmental indicators and often lack a comprehensive evaluation framework that integrates environmental performance with economic, technical, and socio-cultural factors. This limitation underscores the need for a more holistic approach to assessing prefabrication, particularly in context-specific settings such as Iran.

Economic Sustainability

Prefabrication has significant implications for the economic performance of construction projects, influencing cost efficiency, productivity, quality control, and supply chain dynamics. One of the primary advantages of prefabrication lies in its ability to enhance quality control through automated production processes, advanced monitoring systems, and reduced reliance on manual labor, thereby minimizing human error and improving coordination among suppliers and contractors (Hong et al., 2018; Clyde Zhengdao Li et al., 2018; L. Li et al., 2018; M. Nemati et al., 2017).

In addition to quality improvements, prefabrication has been associated with increased productivity, particularly through the integration of information technologies and optimized manufacturing processes. The use of multi-skilled labor, engineering innovations, and controlled factory environments enables more efficient production workflows and reduces on-site uncertainties (Arashpour et al., 2018; Liu et al., 2018; Wu et al., 2021; Yoo et al., 2019). However, these benefits are contingent upon effective coordination and information exchange. Inadequate integration between design, manufacturing, and construction phases may lead to schedule delays, rework, and inefficiencies (Arashpour et al., 2017; C. Z. Li et al., 2018; Yi et al., 2020; L. Zhang et al., 2018; W. Zhang et al., 2018).

A critical challenge associated with prefabrication is its relatively high initial capital cost compared to conventional construction methods. These costs arise from investments in specialized machinery, transportation logistics, skilled labor, and material production, which can reduce stakeholders’ willingness to adopt prefabrication, particularly in cost-sensitive markets (Hong et al., 2018; Jiang et al., 2018; Wang et al., 2018; Xue et al., 2017, 2018; Zhu et al., 2018). Furthermore, the assembly and transportation of prefabricated components require precise planning and coordination, adding to logistical complexity and potential cost escalation.

From a broader perspective, the economic feasibility of prefabrication is strongly influenced by external market conditions. In developing countries, barriers such as limited industrial capacity, insufficient regulatory frameworks, lack of standardization, and weak incentive structures hinder the realization of economies of scale (Li et al., 2020; Xue et al., 2017). These constraints highlight the importance of adopting a holistic supply chain management approach and improving information integration across all project stages to maximize the economic benefits of prefabrication (Li et al., 2017; Liu et al., 2018).

Despite the recognized economic advantages and challenges, existing studies often examine these factors in isolation and fail to provide an integrated framework that captures their interdependencies. This limitation reinforces the need for a comprehensive and context-specific evaluation model to assess the economic viability of prefabrication, particularly within the Iranian construction industry.

Social Sustainability

Social sustainability is a critical dimension of construction project performance, particularly in relation to occupational safety, workforce well-being, and public acceptance. Construction activities are inherently associated with significant health and safety risks due to labor-intensive operations, complex site conditions, and exposure to hazardous environments (Chang et al., 2020; Golchin Rad & Kim, 2018). Prefabrication has the potential to mitigate these risks by transferring a substantial portion of construction activities to controlled factory settings.

Specifically, prefabricated construction improves worker safety and health by reducing high-risk on-site activities, minimizing work at heights, and limiting exposure to adverse weather conditions (Wu et al., 2021; Yuan et al., 2018). The more controlled and standardized working environment associated with prefabrication enhances operational safety and reduces uncertainty during execution. In addition, the reduction of construction-related pollutants—such as dust, noise, and emissions—benefits not only construction workers but also surrounding communities, thereby improving overall social well-being (Jin et al., 2021).

Beyond occupational considerations, the adoption of prefabrication is strongly influenced by broader social and institutional factors. Government policies, industry culture, and stakeholder attitudes play a significant role in shaping the acceptance of prefabrication technologies (Chen et al., 2017; Cheng & Ma, 2020). In many cases, developers prioritize short-term economic gains over long-term social and environmental benefits, which can hinder the adoption of prefabrication (Tam et al., 2015). Furthermore, public perception—including client and end-user attitudes—represents a crucial determinant of market acceptance and diffusion of prefabricated construction systems (Li et al., 2019).

Despite the recognized importance of social factors, existing studies often lack a systematic approach to evaluating their impact on prefabrication adoption. Moreover, the relative importance and interaction of these factors are highly context-dependent, particularly in developing countries such as Iran, where cultural, institutional, and market conditions differ significantly from those in developed contexts (L. Li et al., 2018; W. Zhang et al., 2018). This highlights the need for a structured and context-sensitive framework to assess social sustainability dimensions alongside economic, environmental, and technical factors.

Previous Studies on Prefabrication and Sustainable Construction in Iran

In Iran, conventional construction management practices are predominantly structured around the project management triangle—cost, time, and quality—and are typically assessed through qualitative judgments based on practitioners' experience. However, with the increasing recognition of environmental and social impacts, sustainable construction has emerged as a critical concern. Within the Iranian context, existing research can be broadly categorized into two main streams.

The first stream focuses on evaluating building sustainability by examining selected dimensions associated with prefabrication. For example, Solaimani and Sedighi (2020) conducted a comprehensive review of 118 studies and proposed an integrated framework for sustainable construction, emphasizing the importance of aligning stakeholder objectives throughout the building life cycle (Solaimani & Sedighi, 2020). Jahanbakhsh (2010) identified inefficient decision-making processes and the neglect of environmental considerations as major barriers to achieving sustainable architecture in Iran (Jahanbakhsh, 2010). Furthermore, Nemati et al., (2018) developed a model for assessing the environmental adaptability of residential complexes (Nemati et al., 2018). As illustrated in Figure 1, which synthesizes eight widely used sustainable building rating systems, their model introduces key evaluation dimensions, including stakeholder synergy, building performance, environmental habitability, and building durability. Despite these contributions, such studies remain largely descriptive and do not provide practical or operational guidance for implementing innovative construction approaches—particularly prefabrication—in pursuit of sustainability objectives.

The conceptual framework of this study, derived from the literature review, is presented in Figure 1. The framework illustrates the key factors influencing the adoption of prefabrication, including construction and operating costs, constructability, external context, and social and environmental considerations, and highlights the relationships among these constructs.

The second stream of research primarily addresses technical aspects of prefabrication, focusing on specific building components or performance criteria. For instance, Rezaiean and Hoseini (2015), Taghdiri and Ghomi (2016), and Mahmmod Zadeh Kani et al., (2017) examine structural and technical characteristics of prefabricated elements (Mahmmod Zadeh Kani et al., 2017; Rezaiean & Hoseini, 2015; Taghdiri & Ghomi, 2016). Taghdiri and Ghomi (2016), for example, compared prefabricated structural systems with conventional on-site methods in terms of seismic performance, cost, and construction waste, suggesting that the development of standards and regulatory frameworks for prefabrication could reduce lifecycle project costs (Taghdiri & Ghomi, 2016). Similarly, Shahpari et al. (2020) evaluated the productivity of prefabricated versus in-situ construction systems using Delphi and multi-criteria decision-making (MCDM) techniques, identifying management, planning, and cost as the most influential productivity factors (Shahpari et al., 2020). Nevertheless, these studies are limited in scope and lack a holistic framework for assessing prefabrication within a broader sustainability context.

Overall, existing approaches to evaluating prefabrication in Iran tend to focus on isolated aspects—either sustainability indicators or technical performance—without integrating these dimensions into a comprehensive assessment framework. In practice, evaluation methods employed by project managers often prioritize material and labor costs while overlooking broader environmental and social criteria, and decision-making processes remain largely experience-based rather than systematically grounded (Nemati et al., 2018). Accordingly, there is a clear lack of comprehensive and methodologically robust research addressing prefabrication from a multidimensional perspective in the Iranian construction context. This study aims to bridge this gap by developing a more integrated approach to evaluating prefabrication in alignment with sustainability principles.

RESEARCH DESIGN

This study employs a mixed-methods research design integrating a systematic literature review, a questionnaire-based survey, and multivariate statistical analysis. Initially, a comprehensive literature review is conducted to identify potential factors influencing the implementation of prefabrication in construction projects. These factors are subsequently incorporated into a structured questionnaire and evaluated through a survey of industry professionals. The collected data are analyzed using exploratory factor analysis (EFA) to identify underlying factor structures, followed by reliability and validity assessments. As illustrated in Figure 2, this integrated approach enables the identification, validation, and categorization of critical factors affecting prefabrication adoption.

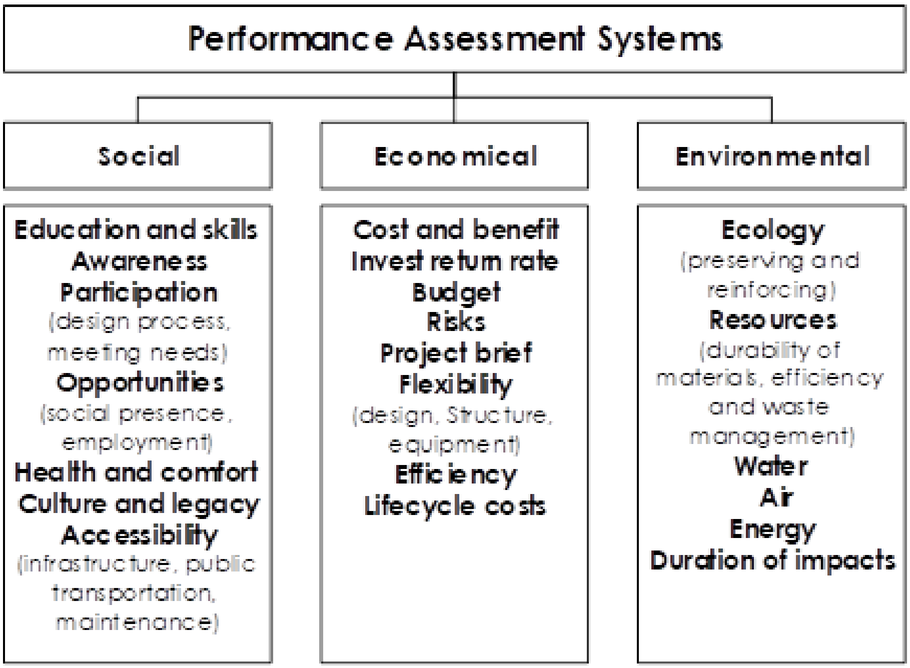

Fig 1. Indicators of Building Performance Assessment Systems (Nemati et al., 2018)

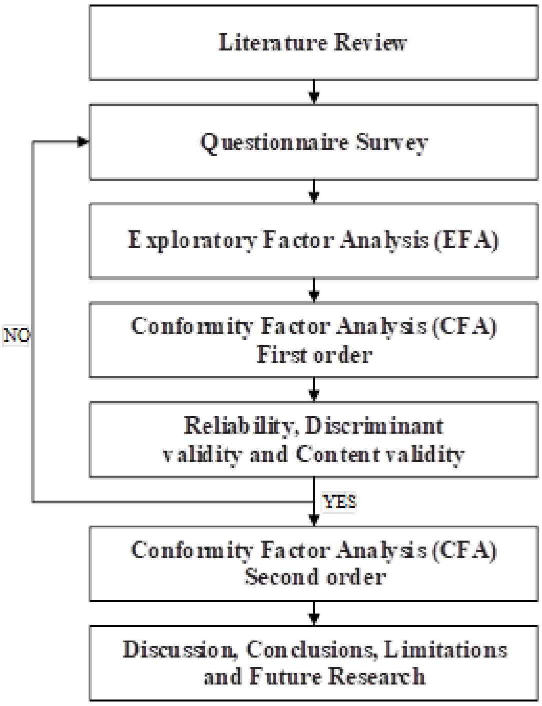

Fig 2. Research Design (Source: Authors)

Data Collection and Sample Selection

To investigate industry perspectives on prefabrication, a survey-based approach was employed. The data collection instrument consisted of a structured questionnaire comprising two main sections: (1) four items capturing respondents' personal and organizational characteristics, and (2) a set of 26 indicators related to prefabrication assessment, derived from the literature review (see Table 1). The questionnaire was developed and subsequently refined based on feedback from four academic experts in the field to ensure content validity and clarity. Respondents were asked to evaluate the importance of each indicator using a five-point Likert scale. Additionally, supplementary explanations were provided within the questionnaire to ensure a consistent understanding of the items.

The survey was administered during the winter of 2021 via email to professionals in the Iranian construction industry. The target population was selected from consulting engineering firms registered with the Iran Plan and Budget Organization, encompassing a diverse range of construction stakeholders. In total, 487 individuals were randomly invited to participate, accompanied by a brief introduction to the study. After a two-week period, reminder emails were distributed to increase the response rate.

A total of 379 responses were received, corresponding to a response rate of approximately 77%. Following data screening, 19 incomplete questionnaires were excluded, resulting in 360 valid responses for subsequent analysis. Among the respondents, 155 were design engineers and project managers working in consulting firms, 38 were manufacturers of prefabricated components, 116 were contractors, and 51 were academic or technical researchers. All participants possessed a minimum of five years of professional experience in the construction industry. The diversity of respondents across different professional groups enhances the representativeness of the sample and supports the validity of the findings (Table 2).

Table 1. The Preliminary List of Indicators

Code	Factors	References
I1	Return on investment	(Durdyev & Ismail, 2019), (Shahpari et al., 2020), (Nemati et al., 2018)
I2	Integration of the supply chain	(L. Li et al., 2018), (W. Zhang et al., 2018), (Nemati et al., 2018)
I3	The efficiency of construction expenses	(Mao et al., 2016), (Hong et al., 2018), (Jiang et al., 2018), (Durdyev & Ismail, 2019), (Shahpari et al., 2020)
I4	Integrated design, construction, and management	(Banihashemi et al., 2018), (Shahpari et al., 2020), (Zhang et al., 2016), (Singh et al., 2015)
I5	Maturity of the design and construction procedures	(L. Li et al., 2018), (Haller et al., 2015)
I6	Costs of construction	(W. Zhang et al., 2018), (Shahpari et al., 2020)
I7	Information sharing and effective communication among participants	(Nemati et al., 2018), (Roohollah Taherkhani & AL Saleh, 2019), (L. Li et al., 2018)
I8	Availability of codes, specifications and regulations	(Clyde Zhengdao Li et al., 2018), (Zhang et al., 2014), (Cao et al., 2015), (L. Li et al., 2018)
I9	Environmental impacts	(Jiang et al., 2018), (W. Zhang et al., 2018), (Shahpari et al., 2020), (Hong et al., 2018), (Ding et al., 2018)
I10	Costs of maintenance	(Li et al., 2014), (Kamali & Hewage, 2016), (M. A. Nemati et al., 2018)
I11	Consistent incentives, promotions and policies	(W. Zhang et al., 2018), (Mao et al., 2015), (Azam Haron et al., 2015), (L. Li et al., 2018)

Code	Factors	References
I12	Architectural quality, adaptability and aesthetics	(Kamali & Hewage, 2016), (Gan et al., 2017), (Jiang et al., 2018), (Nemati et al., 2018), (W. Zhang et al., 2018)
I13	Maturity of technology, manufacturers and suppliers of prefabrication	(Durdyev & Ismail, 2019), (Li et al., 2014), (Jiang et al., 2018)
I14	Reducing the neighborhood environment damages	(Nemati et al., 2018), (W. Zhang et al., 2018), (Shahpari et al., 2020) (Pan & Teng, 2021)
I15	Control mechanism for design and construction and risk management	(Shahpari et al., 2020), (Nemati et al., 2018), (Clyde Zhengdao Li et al., 2018), (Durdyev & Ismail, 2019)
I16	The flexibility of design modifications	(Clyde Zhengdao Li et al., 2018), (W. Zhang et al., 2018), (MA Nemati et al., 2017), (Nemati et al., 2018)
I17	Construction scheduling	(Hong et al., 2018), (Li et al., 2014)
I18	Local materials and workforce	(Shahpari et al., 2020), (MA Nemati et al., 2017)
I19	Costs associated with design and construction management	(W. Zhang et al., 2018), (L. Li et al., 2018), (Nemati et al., 2018)
I20	Project management expertise	(L. Li et al., 2018), (Yang et al., 2016), (Marzagão & Carvalho, 2016)
I21	Coordination with other components of the construction	(Kamali & Hewage, 2016), (Shahpari et al., 2020), (L. Li et al., 2018)
I22	Health and safety in construction and occupation	(Jiang et al., 2018), (Abdalla et al., 2017), (W. Zhang et al., 2018)
I23	Conservative industry culture	(Larsson et al., 2014), (Durdyev & Ismail, 2019)
I24	Local government approach to obtaining permissions	(L. Li et al., 2018), (Li et al., 2016), (Cao et al., 2015)
I25	Performance and durability over the lifespan of the building	(Hong et al., 2018), (Nemati et al., 2018), (W. Zhang et al., 2018), (Jiang et al., 2018)
I26	Reduce construction-related conflicts	(Clyde Zhengdao Li et al., 2018), (W. Zhang et al., 2018), (MA Nemati et al., 2017), (Nemati et al., 2018)

Table 2. A Summary of the Demographic Data of Respondents

Demographic characteristics	Category	Number	(%)
The organization's size (by Number of employees)	Up to 20	11	34
	21–50	17	53
	Above 50	4	13
Profession	Engineers and project managers	155	43
	Manufacturers of prefabricated elements	38	11
	Construction contractors	116	32
	Technical researchers	51	14
Experience in the profession (in years)	6–10	89	25
	11-20	164	45
	Above 21	107	30

Exploratory Factor Analysis

To evaluate the suitability of the dataset for factor analysis, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted. As reported in Table 3, the KMO value exceeds the recommended threshold of 0.50, indicating adequate sampling adequacy, while Bartlett's test is statistically significant at the 0.01 level ($p < 0.01$). These results confirm that the correlation matrix is not an identity matrix and that the data are appropriate for factor analysis (Cleff, 2019).

Table 3. The KMO and Bartlett's Test

KMO and Bartlett's test for sampling adequacy	0.947
Bartlett's test of sphericity	
Approx. $\chi 2$	7628.154
df	325
Sig.	0.000

An initial pool of indicators was developed from the literature and refined through a Delphi process involving experts. The Delphi process resulted in the retention of 26 indicators, which were subsequently used in the EFA. Exploratory Factor Analysis (EFA) was then applied to identify the underlying structure of the variables and to reduce the dataset into a smaller set of meaningful factors. Using the Varimax orthogonal rotation method, four distinct factors were extracted: (1) construction and operating costs, (2) constructability, (3) external context, and (4) society and environmental considerations. This factor structure provides a coherent categorization of the criteria influencing prefabrication in construction projects.

To assess the internal consistency and reliability of the extracted factors, Cronbach's alpha (α) coefficients were calculated. As presented in Table 4, all constructs exhibit alpha values greater than 0.80, exceeding the commonly accepted threshold of 0.70 for established scales (Nunnally, 1975). In addition, the correlation coefficients among the variables are statistically significant, further supporting the reliability and consistency of the measurement model. Therefore, the measurement model can be considered reliable and appropriate for subsequent confirmatory factor analysis (CFA).

Table 4. Correlation Coefficients, Descriptive Statistics, and Cronbach's α

CFSs	Indicators	Mean	Construct mean	Cronbach's α
Construction and operating costs	I6	3.38	3.38	0.939
	I19	3.36		
	I1	3.41		
	I10	3.40		
	I20	3.37		
	I17	3.40		
	I3	3.34		
Constructability	I4	3.42	3.41	0.952
	I7	3.39		
	I15	3.38		
	I16	3.44		
	I5	3.45		
	I26	3.41		
	I21	3.41		
	I2	3.41		
External context	I8	3.41	3.40	0.924
	I24	3.41		
	I13	3.43		
	I23	3.34		
	I11	3.42		
Society and the environment	I25	3.37	3.35	0.932
	I12	3.36		
	I14	3.37		
	I18	3.35		
	I9	3.38		
	I22	3.38		

Conformity Factor Analysis

Confirmatory Factor Analysis (CFA) was conducted to evaluate the measurement model and assess its overall goodness of fit, following the approach proposed by Gerbing and Anderson (1988). The analysis aimed to examine both convergent validity and discriminant validity of the constructs identified through Exploratory Factor Analysis (EFA). Prior to testing the structural relationships, the measurement model was independently evaluated to ensure that the selected indicators adequately represent their respective latent constructs (Shurrab et al., 2019).

The CFA was performed using the maximum likelihood estimation method in AMOS. The dataset included 360 valid responses, with only a minimal amount of missing data (no more than three missing responses per variable). Given the low level and random nature of missing data, the estimation method remains robust, providing efficient and unbiased parameter estimates under the assumption of missing at random (MAR). The results of the construct validity analysis are presented in Table 5.

Convergent validity was assessed by examining standardized factor loadings, composite reliability (CR), and average variance extracted (AVE). The results indicate that all standardized loadings are statistically significant ($p < 0.001$) and exceed the recommended threshold, confirming that the observed variables adequately represent their respective constructs. Additionally, CR values are above the acceptable threshold of 0.70, and AVE values exceed 0.50, further supporting convergent validity (Bagozzi et al., 1991).

Discriminant validity was evaluated by comparing the square root of the AVE for each construct with the inter-construct correlations, as well as by ensuring that correlations between constructs do not exceed their respective reliability estimates (Crocker & Algina, 1986). The results confirm that each construct is empirically distinct from the others, indicating satisfactory discriminant validity.

The overall fit of the first-order measurement model was assessed using multiple goodness-of-fit indices, including the chi-square to degrees of freedom ratio (χ^2/df), root mean square error of approximation (RMSEA), Tucker–Lewis index (TLI), and comparative fit index (CFI). As recommended in the literature, reliance on a single fit index was avoided, and a combination of indices was considered to ensure robust model evaluation (Jöreskog & Sörbom, 1993). The RMSEA value is below the acceptable threshold of 0.08, indicating a reasonable model fit, while TLI and CFI values are close to or exceed 0.90, suggesting an acceptable to good fit, particularly for moderate sample sizes (Kenny et al., 2015; Taasoobshirazi & Wang, 2016). The detailed fit indices are reported in Table 6.

Table 5. Construct Validity Analysis

CFSs/ construct	Convergent validity	Discriminant validity
Construction and operating costs	0.96	0.08
Constructability	0.94	0.12
External context	0.93	0.09
Society and the environment	0.92	0.10

Table 6. CFA first-order Model Good Fit Indices

Model good fit indices	Value
$\chi 2/df$	1.064
GFI	0.93
CFI	0.99
TLI	0.99
RMSEA	0.013

Following the validation of the first-order model, a second-order CFA model was developed to examine the higher-order structure of the constructs, namely construction and operating costs, constructability, external context, and society and environmental considerations. The second-order model demonstrates satisfactory goodness-of-fit and significant path coefficients, confirming the hierarchical structure of the proposed framework. The first-order and second-order measurement models are illustrated in Figure 3 and Figure 4, respectively.

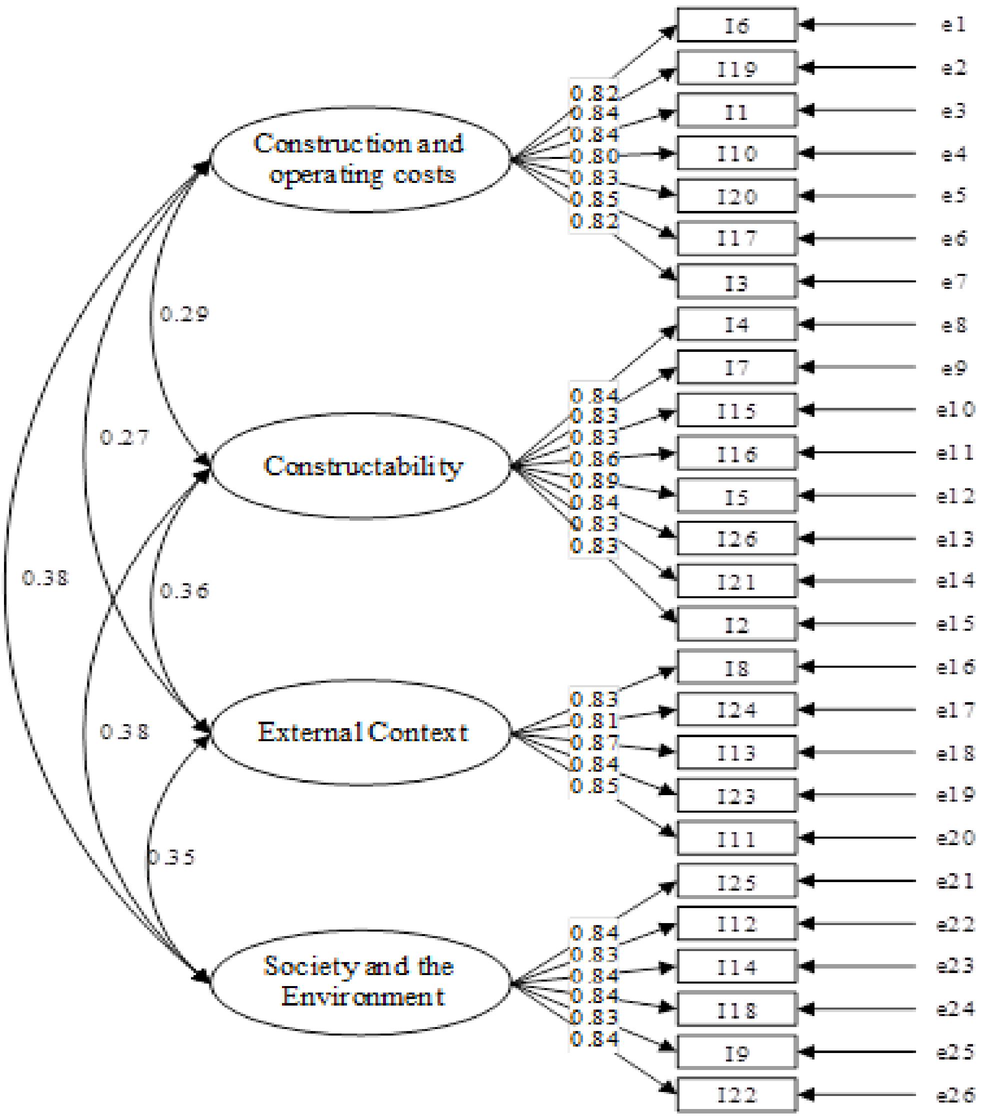

Fig 3. First-order Measurement Model (Source: Authors)

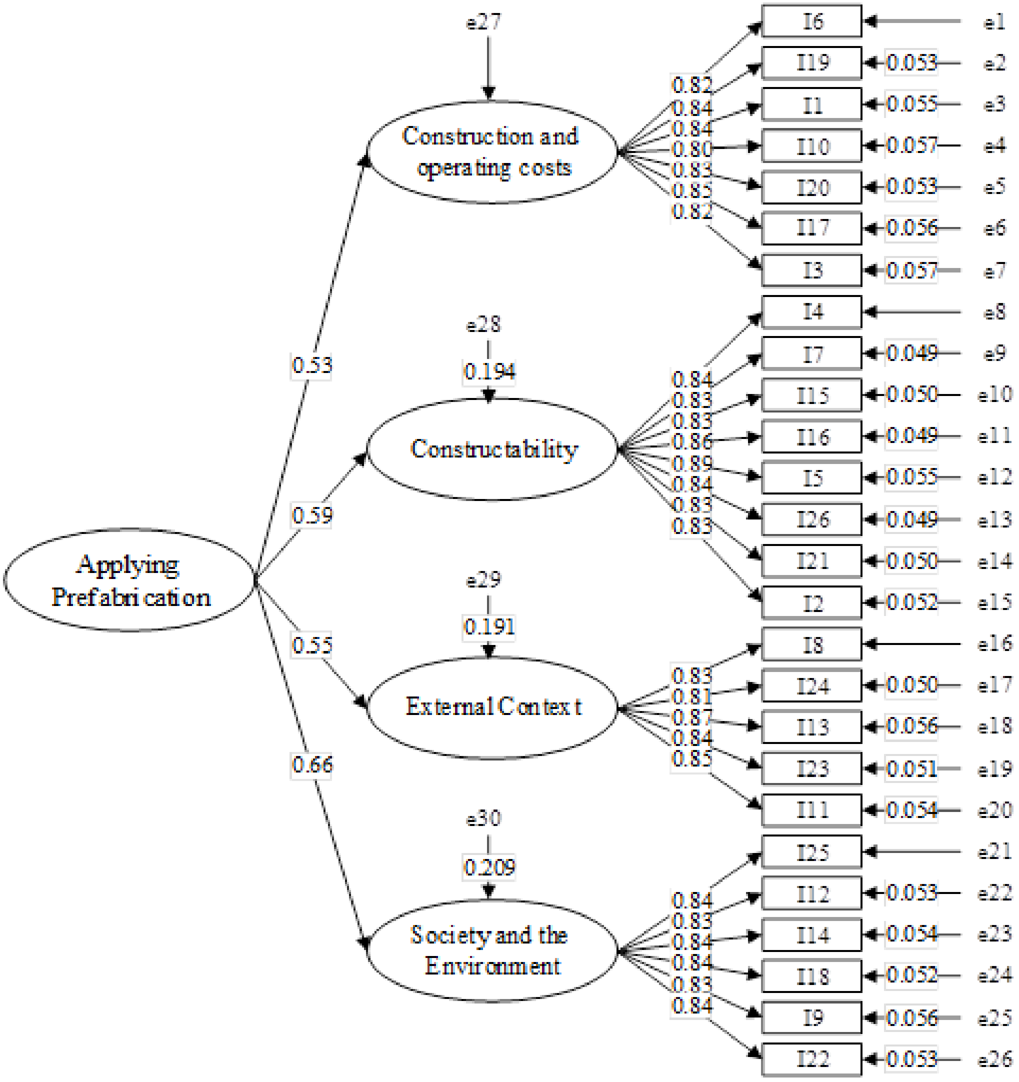

Fig 4. Second-order Measurement Model (Source: Authors)

DISCUSSION

With the increasing awareness of environmental, economic, and social challenges, the demand for sustainable construction has grown significantly. The construction sector is widely recognized as a key driver of sustainable development due to its substantial impact on environmental performance, economic growth, and societal well-being. Despite this importance, the implementation of sustainable construction practices continues to face several challenges, among which uncertainty regarding costs and benefits remains one of the most critical barriers. As highlighted by Hong et al. (2018), enhancing decision-makers' awareness of environmental implications can significantly increase the adoption of innovative construction approaches.

This study contributes to the body of knowledge on sustainable construction by developing and empirically validating a comprehensive framework for assessing prefabrication within the Iranian context. Based on an extensive literature review, a conceptual model was established to capture the multidimensional relationship between prefabrication and sustainability. In addition, the preliminary set of indicators derived from the literature was refined through a Delphi process involving domain experts. The Delphi results led to the elimination, modification, and prioritization of several indicators, ensuring their contextual relevance and content validity before conducting the statistical analyses. Therefore, the final set of variables used in the EFA and CFA reflects both theoretical foundations and expert consensus. The conceptual framework presented in Figure 1 illustrates the relationships among these dimensions and served as the basis for subsequent empirical validation. This model was subsequently examined using empirical data collected from 360 professionals across consulting engineering firms and related sectors in Tehran, providing a robust representation of industry perspectives. Unlike previous studies that primarily focus on isolated factors, this research integrates economic, technical, environmental, and contextual dimensions within a unified second-order analytical framework tailored to the Iranian construction industry.

The results of the Exploratory Factor Analysis (EFA) identified four principal dimensions influencing the adoption of prefabrication: construction and operating costs, constructability, external context, and society and environmental considerations. While cost-related factors remain dominant in decision-making processes, the findings indicate a growing recognition of technical, environmental, and social dimensions among industry stakeholders. This shift suggests an evolving perspective toward more holistic evaluation criteria in construction project planning.

The Confirmatory Factor Analysis (CFA) further validated the proposed measurement models, with both first-order and second-order structures demonstrating satisfactory goodness-of-fit. The first-order model confirms significant relationships among the identified factors, indicating that these dimensions collectively influence stakeholders' decisions regarding the adoption of prefabrication. More importantly, the second-order model reveals that prefabrication is not evaluated solely based on economic considerations but is also shaped by broader internal and external factors.

This finding is particularly significant in the context of sustainable construction, where the implementation of innovative solutions is often associated with higher initial costs and financial uncertainty. The results suggest that decision-making in the Iranian construction industry is gradually transitioning from a purely cost-driven approach toward a more integrated perspective that incorporates sustainability-related criteria. However, given the ongoing challenges in construction quality and the absence of standardized evaluation frameworks, the findings also highlight a critical gap in the availability of comprehensive decision-support tools.

Overall, this study underscores the necessity of developing structured and multidimensional assessment frameworks to support the adoption of prefabrication as a sustainable construction strategy. By addressing both technical and sustainability-related dimensions, such frameworks can facilitate more informed decision-making and contribute to improving the long-term performance of construction projects in Iran.

Construction and Operating Costs

Construction and operating costs encompass both direct and indirect expenditures associated with the building's lifecycle, including design, construction, and post-occupancy phases. The survey results indicate that this dimension is a primary determinant in the adoption of prefabrication in construction projects. Respondents placed particular emphasis on design and construction costs, while also identifying return on investment (ROI) as a critical factor in evaluating project feasibility. This finding reflects the prevailing objective of maximizing profitability in construction projects.

In addition to initial costs, operational expenses were also highlighted as an important consideration. This suggests that decision-makers are increasingly adopting a lifecycle perspective, extending beyond immediate material and labor costs to include long-term performance and maintenance expenditures. These findings are consistent with (Wuni & Shen, 2019), who define cost performance as the extent to which a project is delivered within its initial budget. In this context, cost overruns remain a major constraint in decision-making, and prefabrication—particularly off-site construction methods—has the potential to improve cost predictability and control.

However, the economic implications of prefabrication are not unequivocal. While some studies suggest that prefabrication may lead to higher initial costs, particularly in the early stages of implementation, this increase cannot be generalized across all projects (Xue et al., 2018). On the contrary, the use of standardized and repetitive components can reduce production costs through economies of scale and mass production (Mao et al., 2016).

Moreover, effective stakeholder coordination—particularly through interactive briefing processes during design and construction—can significantly reduce both short-term and long-term costs (Nemati et al., 2018). Conversely, structural barriers such as the lack of prefabrication infrastructure, limited availability of skilled labor, and underdeveloped supply chains may increase upfront costs in the early stages of project execution (Durdyev & Ismail, 2019; Jiang et al., 2018; Li et al., 2014).

Overall, the impact of prefabrication on total project cost remains context-dependent and complex. Uncertainties in cost estimation—arising from limited access to reliable financial data, variability in equipment efficiency, and insufficient post-occupancy performance data—make it difficult to draw definitive conclusions regarding its cost advantages. This highlights the need for more transparent cost data and comprehensive lifecycle cost assessment frameworks to support informed decision-making.

Constructability

Constructability refers to the systematic integration of construction knowledge and experience into the planning, design, and execution phases of a project to achieve optimal technical and operational outcomes. It encompasses the alignment of design solutions with construction constraints, as well as the effective coordination of suppliers, building systems, and project workflows. The survey results identify constructability as a key factor influencing the adoption of prefabrication in construction projects.

Among the constructability-related indicators, the integration of design, construction, and project management processes emerged as the most significant. This highlights the importance of adopting an integrated project delivery perspective, where early collaboration between stakeholders enhances decision-making and project performance. In addition, information sharing and interdisciplinary collaboration were identified as critical enablers of constructability. Effective communication among project participants contributes to improved efficiency, higher construction quality, reduced errors and rework, and overall cost and time savings (Durdyev & Ismail, 2019; Nemati et al., 2018; Taherkhani & Saleh, 2019).

However, achieving such integration remains challenging in practice. The coordination of interdependencies across design and construction stages is inherently complex, time-intensive, and requires advanced technical capabilities. Furthermore, conventional procurement systems and contract structures often limit early contractor involvement and hinder collaboration, thereby weakening constructability outcomes. In line with these findings, Banihashemi et al., (2017) argue that the absence of construction expertise during the early design stages, combined with insufficient alignment between design and construction documentation, leads to increased deficiencies and rework during project execution and operation (Banihashemi et al., 2017).

Overall, the findings emphasize that enhancing constructability is not solely a technical issue but also an organizational and contractual challenge. Strengthening integration mechanisms, improving information exchange, and adopting more collaborative project delivery approaches are essential to fully realize the benefits of prefabrication in construction projects.

External Context

The “external context” factor encompasses five key indicators: (1) availability of codes, specifications, and regulations; (2) local government procedures for obtaining permits; (3) maturity of prefabrication technologies, manufacturers, and suppliers; and (4) consistency of incentives, promotional mechanisms, and public policies. These indicators can be broadly grouped into two dimensions: the regulatory–political environment and the industrial environment.

From a regulatory perspective, respondents identified the availability of comprehensive codes and standards, along with the efficiency of permitting processes, as the most critical elements influencing the adoption of prefabrication. The success of prefabrication is strongly dependent on well-defined and coherent regulatory frameworks (Hong et al., 2018; Jin et al., 2021). Such frameworks provide essential guidance for design, manufacturing, quality control, and performance evaluation. In the Iranian context, the Building and Housing Research Center has made gradual progress in developing standards for prefabricated systems over the past decade; however, this progress has been relatively slow. In addition, despite occasional government incentives—such as tax reductions and financial support—obtaining planning approval remains a complex and time-consuming process. Multiple regulatory bodies are involved, and inconsistencies across local codes further complicate implementation. As noted by L. Li et al. (2018), the presence of clear and consistent specifications and regulations is a decisive factor in facilitating the successful deployment of prefabrication (L. Li et al., 2018).

From an industrial perspective, the maturity of the prefabrication supply chain—including technology readiness, manufacturing capacity, and supplier availability—plays a dual role as both an enabler and a constraint. On one hand, advanced technologies and established supply networks can significantly enhance efficiency and reliability. On the other hand, limited industrial capacity and low market competition may increase costs and reduce accessibility. For example, manufacturers often need to pre-order materials to mitigate production delays and delivery risks, which may increase financial pressure and operational uncertainty (Liu et al., 2018). Furthermore, market dynamics are closely linked to government policies, which influence both supply and demand conditions within the prefabrication sector.

Overall, the findings indicate that external context is a critical determinant of prefabrication adoption, operating beyond project-level considerations. Regulatory inefficiencies, fragmented policy frameworks, and underdeveloped industrial infrastructure collectively hinder the widespread implementation of prefabrication in Iran. Addressing these challenges requires coordinated policy reforms, streamlined approval processes, and strategic investments in industrial capacity to create a supportive ecosystem for prefabrication.

Society and the Environment

Based on the survey results, quality performance and durability of building components emerge as the most influential aspects of prefabrication in relation to societal and environmental outcomes. Prefabrication has been shown to outperform conventional on-site construction in terms of quality consistency (Chen et al., 2010). This advantage stems from the controlled manufacturing environment, where components are produced using standardized processes, often incorporating dry construction techniques and precise jointing systems. As a result, higher dimensional accuracy and improved detailing can be achieved, ultimately enhancing spatial quality and increasing occupant satisfaction.

The second key aspect of this factor is adaptability, defined as a building's capacity to accommodate changing user needs over time with minimal physical intervention. In this regard, prefabrication presents a paradox. While it offers standardization and efficiency, it is often perceived as less flexible in accommodating post-construction modifications. This limitation is particularly evident in contexts where prefabricated systems are predominantly applied in large-scale or social housing projects, where end-users typically have limited influence over design configurations (Lu et al., 2018; Ramezanpour, 2018). Consequently, the rigidity of certain prefabricated systems may lead to reduced long-term adaptability and user-driven customization.

In addition, minimizing impacts on the local environment and community constitutes another important dimension of this factor. Reduced on-site construction activities lead to lower levels of noise, dust, and environmental pollution, thereby improving neighborhood conditions and enhancing the quality of life for local residents (Kamali & Hewage, 2016; Sanga, 2020). Furthermore, the streamlined nature of prefabricated construction processes can simplify installation and reduce project complexity, potentially enabling the use of less specialized labor while still contributing to local economic activity (Chen et al., 2010). These aspects collectively support greater social acceptance and facilitate improved socio-economic interactions within the community.

Despite being ranked lower by respondents compared to other factors, environmental and social considerations remain fundamental drivers for adopting innovative construction methods (Nemati et al., 2018). However, the extent of these benefits appears to be scale-dependent. Larger construction projects tend to realize greater environmental and economic advantages from prefabrication due to economies of scale, whereas smaller projects may experience limited gains (Amin & Abanda, 2019).

Overall, the findings suggest that while prefabrication significantly enhances construction quality and reduces environmental disturbances, its broader societal impact is mediated by issues of adaptability, user engagement, and project scale. Addressing these challenges requires design strategies that integrate flexibility into prefabricated systems, alongside policy measures that promote user-centered and context-sensitive applications.

CONCLUSIONS

Prefabrication has the potential to significantly support Iran's housing strategies in achieving its intended objectives. However, due to the lack of comprehensive and systematic research in this context, substantial ambiguities remain regarding its effective implementation and scalability. Current evaluations of prefabrication are often based on subjective judgments and limited practical experience, with insufficient consideration of feasibility, long-term performance, and broader sustainability drivers. Consequently, there is a clear need for structured frameworks and well-defined criteria to guide its application.

This study addressed this gap by identifying and analyzing the key factors influencing the adoption of prefabrication. This study is among the first to apply a second-order CFA framework to evaluate prefabrication adoption in Iran, providing a validated multidimensional decision-support structure. A total of 26 indicators were derived from the environmental, social, and economic dimensions of sustainability through an extensive literature review. Using exploratory factor analysis (EFA), these indicators were categorized into four latent constructs: construction and operating costs, constructability, external context, and society and the environment. The empirical data were collected through a questionnaire survey administered to construction professionals affiliated with consulting engineering firms under the Iran Plan and Budget Organization in Tehran.

The first-order factor model demonstrated significant interrelationships among the identified factors, indicating that decision-making regarding construction methods is inherently multi-dimensional. Furthermore, the second-order model confirmed that prefabrication is strongly associated with social and environmental considerations, suggesting that stakeholder decisions are not driven solely by economic benefits. This finding is particularly important, as the pursuit of sustainable construction solutions is often perceived to impose additional financial burdens. In contrast, the results of this study indicate that social and environmental awareness play a meaningful role in shaping stakeholder preferences. At the same time, the relatively slow adoption of prefabrication in Iran reinforces the argument that existing evaluation criteria and decision-making frameworks remain inadequate.

This research contributes to the body of knowledge by proposing a comprehensive set of factors and criteria that extend beyond the traditional cost–time–quality paradigm in construction management. By incorporating sustainability dimensions, the proposed framework provides a more holistic basis for evaluating prefabrication. It offers practical value for decision-makers seeking to balance economic efficiency with social and environmental performance.

Nevertheless, several limitations should be acknowledged. The qualitative nature of some indicators may introduce subjectivity and potential misinterpretation in decision-making processes. In addition, the relatively limited sample size constrains the generalizability of the findings. Future research should focus on refining these indicators and developing quantitative assessment tools to evaluate prefabrication performance at the level of individual building components. Moreover, the proposed framework should be validated across different project types, scales, and geographical contexts. The development of life-cycle-based evaluation instruments for prefabricated building elements represents a promising direction for further investigation.

REFERENCES

Abbaszadeh, G. (2016). Pathology of mass housing projects in Iran (Mehr housing plan). *Journal of Fundamental and Applied Sciences*, *8*, 885-915.

Abdalla, S., Apramian, S. S., Cantley, L. F., Cullen, M. R., Mock, C., Nugent, R., Kobusingye, O., & Smith, K. (2017). Occupation and risk for injuries. *Disease Control Priorities*, *7*.

Amin, K., & Abanda, F. H. (2019). Building Information Modelling Plan of Work for Managing Construction Projects in Egypt. *Journal of Construction in Developing Countries*, *24*(2), 23-61. https://doi.org/10.21315/jcdc2019.24.2.2

Arashpour, M., Bai, Y., Aranda-Mena, G., Bab-Hadiashar, A., Hosseini, R., & Kalutara, P. (2017). Optimizing decisions in advanced manufacturing of prefabricated products: Theorizing supply chain configurations in off-site construction. *Automation in Construction*, *84*, 146-153. https://doi.org/10.1016/j.autcon.2017.08.032

Arashpour, M., Kamat, V., Bai, Y., Wakefield, R., & Abbasi, B. (2018). Optimization modeling of multi-skilled resources in prefabrication: Theorizing cost analysis of process integration in off-site construction. *Automation in Construction*, *95*, 1-9. https://doi.org/10.1016/j.autcon.2018.07.027

Azam Haron, N., Abdul-Rahman, H., Wang, C., & Wood, L. C. (2015). Quality function deployment modelling to enhance industrialised building system adoption in housing projects. *Total Quality Management & Business Excellence*, *26*(7-8), 703-718.

Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly*, 421-458. https://doi.org/10.2307/2393203

Banihashemi, S., Hosseini, M. R., Golizadeh, H., & Sankaran, S. (2017). Critical success factors (CSFs) for integration of sustainability into construction project management practices in developing countries. *International Journal of Project Management*, *35*(6), 1103-1119. https://doi.org/10.1016/j.ijproman.2017.01.014

Banihashemi, S., Tabadkani, A., & Hosseini, M. R. (2018). Integration of parametric design into modular coordination: A construction waste reduction workflow. *Automation in Construction*, *88*, 1-12.

Cao, X., Li, Z., & Liu, S. (2015). Study on factors that inhibit the promotion of SI housing system in China. *Energy and Buildings*, *88*, 384-394.

Chang, C., Wu, X., & Yan, X. (2020). Multiobjective optimization of safety risk of prefabricated building construction considering risk correlation. *Mathematical Problems in Engineering*. https://doi.org/10.1155/2020/6404135

Chen, Q., Liu, P.-H., & Chen, C.-T. (2017). Evolutionary game analysis of government and enterprises during promotion process of prefabricated construction. *Journal of Interdisciplinary Mathematics*, *20*(6-7), 1587-1593. https://doi.org/10.1080/09720502.2017.1383564

Chen, Y., Okudan, G. E., & Riley, D. R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. *Automation in Construction*, *19*(2), 235-244. https://doi.org/10.1016/j.autcon.2009.10.004

Cheng, D., & Ma, J. (2020). *Research on the restrictive factors of the development of Chinese prefabricated buildings* IOP Conference Series: Earth and Environmental Science.

Cleff, T. (2019). Applied statistics and multivariate data analysis for business and economics: A modern approach using SPSS, Stata, and Excel. *Switzerland: Springer*. https://doi.org/10.1007/978-3-319-99818-3

Crocker, L., & Algina, J. (1986). Introduction to classical and modern test theory. *New York: Harcourt Brace Jovanovich*.

Dastgheibifard, S. (2016). *Implementation of Supply Chain Management in Iran Construction Industry* Eastern Mediterranean University (EMU)].

Ding, Z., Fan, Z., Tam, V. W., Bian, Y., Li, S., Illankoon, I. C. S., & Moon, S. (2018). Green building evaluation system implementation. *Building and Environment*, *133*, 32-40.

Durdyev, S., & Ismail, S. (2019). Offsite manufacturing in the construction industry for productivity improvement. *Engineering Management Journal*, *31*(1), 35-46.

Gan, Y., Shen, L., Chen, J., Tam, V. W., Tan, Y., & Illankoon, I. (2017). Critical factors affecting the quality of industrialized building system projects in China. *Sustainability*, *9*(2), 216.

Gerbing, D. W., & Anderson, J. C. (1988). An updated paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research*, *25*(2), 186-192. https://doi.org/10.1177/002224378802500207

Ghanbari, J., & Zare, M. H. (2021). Review of Automation and Robotic in Advanced Construction Methods: A Case Study of Karaksa Hotel. *Journal of New Approaches in Civil Engineering*, *5*(2), 1-16. https://doi.org/10.30469/jnace.2021.139387

Ghanbari, J., Zare, M. H., & Safaei Jahromi, S. (2025). Developing a Novel Automated Construction Method for Façade Plastering Using Robotic Mechanism [Research Paper]. *International Journal of Architectural Engineering & Urban Planning*, *35*(2). https://doi.org/10.22068/ijaup.884

Ghoddousi, P., & Hosseini, M. R. (2012). A survey of the factors affecting the productivity of construction projects in Iran. *Technological and Economic Development of Economy*, *18*(1), 99-116. https://doi.org/10.3846/20294913.2012.659345

Golchin Rad, K., & Kim, S.-Y. (2018). Factors affecting construction labor productivity: Iran case study. *Iranian Journal of Science and Technology, Transactions of Civil Engineering*, *42*(2), 165-180. https://doi.org/10.1007/s40996-018-0094-1

Haller, M., Lu, W., Stehn, L., & Jansson, G. (2015). An indicator for superfluous iteration in offsite building design processes. *Architectural Engineering and Design Management*, *11*(5), 360-375.

Hashemi, A. (2015). *Offsite manufacturing: a survey on the current status and risks of offsite construction in Iran*

Hessari, P., Zandieh, M., & Mahmuodzadeh Kani, I. (2018). The significance of the priority of applying the parameters of sustainable development in combined cycle power plant design. *International Journal of Architectural Engineering & Urban Planning*, *28*(1), 105-115. https://doi.org/10.22068/ijaup.28.1.105

Hong, J., Shen, G. Q., Li, Z., Zhang, B., & Zhang, W. (2018). Barriers to promoting prefabricated construction in China: A cost–benefit analysis. *Journal of cleaner production*, *172*, 649-660. https://doi.org/10.1016/j.jclepro.2017.10.171.

Hosseini, M. R., Martek, I., Zavadskas, E. K., Aibinu, A. A., Arashpour, M., & Chileshe, N. (2018). Critical evaluation of off-site construction research: A Scientometric analysis. *Automation in Construction*, *87*, 235-247. https://doi.org/10.1016/j.autcon.2017.12.016

Jahanbakhsh, H. (2010). *Developing a model for planning and methodology of sustainable architecture in Iran* Iran University of Science & Technology].

Jiang, L., Li, Z., Li, L., Li, T., & Gao, Y. (2018). A framework of industrialized building assessment in China based on the structural equation model. *International Journal of Environmental Research and Public Health*, *15*(8), 1687.

Jin, X., Shen, G. Q., & Ekanayake, E. (2021). Improving construction industrialization practices from a socio-technical system perspective: A Hong Kong case. *International Journal of Environmental Research and Public Health*, *18*(17), 9017. https://doi.org/10.3390/ijerph18179017

Jöreskog, K. G., & Sörbom, D. (1993). LISREL 8: Structural equation modeling with the SIMPLIS command language. *Scientific Software International*.

Kamali, M., & Hewage, K. (2015). A framework for comparative evaluation of the life cycle sustainability of modular and conventional buildings. *Modular and Offsite Construction (MOC) Summit Proceedings*(150-157). https://doi.org/10.29173/mocs22

Kamali, M., & Hewage, K. (2016). Life cycle performance of modular buildings: A critical review. *Renewable and Sustainable Energy Reviews*, *62*, 1171-1183. https://doi.org/10.1016/j.rser.2016.05.031

Kenny, D. A., Kaniskan, B., & McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociological Methods & Research*, *44*(3), 486-507. https://doi.org/10.1177/0049124114543236

Larsson, J., Eriksson, P. E., Olofsson, T., & Simonsson, P. (2014). Industrialized construction in the Swedish infrastructure sector: core elements and barriers. *Construction Management and Economics*, *32*(1-2), 83-96.

Li, C. Z., Hong, J., Fan, C., Xu, X., & Shen, G. Q. (2018). Schedule delay analysis of prefabricated housing production: A hybrid dynamic approach. *Journal of Cleaner Production*, *195*, 1533-1545. https://doi.org/10.1016/j.jclepro.2018.05.134

Li, C. Z., Hong, J., Xue, F., Shen, G. Q., Xu, X., & Mok, M. K. (2016). Schedule risks in prefabrication housing production in Hong Kong: a social network analysis. *Journal of cleaner production*, *134*, 482-494.

Li, C. Z., Xu, X., Shen, G. Q., Fan, C., Li, X., & Hong, J. (2018). A model for simulating schedule risks in prefabrication housing production: A case study of six-day cycle assembly activities in Hong Kong. *Journal of cleaner production*, *185*, 366-381.

Li, C. Z., Zhong, R. Y., Xue, F., Xu, G., Chen, K., Huang, G. G., & Shen, G. Q. (2017). Integrating RFID and BIM technologies for mitigating risks and improving schedule performance of prefabricated house construction. *Journal of Cleaner Production*, *165*, 1048-1062. https://doi.org/10.1016/j.jclepro.2017.07.156

Li, L., Li, Z., Wu, G., & Li, X. (2018). Critical success factors for project planning and control in prefabrication housing production: A China study. *Sustainability*, *10*(3), 836.

Li, X., Wang, C., Alashwal, A., & Bora, S. (2020). Game analysis on prefabricated building evolution based on dynamic revenue risks in China. *Journal of Cleaner Production*, *267*, 121730. https://doi.org/10.1016/j.jclepro.2020.121730

Li, Y., Hwang, B., Shan, M., & Looi, K. (2019). *Developing a Knowledge-based Decision Support System for Prefabricated Prefinished Volumetric Construction* IOP Conference Series: Earth and Environmental Science.

Li, Z., Shen, G. Q., & Xue, X. (2014). Critical review of the research on the management of prefabricated construction. *Habitat international*, *43*, 240-249.

Liu, J., Gong, E., Wang, D., & Teng, Y. (2018). Cloud model-based safety performance evaluation of prefabricated building project in China. *Wireless Personal Communications*, *102*(4), 3021-3039. https://doi.org/10.1007/s11277-018-5323-3

Liu, J., & Zou, Z. (2021). *Application of BIM technology in prefabricated buildings* IOP Conference Series: Earth and Environmental Science.

Lu, W., Chen, K., Xue, F., & Pan, W. (2018). Searching for an optimal level of prefabrication in construction: An analytical framework. *Journal of Cleaner Production*, *201*, 236-245. https://doi.org/10.1016/j.jclepro.2018.07.319

Mahmmod Zadeh Kani, I., Lahour Pour, S., & Godini, J. (2017). Environmental Sustainability assessment of Industrial

Construction Technologies (Case study: In-Situ and Precast Concrete Construction Methods). *Amirkabir Journal of Civil Engineering*, *49*(3), 565-576. https://doi.org/10.22060/ceej.2016.11306.1011

Mao, C., Shen, Q., Pan, W., & Ye, K. (2015). Major barriers to off-site construction: the developer's perspective in China. *Journal of Management in Engineering*, *31*(3), 04014043.

Mao, C., Xie, F., Hou, L., Wu, P., Wang, J., & Wang, X. (2016). Cost analysis for sustainable off-site construction based on a multiple-case study in China. *Habitat International*, *57*, 215-222. https://doi.org/10.1016/j.habitatint.2016.08.002

Marzagão, D. S. L., & Carvalho, M. M. (2016). Critical success factors for Six Sigma projects. *International Journal of Project Management*, *34*(8), 1505-1518.

Nemati, M., Bemanian, M., & Ansari, M. (2017). A framework for sustainable architecture in Iran with emphasis on the views of scholars. *Journal of Building Performance*, *8*(1), 43-54.

Nemati, M., Bemanian, M., & Ansari, M. (2017). A framework for sustainable architecture in Iran with emphasis on the views of scholars. *Journal of Building Performance ISSN*, *8*(1), 2017.

Nemati, M. A., Bemanian, M. R., & Ansari, M. (2018). Factors of Environmental Assessment of Buildings in Residential Complexes, Using the Existing Building Performance Assessment Tools. *Honar-Ha-Ye-Ziba: Memary Va Shahrsazi*, *23*(1), 19-30. https://doi.org/10.22059/JFAUP.2018.238430.671765

Nunnally, J. C. (1975). Psychometric theory—25 years ago and now. *Educational Researcher*, *4*(10), 7-21. https://doi.org/10.2307/1175619

Pan, W., & Teng, Y. (2021). A systematic investigation into the methodological variables of embodied carbon assessment of buildings. *Renewable and Sustainable Energy Reviews*, *141*, 110840. https://doi.org/10.1016/j.rser.2021.110840

Ramezanpour, M. (2018). Affordability Principles in Low-Income Housing Based on Residents' Perspective (Case Study: Babolsar Mehr housing). *Journal of Housing and Rural Environment*, *37*(162), 43-56.

Rezaiean, A., & Hoseini, S. A. (2015). Selecting the Optimal Building System Using Multiple Criteria Decision Making Emphasising on Three Methods of TOPSIS, SAW, AHP. *Journal of Structural and Construction Engineering*, *2*(2), 16-27. https://doi.org/10.22065/jsce.2015.16911

Sadeghian, S., Nafezi, Y., Soltanmohammadlou, S., Kianfar, A., & Irvin, E. (2021). Study of Sustainable Development in Parks of North Tehran According to SDG11, Case Studies: Niyavaran and Qeytariyeh Parks. *International Journal of Architectural Engineering & Urban Planning*, *31*(2), 1-12. https://doi.org/10.22068/ijaup.31.2.553

Sanga, S. A. (2020). Compliance with Building Material Specifications among Informal Skilled Construction Workers in Dar es Salaam, Tanzania. *Journal of Construction in Developing Countries*, *25*(2), 47–69. https://doi.org/10.21315/jcdc2020.25.2.3

Shahpari, M., Saradj, F. M., Pishvaee, M. S., & Piri, S. (2020). Assessing the productivity of prefabricated and in-situ construction systems using hybrid multi-criteria decision making method. *Journal of Building Engineering*, *27*, 100979.

Shen, J., Krietemeyer, B., Bartosh, A., Gao, Z., & Zhang, J. (2021). Green Design Studio: A modular-based approach for high-performance building design. *Building Simulation*, *14*(6), 1731–1747. https://doi.org/10.1007/s12273-021-0775-y

Shen, L.-y., Tam, V. W., Tam, L., & Ji, Y.-b. (2010). Project feasibility study: the key to successful implementation of sustainable and socially responsible construction management practice. *Journal of Cleaner Production*, *18*(3), 254-259. https://doi.org/10.1016/j.jclepro.2009.10.014

Shurrab, J., Hussain, M., & Khan, M. (2019). Green and sustainable practices in the construction industry: a confirmatory factor analysis approach. *Engineering, Construction and Architectural Management*, *26*(6), 1150-1175. https://doi.org/10.1108/ecam-02-2018-0056

Singh, M. M., Sawhney, A., & Borrmann, A. (2015). Modular coordination and BIM: Development of rule based smart building components. *Procedia Engineering*, *123*, 519-527.

Solaimani, S., & Sedighi, M. (2020). Toward a holistic view on lean sustainable construction: a literature review. *Journal of Cleaner Production*, *248*, 119213. https://doi.org/10.1016/j.jclepro.2019.119213

Taasoobshirazi, G., & Wang, S. (2016). The performance of the SRMR, RMSEA, CFI, and TLI: An examination of sample size, path size, and degrees of freedom. *Journal of Applied Quantitative Methods*, *11*(3), 31-39.

Taghdiri, A., & Ghomi, S. G. (2016). Advantages of Prefabrication Construction in Comparison with Conventional Construction. *Journal of Architecture and Urbanism*, *8*(15), 15-28.

Taherkhani, R., & Saleh, A. (2019). Awareness and prevalence of Industrialized Building System (IBS) in Iran. *Jurnal Teknologi*, *81*(6).

Taherkhani, R., & Saleh, A. (2019). Awareness and prevalence of Industrialized Building System (IBS) in Iran. *journal of Technology*, *81*(6), 161–170. https://doi.org/10.11113/jt.v81.13840

Tam, V. W., Fung, I. W., Sing, M. C., & Ogunlana, S. O. (2015). Best practice of prefabrication implementation in the Hong Kong public and private sectors. *Journal of Cleaner Production*, *109*, 216-231. https://doi.org/10.1016/j.jclepro.2014.04.050

Wang, Q., Guo, Z., Mei, T., Li, Q., & Li, P. (2018). Labor crew workspace analysis for prefabricated assemblies' installation: A 4D-BIM-based approach. *Engineering, Construction and Architectural Management*, *25*(3), 389-411. https://doi.org/10.1108/ECAM-03-2017-0051

Wu, Z., Luo, L., Li, H., Wang, Y., Bi, G., & Antwi-Afari, M. F. (2021). An Analysis on Promoting Prefabrication Implementation in Construction Industry towards Sustainability. *International Journal of Environmental Research and Public Health*, *18*(21), 11493. https://doi.org/10.3390/ijerph182111493

Wuni, I. Y., & Shen, G. Q. (2019). Holistic review and conceptual framework for the drivers of offsite construction: A total interpretive structural modelling approach. *Buildings*, *9*(5), 117. https://doi.org/10.3390/buildings9050117

Xue, H., Zhang, S., Su, Y., & Wu, Z. (2017). Factors affecting the capital cost of prefabrication—A case study of China. *Sustainability*, *9*(9), 1512. https://doi.org/10.3390/su9091512

Xue, H., Zhang, S., Su, Y., & Wu, Z. (2018). Capital cost optimization for prefabrication: A factor analysis evaluation model. *Sustainability*, *10*(1), 159. https://doi.org/10.3390/su10010159

Yang, L.-R., Chen, J.-H., & Chang, S.-P. (2016). Testing a Framework for Evaluating Critical Success Factors of Projects. *Journal of Testing and Evaluation*, *44*(1), 19-30.

Yi, W., Phipps, R., & Wang, H. (2020). Sustainable ship loading planning for prefabricated products in the construction industry. *Sustainability*, *12*(21), 8905. https://doi.org/10.3390/su12218905

Yoo, M., Kim, J., & Choi, C. (2019). Effects of BIM-based construction of prefabricated steel framework from the perspective of SMEs. *Applied Sciences*, *9*(9), 1732. https://doi.org/10.3390/app9091732

Yuan, J., Chen, K., Li, W., Ji, C., Wang, Z., & Skibniewski, M. J. (2018). Social network analysis for social risks of construction projects in high-density urban areas in China. *Journal of Cleaner Production*, *198*, 940-961. https://doi.org/10.1016/j.jclepro.2018.07.109

Zhang, J., Long, Y., Lv, S., & Xiang, Y. (2016). BIM-enabled modular and industrialized construction in China. *Procedia engineering*, *145*, 1456-1461.

Zhang, L., Chen, L., Wu, Z., Zhang, S., & Song, H. (2018). Investigating young consumers' purchasing intention of green housing in China. *Sustainability*, *10*(4), 1044. https://doi.org/10.3390/su10041044

Zhang, W., Lee, M. W., Jaillon, L., & Poon, C.-S. (2018). The hindrance to using prefabrication in Hong Kong's building industry. *Journal of Cleaner Production*, *204*, 70-81. https://doi.org/10.1016/j.jclepro.2018.08.190

Zhang, X., Skitmore, M., & Peng, Y. (2014). Exploring the challenges to industrialized residential building in China. *Habitat International*, *41*, 176-184.

Zhu, J., Shi, Q., Wu, P., Sheng, Z., & Wang, X. (2018). Complexity analysis of prefabrication contractors' dynamic price competition in mega projects with different competition strategies. *Complexity*. https://doi.org/10.1155/2018/7619370

AUTHOR (S) BIOSKETCHES

M .A. Nemati., *Department of Architecture, Firouzabad Higher Education Center, Shiraz University of Technology, Shiraz, Iran*

Email: Nemati@fabad-ihe.ac.ir

J. Ghanbari., *Department of Architecture, Shiraz University, Shiraz, Iran*

Email: J.Ghanbari@shirazu.ac.ir

M.H. Zare., *Department of Architecture, Shiraz University, Shiraz, Iran*

Email: mh.zare@shirazu.ac.ir

HOW TO CITE THIS ARTICLE

Nemati, M A., Ghanbari, J., Zare, M.H. (2026). Factors Affecting the Application of Prefabrication in Construction Projects: A Sustainability Approach in Iran. *Int. J. Architect. Eng. Urban Plan*, 36(2): 1-24, https://dx.doi.org/10.22068/ijaup.720

URL: http://ijaup.iust.ac.ir