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DECISION-MAKING IN SELECTING PRIVATE HOUSING PROJECT IMPLEMENTATION DELIVERY BASED ON CONTRACTOR PRODUCTIVITY MANAGEMENT: AN AHP AND BSC APPROACH

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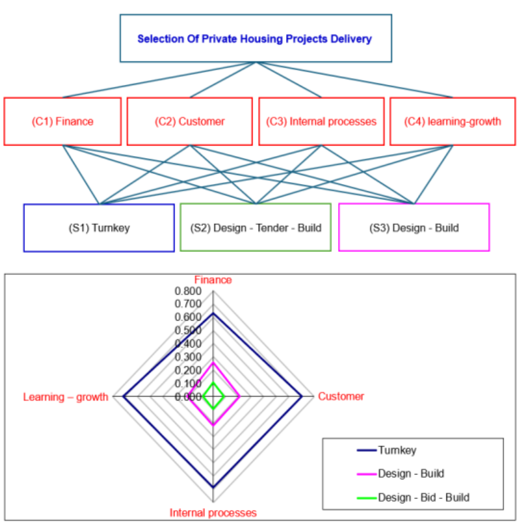
Graphical abstract



Abstract

Selecting the correct delivery method is crucial for private housing projects, as it directly affects contractor productivity and overall project success. While various approaches exist, a structured decision-support model that integrates multiple evaluation criteria is still lacking. This study fills that gap using the Analytic Hierarchy Process (AHP) and Balanced Scorecard (BSC) frameworks to assess three standard delivery methods: Turnkey, Design - Tender - Build, and Design - Build. By analysing financial performance, customer satisfaction, internal processes, and learning and growth, the research identifies Turnkey as the most effective approach for maximizing contractor productivity. It offers clear selection guidelines for project owners, helping them make informed, data-driven decisions. However, the findings are context-dependent, as project-specific factors may influence the optimal choice. This study contributes to construction management research by integrating AHP and BSC into a unified model for selecting project delivery methods. Unlike prior studies focusing on isolated aspects, it provides a comprehensive perspective on contractor productivity. The findings hold practical value for project owners, construction managers, and policymakers, offering a systematic approach to enhance decision-making, increase efficiency, and support sustainable development in the construction industry.

Keywords: Analytical Hierarchical Process; Balanced Scorecard; Contractor Productivity Management; Project Implementation Delivery; Private Housing Project

1.0 INTRODUCTION

The construction industry is a cornerstone of global economic development, serving as a vital sector that influences and drives various other industries [1, 2]. As a fundamental component of the economy, construction facilitates the exchange of goods and services, promoting growth and progress within a country [3, 4]. The industry's productivity, particularly that of contractors, is crucial in this process, contributing to cost savings and revenue increases. This benefits the broader economy due to the interlinked nature of construction with other sectors. However, enhancing and maintaining productivity remains a significant challenge, necessitating implementing complex and essential measures [5, 6].

Decision-making in construction project implementation is critical to project success, helping to anticipate potential risks and mitigate the damage caused by delays [7]. Effective decision-making involves selecting the most suitable alternative among various choices, a process often complicated by the multitude of decision-making challenges faced by industry professionals [8]. The Balanced Scorecard (BSC), with its four perspectives—finance, customer, internal business processes, and learning and growth—has been strongly associated with productivity and quality management in construction projects. Integrating the BSC with the Analytic Hierarchy Process (AHP) provides a robust framework for evaluating and selecting the optimal delivery method for construction projects.

This study aims to address a gap in the literature by focusing on selecting delivery methods for private housing projects based on contractor productivity. Utilizing the AHP and BSC analyses, the research evaluates various delivery methods for their effectiveness and efficiency in achieving high productivity levels. Previous studies have explored aspects such as public-private partnerships [9], progressive design-build challenges [10], and labor productivity trends [11], but there is a notable gap in applying these frameworks to private housing projects.

The integration of AHP and BSC offers a comprehensive approach to decision-making. AHP assists in structuring complex decision problems, allowing for a systematic comparison of alternatives based on multiple criteria [12-14]. This method has been successfully applied in various construction-related scenarios, such as equipment selection [15] and performance evaluation [16]. Conversely, the BSC framework provides a balanced view of organizational performance, incorporating both financial and non-financial metrics, and has been widely implemented in industries, including construction [17, 18].

This research is significant for several reasons. Firstly, it fills a critical gap by focusing on private housing projects, an area not extensively studied regarding delivery method selection based on contractor productivity. Secondly, it offers a structured decision-making framework combining AHP and BSC, providing a practical tool for project owners and managers. The findings have the potential to enhance project outcomes and ensure successful delivery by guiding stakeholders in selecting the most suitable implementation approach. In conclusion, this study aims to provide comprehensive guidelines for selecting the most appropriate delivery methods for private housing projects based on contractor productivity. By leveraging AHP and BSC analyses, the research addresses existing gaps and offers valuable contributions to various stakeholders in the construction industry, fostering improved project outcomes and economic benefits.

1.1 The Balanced Scorecard (BSC)

Since the 1930s, quality management has been a top priority amid global competition and economic crises [19]. Early models like the Deming Prize (DP) and Malcolm Baldrige National Quality Award (MBNQA) were instrumental in advancing Total Quality Management (TQM) [20]. The BSC, introduced by Kaplan and Norton in 1992, revolutionized performance measurement and strategic management [17, 21]. Initially focused on performance metrics, the BSC evolved into a comprehensive strategic management system [17, 22, 23].

The BSC encompasses four perspectives: finance, customer, internal processes, and learning-growth, providing a holistic view of organizational performance [24]. This framework balances short-term and long-term goals, internal and external factors, and financial and non-financial metrics [25]. BSC's effectiveness lies in aligning vision and strategy with tangible objectives and performance indicators [18].

Although widely used in SMEs, research on BSC in these enterprises remains limited [18, 26]. Effective BSC implementation fosters strategic alignment and performance improvements, while poor management control can lead to conflicts [27, 28]. However, creating and applying a BSC demands significant time and resources, posing a challenge for organizations [29].

1.2 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) was developed by Saaty (1980) specifically to address decision-making issues in situations involving multiple criteria and complexities [12, 13, 30]. AHP simplifies decision-making by analyzing interconnected criteria and prioritizing them based on the goal [15].

Consider the importance of each decision criterion and make trade-offs. AHP involves three steps: (1) a hierarchy is formed with the decision goal at the top and subsequent lower levels representing the breakdown of decision criteria, sub-criteria, and alternatives to reach the goal. (2) Domain experts are then asked to complete pairwise comparisons of each element at each level of the hierarchy, using a nine-point scale, to determine the relative importance of criteria and alternatives. (3) Expert judgments are necessary to verify consistency as AHP allows for subjective judgments, ensuring that each criterion and alternative's importance is accurately determined about the decision goal [31].

Table 1 AHP pairwise comparison scale [12].

Weight	Definition
1	Equal importance
3	Weak importance of one over the other
5	Essential or strong importance
7	Extreme importance
9	Absolute importance
2,4,6,8	Intermediate values between the two adjacent judgments
Reciprocals of previous values	If factor 'i' has one of the previously mentioned numbers assigned to it when compared to factor 'j', then j has the reciprocal value compared to i.

The premises of the constructed AHP include Premise 1-Reversible comparison: The comparison and evaluation of decision-makers must ensure reversible conditions. If A is more important than B * times, B is 1/x times more important than A; Premise 2-Uniformity: the evaluation of decision-makers must be based on a fixed and limited scale; Premise 3-Independence: When decision-makers consider a specific indicator, it is independent of other hands; Premise 4-The structure of the analysis tree must be complete for easy decision-making.

Suppose a decision problem (called a goal) must be evaluated based on multiple criteria (Criterion *C1*, Criterion *C2*,..., Criterion *Cn*). The options included in the comparison are *PA1, PA2*,... *PAm*. The problems are modeled in Figure 1.

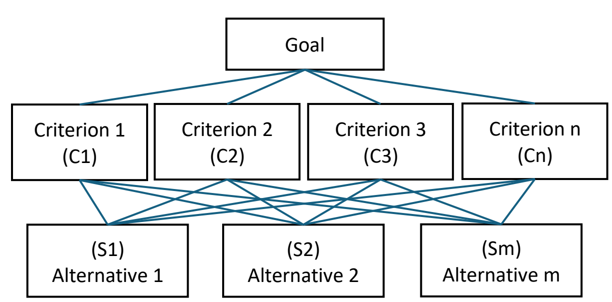


Figure 1 Analytical Hierarchical Process Model

1.3 Private Housing Project

A private housing project refers to the development or construction of residential properties that are privately owned and operated. These projects typically involve the creation of single-family homes, townhouses, apartments, or condominiums for individuals or families to purchase or rent [32, 33].

The selection of private housing project implementation delivery method has been referred to by many authors in their research [9, 34-36]. The authors place the implementation of the private housing project in the general context of the projects without a separate commission for the private housing project.

1.4 Contractor Selection (CS)

A contractor in construction is an organization, or sometimes a person, hired by a customer to perform one job or multiple jobs to complete a project [37]. A Construction Contractor is an individual or entity that takes on, proposes to take on, or claims the ability to take on tasks related to or submits a bid for, constructing, modifying, repairing, expanding, reducing, enhancing, relocating, demolishing, or otherwise altering any building, road, railway, excavation, or other structures, projects, developments, or improvements to real estate. This includes performing these tasks directly or through others. "Construction Contractors" encompasses subcontractors, speciality contractors, prime contractors, and anyone compensated for a construction project's overall management and coordination, except those involved in remediation contracting. This definition applies regardless of whether the contractor acts under a formal contract [38].

Depending on their roles and positions in the project, the responsibilities of contractors also vary, with the leading role being the general or the main contractor. In a study on contractor classification, when investors select construction contractors, many criteria are given for evaluation [39]. The criteria for choosing the first contractor of the construction investor are the ability to complete the project on time, complete it within the cost budget, and meet acceptable quality [39].

The contractor establishes the connection between the investor and the general contractor or between the general contractor and subcontractors [40]; Construction project management often employs various contract methods. These include Design-Tender-Build, using multiple prime contractors, improved traditional methods, Design-Build, a variation called Bridging (Document-Build), and Turnkey contracts. Project delivery methods differ in structure, responsibility allocation, and risk management. Design-Bid-Build follows a linear process, with separate contracts for design and construction. Multiple prime contractors involve various contracts, increasing coordination complexity. Improved Traditional refines traditional methods for efficiency. Design-Build integrates design and construction under one contract. Bridging (Document-Build) combines owner-led preliminary design with a Design-Build contract. Turnkey offers a fully completed project, minimizing owner involvement [10, 41-43]. Today's modern contractors prioritize extensive communication with stakeholders, as effective engagement with critical parties is crucial for their long-term success [44].

The tendering phase involves making precise decisions, particularly when selecting a potential contractor for construction projects [45, 46]. This choice hinges on various aspects, including technical, social, commercial, environmental, and economic competencies. The involvement of these multiple characteristics adds significant complexity to the process. Consequently, selecting the most suitable construction contractor has been debated and researched for many years. Additionally, the construction industry's current diversity and dynamic nature lead clients to have exceedingly high expectations, further complicating the CS process [47].

The selection of a contractor for construction projects is influenced by numerous factors, presenting challenges for the client and their team. Previous CS models have ranked the criteria in decreasing order of importance, which includes experience and past performance, personnel capability, financial stability, health and safety considerations, management skills, equipment capability, quality, reputation of the firm, current workload, contractor relationships, technology, organizational structure of the firm, familiarity with similar geographical locations, history of time and cost overruns in previous projects, interview performance, and accessibility to subcontractors. Many earlier models fail to consider the importance and impact of these criteria comprehensively. It is unrealistic to expect a client to assess competitors' performance based on limited criteria accurately [45-47].

1.5 Contractor Productivity Management (CPM)

Construction productivity represents the ratio of the efficiency of the functional unit of work to the utilization of input resources such as labor, equipment, and materials [48]. In construction, like other manufacturing industries, efficient work consumes fewer inputs and achieves high productivity [49]. A higher construction yield rate leads to more benefits for the project's cost and duration because fewer input resources are used [49] cited by [48]. Companies will increase their competitive advantage if their productivity is high [50]. Productivity management helps to increase the competitiveness of businesses and customer confidence [51] and support the growth goals of enterprises; due to the scale of the contribution of the construction industry to the economies of countries, construction industry productivity has a significant impact on other sectors [11]. Also, productivity is defined in many ways [52].

Unlike labor productivity, productivity is better understood as a quantity of change throughout an activity [52]. Another model that may be relevant to productivity management is the European Foundation for Quality Management (EFQM) model created in 1991, which is made up of nine elements grouped according to five enabling criteria and four outcome criteria [53] and [25]. However, the disadvantage of EFQM is that it can be complex and challenging to implement, which may be less relevant in specific contexts such as small businesses, and it tends to be bureaucratic [55].

1.6 Contractor Selection Criteria Based On BSC's Four Perspectives

This study uses the BSC framework to create a more structured way of selecting private housing contractors. It considers four perspectives: Finance, Customer, Internal Processes, and Learning and Growth. Financial stability ensures contractors manage costs effectively, while customer satisfaction reflects their reputation and reliability. Internal processes focus on efficiency in project execution, covering areas like quality control and resource management. Meanwhile, learning and growth assess a contractor's ability to innovate, train employees, and adapt to industry changes. The study offers a well-rounded approach to making better contractor selection decisions [56].

From the financial perspective, critical criteria include cost-effectiveness, profitability, financial stability, and return on investment [57-60]. Customer perspective criteria encompass customer satisfaction, reputation, responsiveness, and communication [58, 61-64]. The Internal Processes Perspective emphasizes project management, quality control, timeliness, and resource management [64-67]. Finally, the Learning and Growth Perspective considers Employee skills and expertise, Innovation and adaptability, Safety culture, and Sustainability practices [64, 67, 68]. These criteria aid in selecting the most suitable delivery method for private housing projects, factoring in project complexity, cost, schedule, and owner preferences [56]. It is crucial to evaluate these criteria meticulously to ensure alignment with project needs and objectives

2.0 METHODOLOGY

In this study, the sequence of studies is depicted in Figure 2

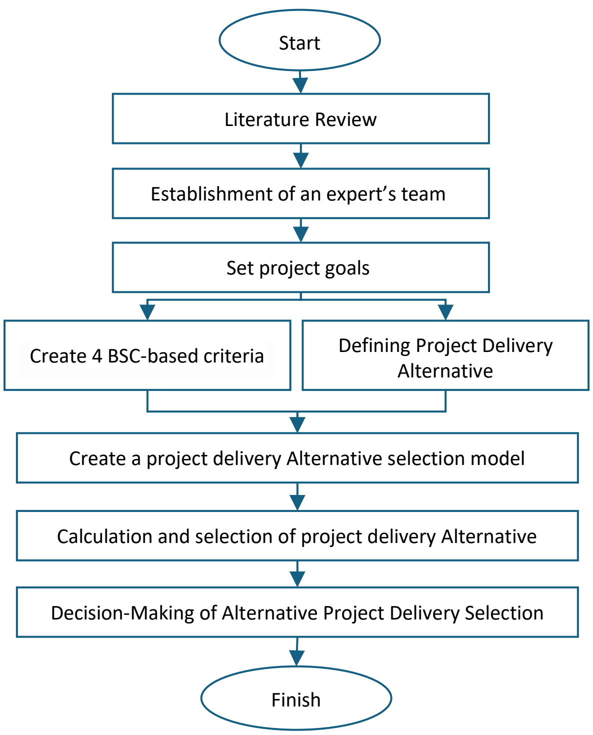


Figure 2 Flowchart of the Research Methodology

Establishing an expert team is essential for selecting the correct assessment to determine the most suitable project delivery alternative. Experts play a crucial role in defining screening criteria, choosing options, and prioritizing criteria through pairwise comparison. Each alternative is evaluated as a "pass" or "fail" based on preliminary screening criteria, with unsuccessful options disqualified. If multiple alternatives remain, the expert team develops a model for selection, incorporating relevant alternatives and criteria. An alternative delivery method is then identified for the private housing project. Five experts were chosen from a pool of 24 candidates; they have more than 20 years of experience in private housing construction in Vietnam, comprising 40% former private housing investors, 40% private housing construction contractors, and the remaining with experience in construction design consulting. They will respond by checking the questionnaire sent to them.

Hierarchical analysis is performed through the following steps:

Step 1: Determine priority for criteria. For the *n* criteria shown in Figure 1, a square matrix of degree *n* is created. The criteria are then compared in pairs, and priority values are assigned in the table (*aij* values, with *i* running in rows and *j* in columns). The pairwise priorities are referenced from Table 1, which contains positive integer values from 1 to 9 or their reciprocals. Each pair of criteria requires two priority values, depending on the comparison order. For example, if criterion *C1* has a priority of 1/3 compared to *C3*, then *C3* will have a priority three times that of *C1*. In the corresponding row for *C1* and column *C3*, the value 1/3 is recorded, while in row *C3* and column *C1*, the value three is assigned, as shown in Table 2. The qualitative meaning of each priority level used in these pairwise comparisons is summarised in Table 3.

Table 2 The metric matrix determines the priority for the criteria

	C1	C2	C3	…	Cn
C1	1(a_{11})	1(a_{12})	1/3(a_{13})		1/7(a_{1n})
C2	1(a_{21})	1(a_{22})	1/5(a_{23})		1/5(a_{2n})
C3	3(a_{31})	5(a_{32})	1(a_{33})		1(a_{3n})
…	…	…	…		…
Cn	7(a_{n1})	5(a_{n2})	1(a_{n3})		1(a_{nn})

Suppose a group of *n* criteria to be compared; the result of pairing comparison between the criteria in the group form a square matrix of degree *n* × *n*, called a symmetric matrix with elements $a_{i,j} = 1/a_{j,i}$ $(i, j = 1, n)$; $a_{i,j} = 1$ when $i = j$. The element $a_{i,j}$ is the arithmetic average of the evaluation results of experts. The matrix can be seen on the diagonal inverse of symmetry from left to right.

Table 3 Evaluate criteria in pairs based on priority. [12]

Priority	Numerical value
Equal priority	1
Equal to moderate priority	2
Moderate priority	3
Moderate to slightly preferred	4
Slightly more preferred	5
Slightly more preferred to significantly prioritized	6
Very preferred	7
Very priority to extremely priority	8
Extremely priority	9

Step 2: Calculating the weight for the criteria; after making the above matrix, the evaluator will calculate the weight for the criteria by adding the sum of the values of the matrix by column and then dividing each value of the matrix by the sum of the corresponding column; the obtained value is instead of the calculated value. The weights assigned to each criterion are *C1, C2, C3,* and so on. The corresponding *Cn* will equal the average of the values in each horizontal row. As a result, have a matrix of 1 column *n* rows.

From the matrix, calculating weighted vector component values $W = [w_{i,j}]_{n*m}$ used on the formula [12]:

$$w_{i,j} = \frac{a_{i,j}}{\sum_{i=1}^{n} a_{i,j}} (i = \overline{1,n}; j = \overline{1,n}) \quad (1)$$

Table 4 Weighted metric matrix for criteria

	C1	C2	C3	…	Cn	Weighting
C1	w_{11}	w_{12}	w_{13}		w_{1n}	w_1
C2	w_{21}	w_{22}	w_{23}		w_{2n}	w_2
C3	w_{31}	w_{32}	w_{33}		w_{3n}	w_3
…	…	…	…		…	…
Cn	w_{n1}	w_{n2}	w_{n3}		w_{nn}	w_n

From the *W* matrix, calculate the weighted vector component value w_j using the following formula:

$$w_j = \frac{\sum_{i=1}^{n} w_{i,j}}{n} \left(j = \overline{1,n}\right) \quad (2)$$

w_j is the weighted score of criterion j and $\sum_{j=1}^{n} w_{i,j} = 1$

Use consistent ratios to check the consistency of expert evaluation, ensuring scientific evaluation. The consistency ratio (*CR*) is determined as follows:

$$CR = \frac{CI}{RI} \quad (3)$$

With: $$\mathrm{CI}\ (consistency\ index) = \frac{\lambda_{max} - n}{n-1} \quad (4)$$

λ_{max} is the eigenvalue of the comparison matrix (eigenvalue), calculated as follows:

$$\lambda_{max} = \sum_{i=1}^{n} \left(w_i * \sum_{j=1}^{n} a_{i,j}\right) \quad (5)$$

n is the number of elements compared in pairs in a single calculation, which is the size of the computational matrix. - *RI* is a random index determined from a given numeric table (Table 4).

Table 5 The random index corresponding to the number of selection criteria considered [14]

n	1	2	3	4	5	6	7	8
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41
n	9	10	11	12	13	14	15	
RI	1.45	1.49	1.51	1.54	1.56	1.57	1.59	

In any case, CR needs 10% at most. For 3*3 size matrices, CR needs to be no greater than 5%, and the corresponding value for 4 × 4 size matrices is 9%. If the *CR* exceeds the mentioned levels, it indicates an inconsistency in the expert's assessment and needs to be evaluated and recalculated [14].

*Step 3: Calculate the priority of options according to each criterion***.** The calculation for each criterion is the same as in Steps 1 and 2. Still, the data in the evaluation compares the priority of the options considered according to each criterion, performing n matrices for n different criteria. As a result, there are n matrices of 1 column m rows. Conducting consistent score testing is necessary to ensure the results are appropriately reliable.

Step 4: Scoring and Selecting the Best Option: This is the final step in evaluating and developing a project delivery plan. First, the *n* matrices (each with 1 column and *m* rows) from Step 3 are combined into a single matrix with *m* rows and *n* columns. This combined matrix is then multiplied by the 1-column, *n*-row matrix obtained in Step 2. The final output is a 1-column, *m*-row matrix, where each row represents a project delivery option. The option with the highest score is identified as the most suitable choice.

In this study, seven alternatives of project delivery were given to the expert group: Self-implementation, Design - Bidding - Build, Using Multiple Prime Contractors, Improved traditional, Design-Build, Bridging, a variant of Design-Build (Document - Build), and Turnkey. As a result, experts select three official alternatives to build models: Design - Bidding - Build, Design - Build, and Turnkey.

The selection criteria developed at one level according to BSC include *C1*: Finance, *C2*: Customer, *C3*: Internal processes, and *C4*: learning-growth.

Research model of Selection of private housing project delivery options based on contractor productivity using the AHP and BSC approach presented in Figure 3.

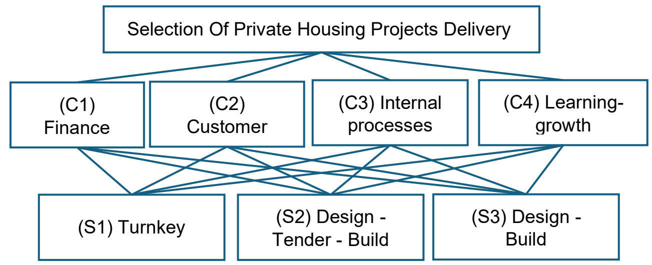


Figure 3 The study model

3.0 RESULTS AND DISCUSSION

In this study, experts' opinion was applied to an example of choosing the method of implementation delivery of a project to build a small-town villa; the analysis results are presented below:

Table 6 Comparison table of criteria pairs

	C1	C2	C3	C4	Calculate $w_{i,j}$ for each group			Weighting
C1	1	2.00	3.00	7.000	0.56	0.50	0.462	0.513
C2	0.500	1	2.00	2.000	0.23	0.20	0.308	0.244
C3	0.333	0.50	1	2.000	0.19	0.15	0.154	0.154
C4	0.143	0.50	0.50	1	0.02	0.15	0.077	0.089
Total	1.976	4.00	6.50	12.00	1	1	1	1

and: Consistency = 2%. λ=4.0613; CI=0.0204; CI/RI=0.02270

Table 7 The resulting calculation table compares pairs of methods against the criterion

Finance	**S1**	**S2**	**S3**	**Calculate $w_{i,j}$ for each group**			**Weighting**
S1	1	3.00	5.000	0.62	0.62	0.56	0.633
S2	0.33	1	3.000	0.27	0.21	0.33	0.260
S3	0.20	0.33	1	0.10	0.07	0.11	0.106
Total	1.53	4.33	9.000	1	1	1	1
and: Consistency = 5%. λ=3.0553; CI=0.0277; CI/RI=0.0477							
Customer	**S1**	**S2**	**S3**	**Calculate $w_{i,j}$ for each group**			**Weighting**
S1	1	4.000	7.000	0.718	0.750	0.636	0.701
S2	0.250	1	3.000	0.179	0.188	0.273	0.213
S3	0.143	0.333	1	0.103	0.063	0.091	0.085
Total	1.393	5.333	11.000	1	1	1	1
and: Consistency = 5%. λ=3.0528; CI=0.0264; CI/RI=0.0455							
Internal processes	**S1**	**S2**	**S3**	**Calculate $w_{i,j}$ for each group**			**Weighting**
S1	1	4.000	6.000	0.706	0.750	0.600	0.685
S2	0.250	1	3.000	0.176	0.188	0.300	0.221
S3	0.167	0.333	1	0.118	0.063	0.100	0.093
Total	1.417	5.333	10.000	1	1	1	1

and: Consistency = 7%. λ=3.0850; CI=0.0425; CI/RI=0.0733							
Learn – growth	**S1**	**S2**	**S3**	**Calculate $w_{i,j}$ for each group**			**Weighting**
S1	1	4.000	8.000	0.727	0.750	0.667	0.715
S2	0.250	1	3.000	0.182	0.188	0.250	0.206
S3	0.125	0.333	1	0.091	0.063	0.083	0.079
Total	1.375	5.333	12.000	1	1	1	1
and: Consistency = 3%. λ=3.0153; CI=0.0264; CI/RI=0.0264							

After calculating the weights, get the set made in Table 8.

Table 8 Summary table of comparisons between alternatives

Summary	**Finance**		**Customer**		**Internal processes**		**Learn – growth**		**Final Score**
	Weighting	Score	Weighting	Score	Weighting	Score	Weighting	Score	
Turnkey	0.513	0.633	0.244	0.701	0.154	0.685	0.089	0.715	**0.665**
Design - Build	0.513	0.260	0.244	0.213	0.154	0.221	0.089	0.206	**0.238**
Design - Tender - Build	0.513	0.106	0.244	0.085	0.154	0.093	0.089	0.079	**0.097**

The Turnkey method selects the best approach for private housing projects based on contractor productivity.

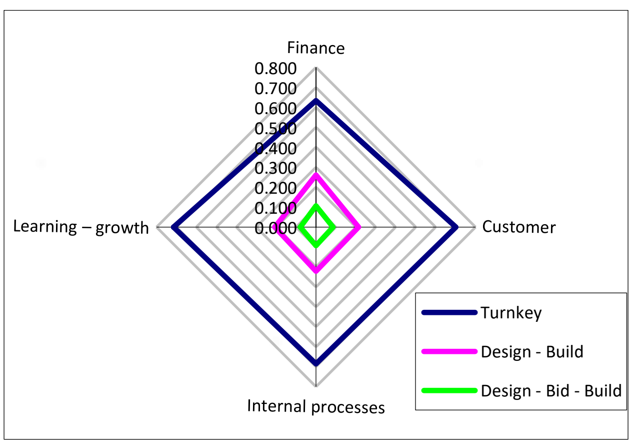


Figure 4 Reflection chart Summary table of comparisons among alternatives

The study's results, especially from Tables 6–8 and Figure 4, offer essential information about how each evaluation criterion affects the choice of project delivery methods. The financial perspective holds the highest weight, highlighting the critical role of cost-effectiveness and profitability in contractor productivity. Customer satisfaction, while also significant, ranks slightly lower, suggesting that while reputation and service quality are essential, they are secondary to financial stability. Internal processes, learning, and growth have the least influence, indicating that project owners prioritize short-term efficiency and cost control over long-term innovation. The comparison of the three delivery methods shows that the turnkey approach consistently scores highest across all criteria. This reinforces its suitability for private housing projects, providing streamlined execution, reduced risk for owners, and improved financial control. Despite its flexibility, Design-Build ranks lower due to challenges in balancing cost and efficiency. Design-Tender-Build scores the lowest, reflecting its inefficiencies and more significant risks related to budget and scheduling. These findings suggest that people making decisions should use a straightforward, organized method that considers different factors when choosing delivery methods. This will help ensure that their choices match project goals and current market conditions, leading to better productivity and success.

Integrating AHP and BSC has led to the selection of the Turnkey methodology as the optimal approach for implementing private housing projects based on contractor productivity. This combination offers a structured and practical framework for evaluating and selecting contractors, ensuring that productivity metrics are thoroughly assessed to enhance overall project success. The turnkey approach aligns well with industry demands for efficiency, cost-effectiveness, and streamlined project management, making it increasingly favored in private housing developments.

The BSC allows project owners to evaluate contractors across multiple dimensions, including finance, customer satisfaction, internal processes, and learning and growth. This holistic approach provides a well-rounded view of each contractor's capabilities, facilitating an informed and equitable selection process. This method ensures that private housing projects meet regulatory and quality benchmarks by aligning contractor evaluation with existing industry standards, such as guidelines from construction development boards and technical agencies. The local building authorities have assessment systems focusing on productivity, cost management, and environmental sustainability. The suggested method includes these critical factors.

The AHP enhances decision-making by offering a structured approach to prioritizing evaluation criteria. AHP uses side-by-side comparisons to fairly weigh factors like financial performance, customer satisfaction, internal efficiency, and innovation potential. This helps project owners choose contractors based on current best practices. This structured prioritization process is particularly relevant in regions where standardized evaluation models are still evolving, allowing for a more data-driven and transparent selection approach.

Implementing the turnkey method, supported by BSC and AHP, enables project owners to select contractors that best align with project objectives and productivity requirements. This organized method helps fit easily into current industry practices by using existing evaluation principles and improving transparency, efficiency, and accountability. This method can be used for more than just one project. It provides a way for policymakers, industry regulators, and professional groups to create consistent evaluations for contractors and enhance performance in the private housing sector.

For stakeholders, this study provides several recommendations. Project owners should combine the turnkey method with AHP and BSC to assess contractors' performance. This will help ensure their work meets quality standards and stays within budget. Training and development programs should be enhanced to equip decision-makers with the skills to implement these methodologies effectively. Contractors are encouraged to improve their internal processes, prioritize sustainability, and adopt digital project management tools, aligning with current industry trends in innovative construction and performance benchmarking. Researchers should study how well AHP and BSC can work in different project settings. They should examine how digital tools, automation, and AI analysis can improve evaluation methods. Policymakers and industry regulators should promote the use of comprehensive frameworks like AHP and BSC by creating official guidelines and certification programs. This will help standardize and integrate practices across the private housing sector.

This integrated approach enhances efficiency and cost-effectiveness and strengthens the regulatory framework for contractor selection, making it more transparent and reliable. The suggested method follows current industry standards and changing rules, providing beneficial advantages for construction boards, technical agencies, and project participants. This helps improve the quality of construction and makes the industry more competitive.

4.0 CONCLUSION

This study concludes that the Turnkey approach is the most effective method for private housing projects, as assessed by industry experts in Vietnam and determined through AHP and BSC analyses focusing on contractor productivity. This conclusion is grounded in a comprehensive criteria evaluation, including finance, customer satisfaction, internal processes, and learning and growth. The Turnkey method ensures optimal productivity throughout the construction phase by providing a systematic and competitive process for selecting the most suitable contractor. The findings of this study are valuable for project owners, offering guidance in choosing the most effective approach for their private housing projects, which can lead to successful outcomes and meet desired objectives.

Moreover, this research addresses existing gaps in the literature by emphasizing the importance of contractor productivity in the selection process. It also aims to shift public perception regarding contractor selection for private projects, highlighting the need for structured decision-making frameworks prioritizing productivity and overall project success.

Despite its contributions, this study has several limitations. The use of the turnkey method with BSC and AHP can differ in private housing projects because of variations in project size, difficulty, and local building rules. The results come from a specific project and may not apply to other private housing types, like significant apartment buildings or buildings that combine different uses. Using these methods takes a lot of time, knowledge, and money, which can be difficult for project owners who don't have access to advanced tools or who are working with tight budgets. Another limitation is the limited number of experts consulted, which may affect the generalizability of the findings. The study relied on a small expert panel, which, while experienced, may not fully capture the diverse perspectives of industry professionals across different regions. Furthermore, the research was conducted exclusively in Vietnam, meaning the conclusions may not fully reflect the challenges and best practices of other countries with different regulatory environments and construction industry structures. Future research should explore the adaptability of AHP and BSC across diverse project environments, including low-cost housing developments, high-rise residential projects, and large-scale urban planning initiatives. Investigating how project size, complexity, and financial constraints influence the effectiveness of these decision-making models could help refine their practical application. Adding more evaluation tools, like sustainability measures, digital project management tools, and risk assessment methods, could strengthen the model and make it more adaptable for different industries. Expanding the study to multiple countries and engaging a broader range of experts could also improve the robustness of the findings. By addressing these areas, future studies can expand the applicability of this approach, ensuring that it remains relevant and flexible to the evolving needs of the construction sector.

In conclusion, integrating AHP and BSC with the Turnkey methodology offers a well-structured and reliable approach for contractor selection based on productivity. This methodology promotes efficiency and cost-effectiveness and enhances the overall success of private housing construction projects, providing crucial insights for project owners and fostering improved practices within the industry.

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Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper

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