

The Integration of Aesthetics, Cost Efficiency, and Buildability in Construction Projects: A Case Study of the Kotabaru Creative Hub

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ABSTRACT

This study examines the dynamics of integrating aesthetics, cost efficiency, and Buildability in building design through the analytical approaches of Function Effectiveness, Semantic Differential (SD), and Analytical Hierarchy Process (AHP). The research employed two types of questionnaires: a Likert scale-based questionnaire to capture respondents' perceptions of the indicators, which were then analyzed using the Function Effectiveness and SD methods, and a dedicated AHP questionnaire to determine the priority of criteria and sub-criteria in decision-making. The results of the Function Effectiveness analysis indicated that all tested indicators fall within the "moderate" category in supporting the design function of buildings. The SD test revealed that the texture and material indicators are the primary aspects influencing design considerations, consistently ranking in the top three. Meanwhile, the AHP results showed that Buildability holds the highest priority as the main criterion in design decisions, followed by aesthetic dimension and lastly cost efficiency. These findings demonstrate the dynamic prioritization among the three aspects, where functionality and ease of construction are emphasized, without entirely neglecting the value of

aesthetics and cost efficiency in building design decisions.

Keywords: *Aesthetics, AHP, Buildability, Function Effectiveness, Semantic Differential*

INTRODUCTION

The integration of aesthetics within the disciplined framework of construction project management presents a central and often contentious dilemma in modern development. On one hand, aesthetics function as a significant value-add, capable of enhancing the visual quality of a building, attracting users, and strengthening a project's public image (Aftab et al, 2014). Product design is a source of competitive advantage for companies and is an important driver of company performance. Beyond commercial benefits, it can also foster more comfortable and inspiring environments, which positively impact on occupant satisfaction with the workplace and occupant perceived health, well-being, and productivity.

Conversely, a strong focus on aesthetics is frequently perceived as a hindrance to the practicalities of project management. Aesthetics is concerned with the knowledge and affects related to sensory experience and corporeality. The pursuit of ambitious aesthetic goals can potentially lead to view of barriers, management barriers is high

consideration and the biggest challenges is higher cost and unfamiliarity with the technologies. Project managers are often caught in a difficult conflict between maintaining project efficiency in terms of cost and time, and satisfying the demanding aesthetic standards set forth by architects and clients (Alhammadi et al, 2020). This tension becomes most acute when aesthetic designs necessitate the use of materials or construction technologies that are inherently more expensive or complex to implement.

The conflict will escalate even further when casualties are involved by the differing priorities of the core disciplines involved. Form and shape are fundamental elements of aesthetics in architecture since they define the structure's overall appearance and identity. Every design element, from shape to proportion, color and texture, works together to form the building's visual identity. In contrast, civil engineers use materials efficiently and adhere to safety standards to provide stability and durability. Disputes arise when an architect's innovative and artistic ideas require technical approaches that are complex or costly, which may be deemed inefficient from an engineering standpoint (Osuzugbo et al, 2023). A dramatic facade or an unconventional building shape might capture public attention but could require additional structural support, thereby increasing both costs and construction difficulty.

A critical mediating factor in this conflict is the concept of Buildability, the terms buildability, and constructability are generally interchangeable, but may have different meanings depending on the context. As defined by Fischer and Tatum (1997), the extent to which the design of building facilitates ease of construction, subject to overall requirement for the completed building. It is not merely about simplifying the construction process but about the strategic integration of construction knowledge at the earliest stages of the design phase. The material selection

problem is of particular importance in achieving the goals of sustainable development in construction projects, Buildability can serve as a powerful tool to reconcile the aspirational demands of aesthetics with the pragmatic constraints of budget and schedule.

While the inherent tension between cost and aesthetics is a well-documented challenge in project management, the specific dynamic where Buildability serves as a primary decision-making criterion remains a less-explored area of research (Zaiman et al, 2024). Previous studies have not adequately focused on the nuanced interplay between aesthetic goals and the practical ease of construction. This study aims to address this gap by investigating the three pillars of sustainability are: environmental pillar, economic pillar and social pillar.

To ground this investigation in a real-world context, this paper utilizes the Kotabaru Creative Hub project as a detailed case study. The project serves as a practical laboratory for examining how these competing priorities are navigated by different stakeholders. Through a multi-method analytical approach, combining Semantic Differential (SD) to gauge perception and the Analytical Hierarchy Process (AHP) to determine priority, this research deconstructs the decision-making process. The study seeks to uncover the underlying logic that governs the trade-offs between creating a building that is visually compelling and one that is practical to build, ultimately offering a clearer framework for balancing these essential project goals.

MATERIALS & METHODS

This study employed a qualitative, descriptive methodology centered on a case study approach. This research design was deliberately chosen as the most appropriate means to explore the subjective, complex, and context-dependent nature of aesthetic judgment and its integration into the practical realities of a construction project. The primary aim was to provide a rich, in-

depth understanding of the subjective experiences, decision-making processes, and underlying rationales of the various stakeholders involved, capturing nuances that quantitative methods might overlook.

The empirical data for this study was sourced from the Creative Hub Kotabaru project in Indonesia, which served as the unit of analysis. A non-probability sampling method was utilized to select a cohort of 30 expert respondents who were directly involved in or impacted by the project. This group was intentionally diversified to ensure a holistic and multi-faceted perspective, comprising architects (30%), contractors (27%), building users (23%), and representatives from the owner, the local tourism agency (20%). This strategic composition allowed for the capture of a wide spectrum of viewpoints, spanning the design, construction, operational, and client-side dimensions of the project.

A dual-questionnaire approach was utilized for data collection to measure different cognitive aspects of the decision-making process. The first instrument, designed for the Semantic Differential (SD) and Function Effectiveness analyses, was administered online via Google Forms for efficiency and accessibility. This questionnaire employed a bipolar Likert-type scale to quantitatively measure the perceived influence of 39 distinct indicators across the three core dimensions of the study: aesthetics, cost efficiency, and Buildability. This tool was designed to capture the stakeholders' aspirational values and beliefs about the importance of each factor in isolation.

The second instrument, designed specifically for the Analytic Hierarchy Process (AHP) is a structured decision-making framework used to prioritize and analyze complex choices based on multiple criteria. This questionnaire required respondents to make a series of direct pairwise comparisons between competing criteria (e.g., Aesthetics vs. Buildability) and their respective sub-criteria. By forcing respondents to make direct trade-offs, this method was chosen to

elicit a priority hierarchy that reflects the practical, real-world decision-making process that occurs when faced with constraints. This approach was critical for uncovering the underlying priorities that guide actions, as opposed to merely stated beliefs.

To ensure the quality and robustness of the collected data, all questionnaire instruments underwent rigorous validation and reliability testing. The validity of each question item was confirmed using item-total correlation analysis, ensuring that each item effectively measured the intended construct. The internal consistency and reliability of the instruments were assessed using Cronbach's Alpha. The analysis yielded a Cronbach's Alpha coefficient of 0.987, which indicates a very high level of reliability. This result confirmed that the data was consistent and suitable for subsequent in-depth analysis.

The data was analyzed using three distinct but complementary techniques. First, Semantic Differential (SD) analysis was used to map and rank the perceived influence of each of the 39 indicators, providing a clear picture of which factors stakeholders believed were most significant. Second, the Analytical Hierarchy Process (AHP) was employed as a multi-criteria decision-making tool to determine the actual priority weights of the main criteria and sub-criteria. This involved constructing pairwise comparison matrices and verifying the consistency of respondent judgments, using a Consistency Ratio (CR) of less than 0.1 as the threshold for accepting the data as reliable. Finally, a Function Effectiveness analysis was conducted as a baseline assessment, which ultimately found that all indicators were of "moderate" effectiveness, suggesting a state of functional compromise among the different project goals.

RESULT: A Duality of Perception and Priority

The results from the three analytical methods Function Effectiveness, Semantic Differential, and AHP provide a multi-

layered understanding of the interplay between aesthetics, cost, and Buildability.

Baseline Assessment: Function Effectiveness Analysis

The Function Effectiveness analysis was conducted as a baseline to assess how well each indicator supports the building's overall design function. The results indicated that all 39 indicators fell into the moderate category, with effectiveness scores ranging from 51.33% to 74.67%. This finding is significant as it suggests a state of functional compromise across the project. No single dimension aesthetics, cost, or Buildability was optimized to its fullest potential at the expense of the others (Rajeshkumar et al, 2021). Instead, a practical balance was achieved, indicating that while all elements contribute to the building's function, there remains potential for further optimization.

The Perception of Influence: Semantic Differential (SD) Analysis

The SD analysis, which measured the perceived influence of each indicator, revealed that stakeholders overwhelmingly

believe aesthetic considerations are the most powerful drivers in the design process. When evaluated in isolation, indicators related to the aesthetic dimension consistently received the highest scores. The top three most influential indicators were:

1. Influence of aesthetic dimension in selecting materials for architectural style (E1): Score = 3.73
2. Influence of aesthetic dimension in selecting general architectural materials (M1): Score = 3.57
3. Influence of aesthetic dimension in selecting facade materials (L1): Score = 3.53

This perceptual dominance of aesthetics establishes a clear aspirational goal among stakeholders. Further analysis of the sub-criteria confirms this pattern; for instance, within the Landscape sub-criterion, the aesthetic dimension (A1, score 3.50) was perceived as more influential than cost efficiency (A2, score 3.03) and Buildability (A3, score 2.80). This pattern underscores a strong belief in the value of visual appeal as a primary consideration in design choices.

Table 1. Final Priority Ranking of Main Decision Criteria (AHP)

Rank	Main Criterion	Priority Weight (Eigenvector)
1	Buildability	0.39
2	Aesthetic Dimension	0.33
3	Cost Efficiency	0.28

This finding establishes the second half of the paradox. Despite the high perceived influence of aesthetics, the pragmatic requirement that a design must be constructible in an efficient and low-risk manner is the ultimate priority. Buildability, with a priority weight of 0.39, emerged as the foundational criterion upon which other decisions are built. This suggests that while aesthetics are highly valued, they are ultimately constrained and shaped by the practical limitations of construction.

The Hierarchy of Practice: Analytical Hierarchy Process (AHP) Analysis

In stark contrast to stakeholder perceptions, the Analytic Hierarchy Process (AHP) is a

multi-criteria decision analysis (MCDA) method that begins by breaking down decisions into a hierarchical structure of a decision-making goal, criteria and alternatives. When constraints are introduced, Buildability emerges as the most critical criterion (Dermawan et al, 2024).

This result highlights a "perception-priority paradox": while stakeholders aspire to high aesthetic achievement, the practical necessity of ensuring a design is constructible ultimately governs the decision-making process. To understand how this paradox is resolved, an analysis of the sub-criteria priorities is essential.

Table 2. Priority Ranking of Sub-Criteria within Each Main Criterion (AHP)

Rank	Aesthetic Dimension	Cost Efficiency	Buildability
1	Tekstur dan Material	Visual Elemen Bangunan	Visual Elemen Bangunan
2	Visual Elemen Bangunan	Elemen Arsitektur	Elemen Arsitektur
3	Elemen Arsitektur	Tekstur dan Material	Tekstur dan Material
4	Landscape	Landscape	Landscape
Rank	Aesthetic Dimension	Cost Efficiency	Buildability

The synthesis of the AHP results reveals a crucial insight: "Tekstur dan Material" is ranked as the most important sub-criterion within the Aesthetic Dimension, while "Visual Elemen Bangunan" ranks highest under both Cost Efficiency and Buildability (Prastowoa et al, 2021). This is a key finding that bridges the gap between aspiration and practice. It indicates that the strategic selection of materials based on their texture and appearance is the primary mechanism for achieving aesthetic goals. Simultaneously, the focus on the visual elements of the building for both cost and ease of construction shows that practitioners prioritize the most visible components of the project when making practical trade-offs.

DISCUSSION

The discussion of the research results is divided into two parts to address the established research questions. The first part will identify the main indicators that bridge the three criteria, while the second part will formulate an optimal integration strategy.

Main Indicators Bridging Aesthetics, Cost Efficiency, and Buildability

In response to the first research question, this study successfully identifies the key indicators that serve as the crucial link between the aspirational goals of aesthetics and the practical realities of construction. The comprehensive analysis reveals that "Texture and Material" and "Visual Building Elements" are the two most critical indicators. These indicators act as the primary levers through which stakeholders navigate the complex trade-offs between creating a visually compelling building and ensuring it is both cost-effective and easy to build.

The AHP results provide the first piece of this puzzle, showing that "Texture and Material" is the top-ranked sub-criterion within the Aesthetic Dimension. This finding is highly significant because it pinpoints the tangible mechanism through which abstract aesthetic intent is translated into physical form. The choice of a material's texture, color, and finish is the most direct and impactful way for a designer to express a specific architectural style or create a desired atmosphere. It is the practical language of aesthetics in the built environment.

This indicator, therefore, serves as the primary negotiation point where the abstract world of design concepts meets the concrete world of construction. When stakeholders discuss how a building should look and feel, the conversation inevitably centers on the properties of the materials that will be used. This makes the selection of "Texture and Material" the central arena where Buildability must be weighed with other determining criteria such as time, cost and quality (Siripob et al, 2019).

The second key indicator, "Visual Building Elements," is identified through its top ranking in both the Cost Efficiency and Buildability criteria within the AHP analysis. This reveals a critical insight into the pragmatic mindset of project stakeholders. When practical constraints such as budget and schedule force trade-offs, the focus of these decisions is overwhelmingly directed toward the most visible components of the building, such as the facade, entryway, and other prominent architectural features.

The strategic importance of this indicator cannot be overstated. It signifies that practitioners intuitively understand that

decisions made on these highly visible elements will have the most significant impact on both the project's budget and its construction timeline (Adham et al, 2024). Simplifying the design of a facade or choosing a more cost-effective material for a prominent visual feature can lead to substantial savings in both money and time, making it a primary target for optimization. This dual focus on "Texture and Material" for aesthetics and "Visual Building Elements" for practical constraints helps to explain the "perception-priority paradox" observed in the study. The high value placed on "Texture and Material" aligns with the aspirational goals captured by the Semantic Differential analysis, where aesthetics were perceived as highly influential. It reflects the desire to create a beautiful building. Conversely, the prioritization of "Visual Building Elements" for cost and buildability reflects the practical hierarchy revealed by the AHP, where ease of construction is paramount.

The case study of the Kotabaru Creative Hub provides a perfect real-world illustration of these indicators in action. The decision to switch from heavy, complex GRC to a combination of lighter, more modular materials like ACP, laser-cut metal, and textured paint was a strategic manipulation of the "Texture and Material" indicator. This change was made to address the practical challenges related to the "Visual Building Elements" of the facade, directly improving its Buildability and cost-effectiveness while still achieving a high-quality aesthetic outcome.

In conclusion, these two indicators "Texture and Material" and "Visual Building Elements" are not merely items on a list; they are the fundamental tools for strategic decision-making in construction projects. They represent the bridge between the artistic vision and the practical execution. By understanding and skillfully managing these two levers, project stakeholders can effectively navigate the inherent tensions among aesthetics, cost, and Buildability,

thereby providing a clear and actionable answer to the first research question.

Optimal Integration Strategy for Aesthetics, Cost, and Buildability

Answering the second research question, this study formulates a clear and actionable integration strategy that is deeply rooted in the empirical findings, particularly the "perception-priority paradox." The most effective strategy is not to simply subordinate one criterion to another, but to adopt a hierarchical approach that uses Buildability as the primary criterion. Buildability has been defined as "the degree at which the design of a building structure aid construction, subject to the overall requirements, while strategically leveraging material selection to satisfy aesthetic goals within those practical constraints.

The cornerstone of this strategy is the prioritization of Buildability over even Cost Efficiency, as revealed by the AHP results (priority weight of 0.39 for Buildability versus 0.28 for Cost Efficiency). This is not merely a technical preference but a sophisticated strategic understanding among experienced practitioners. They recognize that a design's ease of construction is a primary driver of overall project cost and schedule control. Simply put, large-scale infrastructure projects are prone to severe underestimation of costs, delays, and failure to meet original expectations.

Adopting Buildability as the primary criterion transforms it from a simple technical requirement into a foundational approach for managing the entire project ecosystem (Gamil et al, 2017). A design that is easy to build inherently minimizes labor costs by simplifying tasks and reducing the need for highly specialized skills. It also significantly reduces the likelihood of costly errors and rework, which are common sources of budget inflation. Furthermore, delays in the delivery of materials or equipment can have a cascading effect, halting entire projects. This approach is rapidly becoming the standard method for the long-term cost appraisal of buildings and civil infrastructure projects.

This strategic framework is perfectly illustrated by the practical decisions made on the Creative Hub Kotabaru project. The initial design specified the use of GRC, a material selected primarily for its aesthetic qualities. However, its significant weight and complex installation process represented low Buildability. This choice created a direct conflict with the practical realities of the project, posing risks to the existing structure, the budget, and the timeline. It was a classic case of aesthetic aspiration clashing with construction feasibility.

The project team's decision to pivot to a combination of ACP (Aluminium Composite Panel), laser-cut metal, and textured paint represents a direct and successful application of the optimal integration strategy (Haddadi et al, 2016). This move was a conscious prioritization of Buildability. The new materials were significantly lighter, more modular in their application, and far easier and faster to install. This decision was not an abandonment of aesthetic goals but a re-evaluation of how to achieve them.

This material switch demonstrates how the conflict between aesthetics and practicality can be effectively resolved. The team strategically manipulated the "Texture and Material" indicator to achieve a new, equally compelling aesthetic that was fundamentally more constructible and cost-effective. This action provides a clear, real-world answer to the call for an optimal integration strategy: filter decisions through the lens of Buildability first, and then creatively select materials that can deliver the desired aesthetic within those practical boundaries (Abdel et al, 2018).

Furthermore, the finding from the Function Effectiveness analysis, which rated all indicators as "moderate," grounds this entire strategy in the reality of project management. This result suggests that the most effective real-world approach is not to attempt to maximize one criterion at the absolute expense of the others. Instead, the goal should be to achieve a state of optimal

compromise or functional equilibrium. In practice, successful projects exist in a state of a carefully managed balance.

In conclusion, the optimal integration strategy is a multi-step process. It begins with establishing Buildability as the primary, non-negotiable priority. Within that framework, "Texture and Material" should be used as the key tool to creatively and flexibly meet aesthetic requirements. Finally, the overarching goal should be a state of optimal compromise, where aesthetics, Buildability, and cost are carefully balanced to achieve a feasible, successful, and high-quality outcome. This approach reinforces the idea that successful construction management is ultimately the art of navigating constraints to find a functional and elegant equilibrium.

CONCLUSION

This study successfully deconstructed the complex relationship between aesthetics, buildability, and cost efficiency in construction project management. The research confirms that a clear decision-making hierarchy exists, in which the practical requirement of Buildability serves as the primary driver, followed by the aspirational goal of the Aesthetic Dimension, and finally the constraint of Cost Efficiency. A measurable gap was identified between stakeholders' perception of aesthetic influence and the practical prioritization of Buildability in trade-off scenarios. The key to integrating these competing factors lies in the strategic selection of "Texture and Material," which acts as the tangible bridge between abstract design intent and practical construction execution.

Based on these findings, the following strategic recommendations are proposed for practitioners aiming to achieve an optimal balance between these critical project criteria:

Prioritize Material Selection as the Core Integration Point. The choice of materials should be treated as the central nexus where aesthetics and Buildability are reconciled.

This requires early and intensive collaboration between architects and structural engineers is crucial in ensuring the safety, efficiency, and beauty of our built environment to evaluate materials not just on their visual properties, but also on their weight, modularity, installation requirements, and compatibility with available labor skills.

Leverage Modular and Composite Materials. Practitioners should actively seek out and specify modern materials that inherently possess both aesthetic flexibility and high Buildability. Materials such as Aluminium Composite Panels (ACP), laser-cut metal, and advanced architectural composites offer significant advantages as they are often lightweight, support rapid and efficient installation, and can be customized to meet diverse aesthetic requirements.

Design Functional Visual Elements. Aesthetic design consists of more elements than just how it looks. Design isn't a tug-of-war between functionality and aesthetics; it's a dynamic relationship where both aspects can and should enhance one another. For example, a visually striking facade can also be engineered to provide superior thermal insulation, natural ventilation, or acoustic dampening. This approach ensures that aesthetic investments also contribute to the building's performance and long-term value, justifying their inclusion in the project scope.

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