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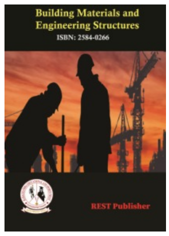


# TOPSIS Approach to Assessing Architectural Sustainability: Energy Efficiency and Aesthetic Appeal Perspectives

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ABSTRACT

Architectural projects play a crucial role in shaping urban development by influencing energy efficiency, aesthetic appeal, community impact, and accessibility. Evaluating these projects using rigorous methodologies is essential for making well-informed decisions. This study utilizes the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method to evaluate five architectural projects across these critical criteria. The aim is to identify strengths and weaknesses, thereby assisting stakeholders in selecting optimal design solutions for sustainable urban environments. The TOPSIS method involves several steps, including data normalization, establishing weighted criteria, and calculating proximity to both ideal and negative-ideal solutions. This systematic approach ensures a comprehensive assessment of each project's performance in energy efficiency, aesthetic appeal, community impact, and accessibility. Among the projects assessed, High-Rise Office Building B excels notably in energy efficiency, while Residential Complex C distinguishes itself with high scores in aesthetic appeal and community impact. Each project exhibits unique strengths and areas for improvement, providing a nuanced perspective on their contributions to urban sustainability. The TOPSIS method proves effective in objectively evaluating architectural projects, offering valuable insights into their environmental and social implications. Decision-makers can leverage these findings to prioritize projects that align closely with sustainability objectives and community requirements, thereby promoting a built environment that enhances urban quality of life and resilience.

## 1. INTRODUCTION

A complete framework that manages the entire system of a business is called enterprise architecture, or EA. It consists of a collection of guidelines, procedures, and models that specify the structure of the company as a whole, taking into account infrastructure, information systems, and business processes. EA encapsulates the essential components of IT and business, as well as their development, with an emphasis on components that are longer-lasting rather than discrete fixes for pressing problems. As a result, EA is essential to maintaining company principles and guaranteeing optimal flexibility and adaptability. The fact that an organization chart offers a comprehensive picture of the company is one of its main features. Architectural practices are typically present in specialized areas of expertise within an organization, though their maturity may vary. However, understanding how architecture varies is challenging due to the diverse methods and techniques used for documentation. Domains are interconnected. From a reductionist perspective, optimizing within individual domains might establish structures in each, but this does not achieve the desired outcome for the organization as a whole. For instance, while supporting highly agile and rapidly evolving business processes is essential, a rigid and inflexible

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technology infrastructure optimized for better performance at a lower scale may not meet these needs. An effective organizational structure provides the necessary insights to balance these demands and helps translate corporate strategy into daily operations. A thorough examination of the emerging research in the field of AM reveals that past studies have mainly concentrated on developing a theoretical foundation, rather than on practical application. While there is a recognized need for advancements, there are no guidelines in place to track the progress of these improvements. Specifically, prior research has lacked consensus on the ethical considerations of AM, its essential elements, and how these elements intersect. [2] The existing definition lacks the detailed training necessary for proper understanding and application of AM. The goal of this research is to create a thorough and useful framework that architects may use to incorporate Architectural Management (AM) into their professional practices, tailored to their unique requirements and situations. A framework like this can help architects better understand and manage their business processes, which will enhance the caliber of services they offer to their customers. It is widely acknowledged that Enterprise Architecture Management (EAM) is an essential discipline for promoting organizational change, enhancing IT landscape transparency, and coordinating business and IT operations. Despite its growing adoption, many EAM initiatives face significant challenges. Issues such as the underutilization of EA documentation and the disempowerment of enterprise architects point to a low level of engagement, leading to the failure of many initiatives. Therefore, this research aims to develop a design theory to help businesses deploy EAM effectively. We first look into the real-world problems that arise when implementing EAM through three field studies.[4] In academic and professional settings, enterprise architecture management (EAM) is frequently mentioned as a tool for managing technology, guaranteeing alignment, directing IT deployments, and evaluating compliance. Notwithstanding its potential, little is known about how to use EAM successfully to produce desired results. We have determined the EAM success elements in order to close this gap. We provide a theoretical model that describes the essential elements and metrics that lead to the success of EAM through surveys of the literature and exploratory interviews. [5]. There seems to be a wide distribution of shares among the participants. This includes defining the role of the design leader and the status of the design management function concerning project management, as well as the levels of design firms. It is essential to clearly identify the framework for relevant and planned information processes and systems. The communication among designers within a design team is somewhat unique. Designers are typically creative, visionary, spatial, and abstract thinkers with a significant level of technical knowledge and experience. Their primary tools for conveying information include sketches, plans, images, and maps.[6]. For multidisciplinary design teams, the challenges in designing information architecture are just as relevant as they are for design firms. However, the increasing information load requires both a generic and project-specific information architecture. Unfortunately, the information architecture within design and design organizations seldom integrates effectively into the project knowledge bases of design teams. When considering information architecture in PWS, the concept of the information life cycle becomes relevant. Digital information plays a crucial role during collaboration, and the finalized, edited information remains significant even after the project's completion. Although this final information is valuable to the customer, it may be organized in a fragmented manner.[7]. Although enterprise architectural management (EAM) is gaining popularity, its organizational applications are not well understood by scholars or practitioners. Through a thorough examination of existing literature and an in-depth analysis of eight case studies, we have created a taxonomy that divides EAM applications into three groups according to the extent of enterprise architecture. Employers can use Enterprise Architecture Management (EAM) to design, plan, and execute IT strategies; support the planning and execution of business strategies; or improve the process of developing business strategies. Our research casts doubt on the conventional IT-centric understanding of EAM and suggests that it actually aids in an organization's overall structure and development. We saw that the enterprise architecture (EA) function not only oversees IT architecture design in the situations of Beta and Kappa, but also handles business architecture activities. The EA function is responsible for creating components that actualize business capabilities in addition to designing IT components. The existence of enterprise business architects is a crucial difference between these scenarios and those with an IT focus. Within these companies, the business and IT architecture teams are in charge of managing their respective domains and share responsibility for EAM. The EA function is responsible for creating components that actualize business capabilities in addition to designing IT components. The existence of enterprise business architects is a crucial difference between these scenarios and those with an IT focus. Within these companies, the business and IT architecture teams are in charge of managing their respective domains and share responsibility for EAM. [8]. Overall, the aim of application architecture management is to achieve effective and efficient integration of business and process architectures with software and IT architecture. Due to the numerous possible modeling layers, scenarios, and design goals, there are a variety of approaches present in both the application architecture management literature and business practice. The aim of this paper is to develop a unified process reference model for the controlled evolution of application architecture. Positioned as the interface between business-oriented and IT-oriented architecture layers, the focus is on the application layer's pivotal role in achieving effective IT-business alignment. The initial step involves analyzing the positioning of application framework management within information management to define specific objectives and framework conditions. Subsequently, concrete approaches to managing application infrastructure can be identified. A critical evaluation and comparison of various approaches from both literature and practical applications will then form the basis for deriving a comprehensive model of architectural processes. [9]. One of the primary aims of Enterprise Architecture Management (EAM) is to align an organization with its business needs and objectives, particularly those related to business services. EAM plays a crucial role in designing and ensuring a cohesive enterprise structure, business processes, and infrastructure. By doing so, it transforms corporate governance into informed corporate governance. However, incidents such as security breaches, such as database corruption, can introduce misalignments between business goals and their implementation through the information system. Addressing these misalignments requires increasingly complex solutions that may not always be technically or economically feasible for the company to fully resolve all potential violations. In this paper, we propose integrating security risk management and enterprise architecture management through conceptual mapping between their met models. This mapping facilitates closer alignment of risk management and organizational structure methodologies. The advantages of this integration are demonstrated through a case study, where an enterprise architecture model aids in identifying business and information system assets. The approach also proposes modeling risk treatment, emphasizing the value and rationale behind architectural elements.[10]. Enterprise architecture (EA) is a compelling research area within the management information systems discipline. However, for practitioners, the design of the EA management function within an organization holds greater relevance. This is particularly crucial for companies in the process of establishing EA management, aiming to enhance business and IT alignment. Such companies must move beyond mere declarations of intent, navigating through various frameworks and tools that promise guidance in this endeavor.[11]. The paper seeks to offer a structured review of methods for managing enterprise architecture and exploring strategic opportunities in information system planning. EAM plays a crucial role in IT planning, facilitating some opportunities for aligning business and IT and advancing enterprise engineering. The analytical approach based on EAM is seen as a conceptual trial illustrating how EA can enhance strategic alignment and IS planning. Enterprise Architecture Management (EAM) can effectively address the complexities of Strategic Information System Planning (SISP) amidst digital transformation challenges. It enables organizations to manage interconnected factors comprehensively, emphasizing the need for agile, flexible planning and implementation. Critical aspects include ensuring maintenance and scalability.[12]. This study aims to explore how various tourism brands relate to each other, examining brand management practices within Catalonia and their practical implications across four selected tourist destinations. It focuses on analyzing strategic relationships among tourism brands and describing brand architecture management, including the roles and responsibilities across different management levels.[13]. Risk management is crucial in guiding organizations through information system (IS) security challenges today. However, IS security risk management (ISSRM) is intricate and involves multiple disciplines within the IS context, making it a demanding and ongoing process. We argue that integrating Enterprise Architecture Management (EAM) can help address these challenges. A critical initial step towards better integration of these domains involves defining an integrated EAM-ISSRM conceptual model. [14]. This study aims to enhance understanding of the interactions among various tourism brands, examining how brand management is applied within Catalonia and its practical impacts on four selected tourist destinations. It will analyze and outline strategic relationships among tourism brands, focusing on brand architecture management and defining the roles and responsibilities across different management levels. Thus, this research provides a practical application of the theoretical foundation of brand architecture management. It contributes to understanding the constraints and challenges faced by tourism destinations when implementing a cohesive and organized brand architecture management system. [15]. This article introduces enterprise architecture management (EAM) models, which adopt a methodological approach to EA management. It categorizes these models into three types of patterns: M-patterns document proven methods for addressing typical EA management challenges, V-patterns illustrate best practice visualizations, and

I-patterns outline information needs for EA management. Together, these patterns establish a model language for EA management, as detailed in this article. [16].

## 2. TOPSIS METHOD

Decision-making is essential in both personal and business contexts. Although multi-criteria decision-making methods offer tools for decision-makers, they differ in assumptions and theoretical foundations. Thus, choosing the appropriate method is often more important than the decision itself. The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method, a popular approach, has garnered significant research interest, resulting in several enhanced versions. This study investigates the conventional TOPSIS method and identifies its limitations through experimental simulations. By conducting detailed simulations with practical applications, the study seeks to improve the theoretical understanding of TOPSIS and contribute to its refinement. [17]. Recently, many researchers have focused on developing, extending, suggesting, and utilizing the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to tackle decision-making issues. Key inquiries have centered on the impact of TOPSIS on problem-solving and its effectiveness in practical decision-making scenarios. This review examines the latest innovations in TOPSIS methodology put forth by scholars. To achieve this objective, the study examines 105 research papers published from 2000 to 2015 that have enhanced, expanded, suggested, or utilized TOPSIS for addressing decision-making challenges. The analysis reveals that 49 researchers have advanced or refined the TOPSIS technique, while 56 have introduced novel modifications during this period. Additionally, the study underscores a significant surge in modifications related to TOPSIS in 2011 compared to previous years. Among Multiple Criteria Decision Making (MCDM) methods, TOPSIS ranks as the second most popular. Many scholars have applied TOPSIS to solve both straightforward and intricate problems across diverse domains, adapting and extending it to meet specific requirements. The evolution of TOPSIS and its widespread application across various problem-solving contexts reflects broader trends observed in all MCDM methodologies. Given these advancements, there is a clear necessity for a systematic review to consolidate recent progress in the TOPSIS technique. This paper specifically focuses on literature proposing enhancements, extensions, or novel adaptations of TOPSIS. However, previous studies have also utilized TOPSIS and its fuzzy variant for tasks such as evaluation, selection, ranking, and criteria identification, among others. Nonetheless, these studies may not consistently capture recent developments. Thus, while this study's scope aims to align with its objectives, it may have excluded relevant publications that utilize TOPSIS, potentially overlooking valuable contributions in other areas. [18]. in the traditional TOPSIS process, performance ratings and criteria weights are specified as exact values. Recently, Abo-sienna and Ameer expanded the TOPSIS approach to tackle multi-objective nonlinear programming issues. Jahanshaloo et al. further refined TOPSIS, developing a methodology for solving multi-criteria decision-making problems. In real-world scenarios, incomplete or unattainable information often introduces ambiguity, especially in human judgments and preferences, which are not always precisely quantifiable. As a result, data (attributes) frequently exhibit fuzziness or imprecision. Efforts have thus been directed towards extending TOPSIS to accommodate fuzzy data. In situations where attribute values are difficult to determine precisely, they are treated as fuzzy data. Therefore, this paper extends the TOPSIS method to handle fuzzy data and presents an algorithm for identifying the most optimal option. This approach aids in selecting the best alternative when data ambiguity is present among available choices. [19]. However, the TOPSIS method is not without its limitations. One significant concern is rank reversal, where the preference order of alternatives can change upon adding or removing an option from the decision-making process. In certain cases, this may lead to complete rank inversion, where an alternative originally deemed the best could become the worst, and vice versa. Such outcomes are often deemed unacceptable in many decision-making scenarios. [20]. Previous studies have employed TOPSIS for selecting diverse manufacturing facilities, utilizing a variety of mathematical models, heuristics, and MCDM techniques.[21]. In recent decades, various multicriteria decision support methods have been utilized to aid decision makers in selecting optimal alternatives for diverse decision problems. However, these methods have been criticized in the literature for a phenomenon known as rank reversal. This issue, particularly in relation to the TOPSIS method, remains insufficiently explored. Our review of existing literature revealed that studies typically focus on analyzing changes in rankings caused by adding or removing alternatives, with proposed solutions often limited to case studies of narrow applicability. Consequently, we conducted an initial analysis to identify documented instances of rank inversion and to highlight significant gaps in understanding related to the TOPSIS method. Subsequently, we developed a framework to evaluate both the TOPSIS method itself and the proposed solutions. Finally, this paper introduces a new method called R-TOPSIS, which demonstrated robustness in the conducted tests, as no instances of rank inversion were observed in the simulated or real-world cases used for validation. To assess its adherence to the classic TOPSIS method, the proposed method was validated using dispersion and similarity statistics. [22]. The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) was originally developed by Hwang and Yoon to address Multiple Criteria Decision Making (MCDM) problems. At its core, TOPSIS selects an alternative that is closest to the positive ideal solution and farthest from the negative ideal solution. In traditional MCDM approaches, the weights of criteria and attributes are precisely defined. In the classical TOPSIS method, evaluations of alternatives and criteria weights are specified as exact values. This method has been effectively applied across diverse fields, and a comprehensive survey detailing its applications is readily accessible. However, accurately pinpointing the precise values of alternative evaluations based on specific criteria can be challenging. Therefore, these evaluations are frequently expressed as fuzzy values. Existing literature includes studies that explore fuzzy extensions of the TOPSIS method. However, these extensions are often incomplete because they typically present the best solutions either as exact values (non-fuzzy) or as unattainable fuzzy values within the decision matrix. [23]. A novel TOPSIS approach for robot selection is proposed, where evaluations of different alternatives and subjective criteria, along with criteria weights, are linguistically represented using fuzzy numbers. To ensure alignment between the objective criteria values and the linguistic evaluations of subjective criteria, objective criteria values are transformed into dimensionless indices. Each weighted estimator's membership function is established through interval arithmetic of fuzzy numbers. To simplify the aggregation of fuzzy numbers, these weighted estimates are converted into crisp values using the mean ranking elimination method. A proximity coefficient is then introduced to determine the ranking of alternatives by measuring their distances from both the ideal and negative-ideal solutions. A numerical example illustrates the computational steps of this proposed method.[24]. This study presents a multi-attribute decision-making approach using the TOPSIS method, where both attribute weights and values are defined as interval fuzzy values. Initially, interval fuzzy attribute values are processed using a weighting function based on the operational rules of interval fuzzy values, and the best and worst solutions are identified using a scoring function. Distances between interval fuzzy values are defined, as well as the distances from each project to the ideal and worst solutions. The relative closeness is then computed using the TOPSIS method, and project rankings are determined based on these closeness values. Finally, a case study is presented to illustrate the procedural steps of the proposed method and validate its effectiveness. [25]. The TOPSIS method, which aligns preferences with the best solution, remains one of the most popular techniques for multi-criteria decision-making (MCDM). The TOPSIS method was originally designed to handle only real-valued data. However, accurately estimating alternatives based on specific criteria can be challenging, often resulting in these estimates being treated as intervals. Several studies have explored interval extensions of the TOPSIS method, but these extensions typically rely on heuristic methods to define positive and negative optimal solutions. These ideal solutions are often presented as real values or intervals that cannot realistically be achieved within the decision matrix, contradicting the principles of the classical TOPSIS method. In response to these limitations, this paper introduces a novel direct approach to extending the TOPSIS method using intervals. This approach aims to avoid heuristic assumptions and enhance the applicability of the method in practical decision-making scenarios. In numerical examples, we illustrate that this "direct interval extension of the TOPSIS method" can yield notably different final rankings of alternatives. [26]. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is highly effective for swiftly identifying the best alternative. This study introduces a combined approach using entropy weighting and TOPSIS for selecting information systems. Here, information entropy is used to determine the objective weights of evaluation criteria, and a modified TOPSIS method is applied to rank a limited set of potential alternatives based on preferences. This methodology aids in selecting the most suitable information system that aligns with the decision criteria. [27]. When applying TOPSIS, several crucial steps involve assessing the relative importance of different attributes and evaluating each alternative's performance based on these attributes. Given the inherent imprecision in human judgments, obtaining precise data can often be challenging. Therefore, extending TOPSIS to accommodate a fuzzy environment is a natural evolution of the model. In many scenarios, available information may not suffice to accurately determine the membership degree of certain elements, resulting in ambiguity between membership and non-membership. In such cases, interval-valued fuzzy sets (IVFSs) are particularly useful, as they address uncertainty associated with unknown membership values. An IVFS employs an interval-valued membership function, which denotes the degree of membership as a closed interval. IVFSs have demonstrated effectiveness in managing uncertainty. This paper tackles uncertainty in TOPSIS using Interval-Valued Fuzzy Sets (IVFS) theory. We propose an extended TOPSIS method to address Multi-Attribute Decision Making (MADM) problems with interval-valued fuzzy data. The proposed method is exemplified through a numerical illustration, and various distance metrics are discussed. Furthermore, we conduct an extensive analysis by comparing preference orders derived from different distance measures. Rather than empirical analysis, we simulate 1,000,000 datasets to encompass nearly all conceivable real-world scenarios. The outcomes are evaluated using diverse distance measures such as Hamming distance, Euclidean distance, and their normalized counterparts. Several comparison indices are examined, including consistency ratio, odds ratio of the best choice, and mean Spearman correlation coefficients. [28]. A literature review reveals a significant gap regarding the application of the fuzzy TOPSIS method in group decision-making contexts. Decision-makers (DMs) often seek a straightforward and logically structured mathematical tool to enhance decision-making processes. Therefore, this paper introduces a new fuzzy modified TOPSIS method tailored for use by groups of DMs. This method integrates both subjective judgments and objective information, reflecting real-world complexities. It is rooted in the concepts of positive ideal and negative ideal points to tackle multi-judge and multi-criteria decision-making challenges within a fuzzy environment. In this approach, the performance evaluation values of each alternative based on selected criteria, along with the weights of these criteria, are represented as linguistic variables expressed through triangular fuzzy numbers. [29]. the main objective of this paper is to provide practitioners with a refined approach to traditional research, focusing on managing imprecision and prioritizing criterion measurement dimensions. For this study, we analyze shopping websites in Taiwan as a case study. Twelve experts are invited to assess different shopping websites using the proposed fuzzy TOPSIS method. Fuzzy TOPSIS is utilized to establish the weights of evaluation criteria and rank four alternative shopping websites. This research aims to offer empirical insights aimed at improving managerial performance within the online shopping industry [30].

## 3. RESULTS AND DISCUSSION

**TABLE 1.** Architectural Management

| Alternative | Energy Efficiency (kWh/sqft) | Aesthetic Appeal | Community Impact (1–5) | Accessibility (miles) |
|---|---|---|---|---|
| Mixed-Use Development A | 20 | 8 | 4 | 0.5 |
| High-Rise Office Building B | 25 | 7 | 3 | 0.2 |
| Residential Complex C | 18 | 9 | 5 | 0.3 |
| Educational Institution D | 22 | 6 | 4 | 0.7 |
| Healthcare Facility E | 30 | 8 | 4 | 0.4 |

Table 1 evaluates five architectural projects based on four key parameters: energy efficiency, aesthetic appeal, community impact, and accessibility. Mixed-Use Development A has an energy efficiency of 20 kWh/sqft, a high aesthetic appeal score of 8, a community impact rating of 4, and is located 0.5 miles from public transport.

High-Rise Office Building B demonstrates better energy efficiency at 25 kWh/sqft but has a slightly lower aesthetic appeal of 7 and a community impact rating of 3. It is highly accessible, situated just 0.2 miles from public transport. Residential Complex C has lower energy efficiency at 18 kWh/sqft but excels in aesthetic appeal (9) and achieves the highest community impact rating of 5, with moderate accessibility at 0.3 miles.

Educational Institution D records an energy efficiency of 22 kWh/sqft, a lower aesthetic appeal of 6, and a community impact rating of 4. It is the least accessible option, located 0.7 miles from public transport. Healthcare Facility E stands out with the highest energy efficiency at 30 kWh/sqft, a strong aesthetic appeal of 8, and a community impact rating of 4, with good accessibility at 0.4 miles.

Figure 1 evaluates five architectural projects based on four key parameters: energy efficiency, aesthetic appeal, community impact, and accessibility. Mixed-Use Development A has an energy efficiency of 20 kWh/sqft, a high aesthetic appeal rating of 8, a community impact score of 4, and is located 0.5 miles from public transport.

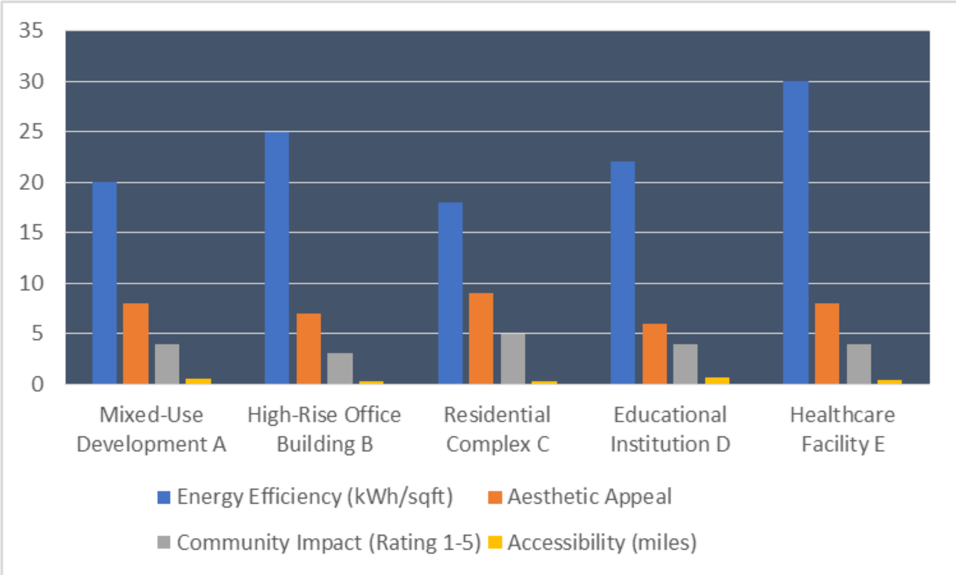


**FIGURE 1.** Architectural management

High-Rise Office Building B demonstrates higher energy efficiency at 25 kWh/sqft but has a slightly lower aesthetic appeal score of 7 and a community impact rating of 3. It is highly accessible, situated just 0.2 miles from public transport. Residential Complex C has a lower energy efficiency of 18 kWh/sqft but excels with an aesthetic appeal rating of 9 and the highest community impact rating of 5, with moderate accessibility at 0.3 miles.

Educational Institution D records an energy efficiency of 22 kWh/sqft, a lower aesthetic appeal rating of 6, and a community impact score of 4. It is the least accessible option, located 0.7 miles from public transport. Healthcare Facility E stands out with the highest energy efficiency of 30 kWh/sqft, a strong aesthetic appeal rating of 8, and a community impact score of 4, with good accessibility at 0.4 miles.

**TABLE 2.** Normalized Data

| Alternative | Energy Efficiency (kWh/sqft) | Aesthetic Appeal | Community Impact (1–5) | Accessibility (miles) |
|---|---|---|---|---|
| Mixed-Use Development A | 0.3826 | 0.467 | 0.44173 | 0.4927 |
| High-Rise Office Building B | 0.4782 | 0.408 | 0.33129 | 0.1971 |
| Residential Complex C | 0.3443 | 0.525 | 0.55216 | 0.2956 |
| Educational Institution D | 0.4208 | 0.350 | 0.44173 | 0.6897 |
| Healthcare Facility E | 0.5739 | 0.467 | 0.44173 | 0.3941 |

Table 2 presents the normalized data of five architectural projects evaluated using the TOPSIS method across four criteria: energy efficiency, aesthetic appeal, community impact, and accessibility. Mixed-Use Development A demonstrates balanced performance across all parameters, with a slight advantage in accessibility (score: 0.4927). High-Rise Office Building B excels in energy efficiency (score: 0.4782) but scores lower in aesthetic appeal (0.4082) and community impact (0.3313), with the lowest accessibility score (0.1971). Residential Complex C shows moderate energy efficiency (score: 0.3443) but leads in aesthetic appeal (0.5249) and community impact (0.5522), albeit with lower accessibility (0.2956). Educational Institution D balances energy efficiency (score: 0.4208) with high accessibility (0.6897) despite lower aesthetic appeal (0.3499). Healthcare Facility E achieves top scores in energy efficiency (0.5739) and aesthetic appeal (0.4666), with notable community impact (0.4417) and good accessibility (0.3941). This analysis aids decision-makers in architectural management by identifying project strengths and weaknesses for more informed evaluations.

Figure 2 illustrates the normalized evaluation data for five architectural projects using the TOPSIS method across four criteria: energy efficiency, aesthetic appeal, community impact, and accessibility. Mixed-Use Development A demonstrates a well-balanced performance across all parameters, with a slight edge in accessibility (score: 0.4927). High-Rise Office Building B excels primarily in energy efficiency (score: 0.4782), but shows lower scores in aesthetic appeal (0.4082)

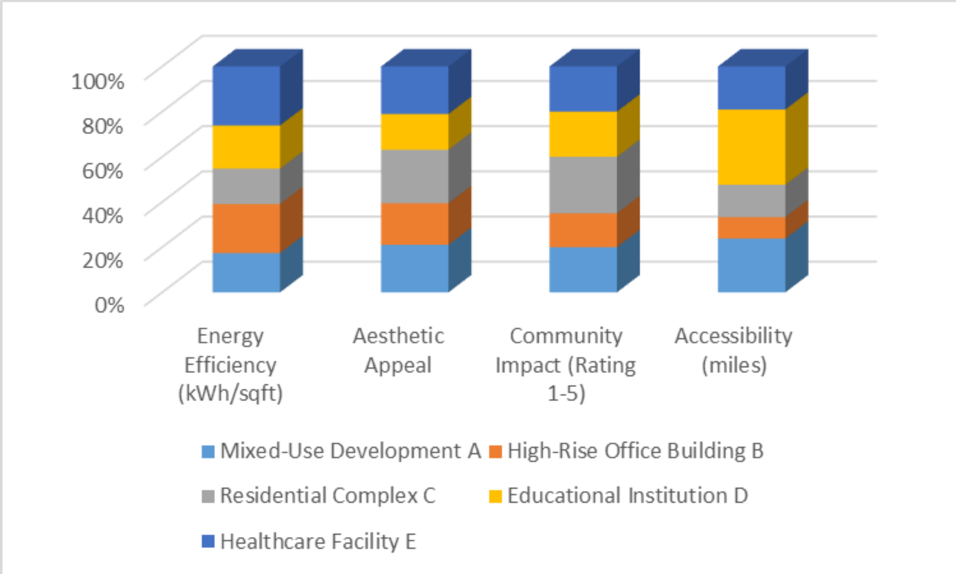


**FIGURE 2.** Normalized data

and community impact (0.3313), with the lowest accessibility score (0.1971). Residential Complex C displays moderate energy efficiency (score: 0.3443) but leads in aesthetic appeal (0.5249) and community impact (0.5522), although it has a lower accessibility score (0.2956). Educational Institution D balances energy efficiency (score: 0.4208) with high accessibility (0.6897) despite a lower score in aesthetic appeal (0.3499). Healthcare Facility E achieves top scores in energy efficiency (0.5739) and aesthetic appeal (0.4666), with notable community impact (0.4417) and good accessibility (0.3941). This graphical representation assists decision-makers in architectural management by highlighting project strengths and weaknesses for more informed evaluations.

**TABLE 3.** Weights

| Alternative | Energy Efficiency (kWh/sqft) | Aesthetic Appeal | Community Impact (1–5) | Accessibility (miles) |
|---|---|---|---|---|
| Mixed-Use Development A | 0.25 | 0.25 | 0.25 | 0.25 |
| High-Rise Office Building B | 0.25 | 0.25 | 0.25 | 0.25 |
| Residential Complex C | 0.25 | 0.25 | 0.25 | 0.25 |
| Educational Institution D | 0.25 | 0.25 | 0.25 | 0.25 |
| Healthcare Facility E | 0.25 | 0.25 | 0.25 | 0.25 |

Table 3 depicts the allocation of equal weights (0.25 each) to four evaluation parameters for five architectural projects. These parameters include energy efficiency, aesthetic appeal, community impact, and accessibility, signifying their equal importance in the assessment process. Mixed-Use Development A, High-Rise Office Building B, Residential Complex C, Educational Institution D, and Healthcare Facility E all receive identical weightings for each parameter, ensuring a balanced evaluation across energy efficiency, aesthetic appeal, community impact, and accessibility. This approach underscores the objective of fair and impartial decision-making in architectural management, promoting comprehensive assessments that consider all aspects equally.

**TABLE 4.** Weighted Normalized Decision Matrix

| Alternative | Energy Efficiency (kWh/sqft) | Aesthetic Appeal | Community Impact (1–5) | Accessibility (miles) |
|---|---|---|---|---|
| Mixed-Use Development A | 0.0956 | 0.117 | 0.11043 | 0.1232 |
| High-Rise Office Building B | 0.1196 | 0.102 | 0.08282 | 0.0493 |
| Residential Complex C | 0.0861 | 0.131 | 0.13804 | 0.0739 |
| Educational Institution D | 0.1052 | 0.087 | 0.11043 | 0.1724 |
| Healthcare Facility E | 0.1435 | 0.117 | 0.11043 | 0.0985 |

Table 4 displays the weighted normalized data for five architectural projects assessed using the TOPSIS method across four criteria: energy efficiency, aesthetic appeal, community impact, and accessibility. Mixed-Use Development A achieves scores of 0.0956 for energy efficiency, 0.1166 for aesthetic appeal, 0.1104 for community impact, and 0.1232 for accessibility. This indicates strong performance across all parameters, particularly highlighting its excellence in accessibility. High-Rise Office Building B scores higher in energy efficiency at 0.1196 but lower in aesthetic appeal (0.1021), community impact (0.0828), and accessibility (0.0493), marking it as strong in energy efficiency but weaker in other aspects, notably accessibility. Residential Complex C scores lower in energy efficiency at 0.0861 but excels in aesthetic appeal (0.1312) and community impact (0.1380), with a moderate score in accessibility (0.0739). This emphasizes its strengths in design and community benefits, despite lower energy efficiency. Educational Institution D demonstrates balanced performance with scores of 0.1052 in energy efficiency, 0.0875 in aesthetic appeal, 0.1104 in community impact, and the highest score in accessibility at 0.1724, highlighting its strong emphasis on accessibility despite lower aesthetic appeal. Healthcare Facility E achieves the highest score in energy efficiency at 0.1435 and strong aesthetic appeal at 0.1166, with community impact and accessibility scores of 0.1104 and 0.0985 respectively, showcasing overall strong performance, particularly in energy efficiency. This analysis provides insights into the strengths and weaknesses of each project, aiding decision-makers in architectural management to conduct thorough and balanced evaluations.

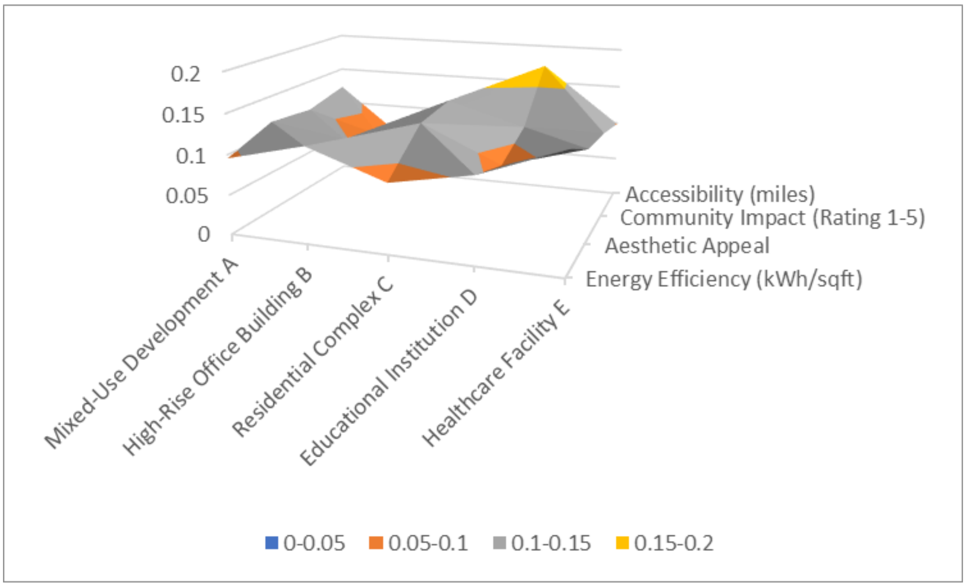


**FIGURE 3.** Weighted normalized decision matrix

Figure 3 presents the weighted normalized data for five architectural projects assessed using the TOPSIS method across four criteria: energy efficiency, aesthetic appeal, community impact, and accessibility. Mixed-Use Development A achieves scores of 0.0956 for energy efficiency, 0.1166 for aesthetic appeal, 0.1104 for community impact, and 0.1232 for accessibility, indicating strong performance across all parameters, particularly excelling in accessibility. High-Rise Office Building B scores higher in energy efficiency at 0.1196 but lower in aesthetic appeal (0.1021), community impact (0.0828), and accessibility (0.0493), highlighting its strength in energy efficiency but weakness in other areas, notably accessibility. Residential Complex C scores lower in energy efficiency at 0.0861 but excels in aesthetic appeal (0.1312) and community impact (0.1380), with a moderate score in accessibility (0.0739), emphasizing its strengths in design and community benefits despite lower energy efficiency. Educational Institution D demonstrates balanced performance with scores of 0.1052 in energy efficiency, 0.0875 in aesthetic appeal, 0.1104 in community impact, and the highest score in accessibility at 0.1724, underscoring its strong emphasis on accessibility despite lower aesthetic appeal. Healthcare Facility E achieves the highest score in energy efficiency at 0.1435 and strong aesthetic appeal at 0.1166, with community impact and accessibility scores of 0.1104 and 0.0985 respectively, showcasing overall strong performance, particularly in energy efficiency. This analysis provides a comprehensive overview of each project's strengths and weaknesses, assisting decision-makers in architectural management to conduct thorough and balanced evaluations.

**TABLE 5.** The Ideal Best ($A^+$) and Ideal Worst ($A^-$) Values

| | Energy Efficiency (kWh/sqft) | Aesthetic Appeal | Community Impact (1–5) | Accessibility (miles) |
|---|---|---|---|---|
| $A^+$ | 0.1435 | 0.1312 | 0.0828 | 0.0493 |
| $A^-$ | 0.0861 | 0.0875 | 0.1380 | 0.1724 |

Table 5 outlines the ideal best (A+) and ideal worst (A-) values for architectural projects evaluated using the TOPSIS method across four parameters: energy efficiency, aesthetic appeal, community impact, and accessibility. Ideal Best (A+) values signify optimal performance. The highest energy efficiency value, at 0.1435, represents the project achieving the utmost efficiency. Aesthetic appeal is best represented by a score of 0.1312, indicating the most visually appealing design. The ideal community impact score is 0.0828, reflecting the most positive impact on the community. Lastly, the best accessibility value is 0.0493, indicating the closest proximity to public transport, which is highly desirable. Ideal Worst (A-) values represent the least favorable performance. The lowest energy efficiency score, at 0.0861, signifies the least efficient project. Aesthetic appeal is least favorable at 0.0875, representing the least attractive design. The worst community impact score is 0.1380, indicating the most negative impact on the community. Accessibility is worst at 0.1724, indicating the project furthest from public transport. These ideal values serve as benchmarks for evaluating each project's performance. By comparing actual project scores to these benchmarks, decision-makers can assess strengths and weaknesses. Projects closer to the A+ values are considered better performers, while those closer to the A- values indicate areas needing improvement. This approach supports informed and balanced decision-making in architectural management by highlighting best and worst-case scenarios across evaluation parameters.

**TABLE 6.** The Ideal Solution ($S_i^+$) and the Negative-Ideal Solution ($S_i^-$)

| Alternative | $S_i^+$ | $S_i^-$ |
|---|---|---|
| Mixed-Use Development A | 0.0934 | 0.06427 |
| High-Rise Office Building B | 0.03771 | 0.13983 |
| Residential Complex C | 0.08336 | 0.10781 |
| Educational Institution D | 0.13896 | 0.03359 |
| Healthcare Facility E | 0.05833 | 0.10182 |

Table 6 illustrates the separation distances of each architectural project from the ideal solution (SI Plus) and the negative-ideal solution (SI Negative) using the TOPSIS method. These distances provide insights into how each alternative compares to the best and worst possible scenarios. Mixed-Use Development A has an SI Plus value of 0.0934 and an SI Negative value of 0.0643, indicating a moderate distance from both the ideal and negative-ideal solutions. This suggests a balanced performance across all parameters without exceptional performance in any. High-Rise Office Building B shows a lower SI Plus value of 0.0377, indicating it is closer to the ideal solution compared to other projects. However, its SI Negative value is the highest at 0.1398, suggesting it is also relatively close to the worst-case scenario.

Figure 4 visually represents the separation distances of each architectural project from the ideal solution (SI Plus) and the negative-ideal solution (SI Negative) using the TOPSIS method. These distances provide valuable insights into how each alternative compares to the best and worst possible scenarios. Mixed-Use Development A is depicted with an SI Plus value of 0.0934 and an SI Negative value of 0.0643, indicating a moderate distance from both the ideal and negative-ideal solutions. This suggests a balanced performance across all parameters without exceptional strengths or weaknesses. High-Rise Office Building B exhibits a lower SI Plus value of 0.0377, indicating it is closer to the ideal solution compared to other projects. However, its SI Negative value is the highest at 0.1398, suggesting it is also relatively close to the worst-case scenario. This polarized performance underscores strengths in certain parameters but weaknesses in others.

Table 7 displays the Closeness Coefficient (Ci) values and the corresponding ranks for five architectural projects using the TOPSIS method. The Closeness Coefficient indicates how close each alternative is to the ideal solution, with higher values representing better performance. High-Rise Office Building B ranks first with a Ci value of 0.7876, indicating it is the closest to the ideal solution among all projects. This suggests that despite some weaknesses, it performs exceptionally well overall, making it the top choice in this evaluation. Healthcare Facility E ranks second with a Ci value of 0.6358. This

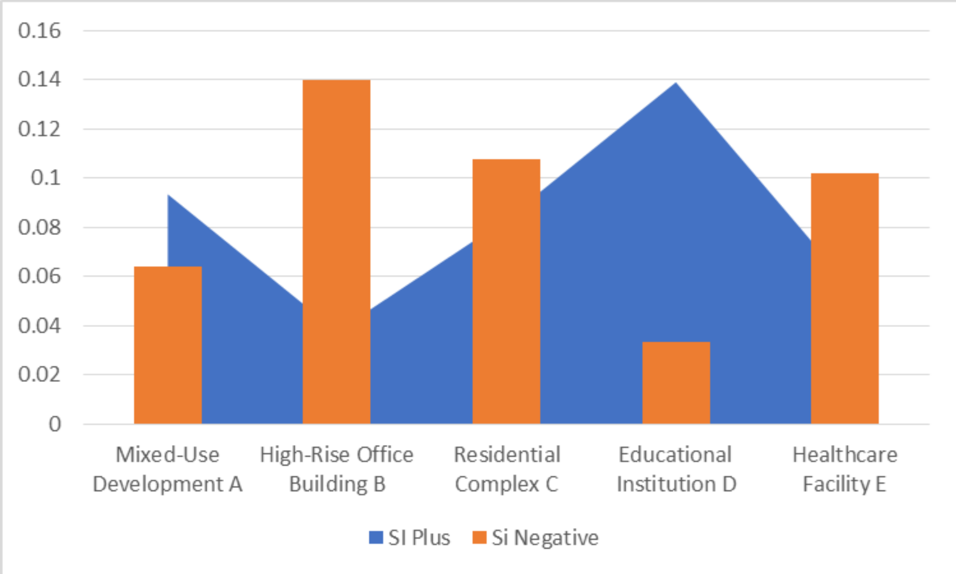


**FIGURE 4.** The ideal solution (SI Plus) and the negative-ideal solution (SI Negative)

**TABLE 7.** Rank

| **Alternative** | $C_i$ | **Rank** |
|---|---|---|
| Mixed-Use Development A | 0.40765 | 4 |
| High-Rise Office Building B | 0.78759 | 1 |
| Residential Complex C | 0.56394 | 3 |
| Educational Institution D | 0.19466 | 5 |
| Healthcare Facility E | 0.63579 | 2 |

shows a strong performance across the parameters, making it a highly favorable option, although slightly behind High-Rise Office Building B in terms of overall closeness to the ideal solution. Residential Complex C holds the third rank with a Ci value of 0.5639. This reflects a balanced performance, with the project being moderately close to the ideal solution, suggesting it is a good but not the best option among the evaluated projects. Mixed-Use Development A is ranked fourth with a Ci value of 0.4077. This indicates a relatively average performance, as it is closer to the negative-ideal solution compared to the top-ranking alternatives, pointing to several areas that need improvement. Educational Institution D is ranked last with a Ci value of 0.1947, highlighting that it is the furthest from the ideal solution among all the projects. This suggests that it has the most room for improvement and is currently the least favorable option in this evaluation. These Closeness Coefficient values and ranks provide a clear comparative understanding of each project's performance, aiding decision-makers in identifying the most optimal architectural projects based on their proximity to the ideal solution.

Figure 5 presents the Closeness Coefficient (Ci) values and corresponding rankings for five architectural projects evaluated using the TOPSIS method. The Ci values indicate how closely each alternative approaches the ideal solution, where higher values signify better performance. High-Rise Office Building B achieves the highest rank, with a Ci value of 0.7876, indicating it is closest to the ideal solution among all projects. This suggests strong overall performance despite some weaknesses, making it the top choice in this evaluation. Healthcare Facility E follows closely in second place with a Ci value of 0.6358, indicating strong performance across the parameters and positioning it as a highly favorable option, though slightly behind High-Rise Office Building B in closeness to the ideal solution. Residential Complex C holds the third rank with a Ci value of 0.5639, reflecting a balanced performance and moderate proximity to the ideal solution. This suggests it is a good option but not the best among the evaluated projects. Mixed-Use Development Ais ranked fourth with a Ci value of 0.4077, indicating a relatively average performance. It is closer to the negative-ideal solution compared to higher-ranking alternatives, indicating areas that require improvement. Educational Institution Dranks last with a Ci value of 0.1947, indicating it is the furthest from the ideal solution among all projects. This suggests significant room for improvement and positions it as the least favorable option in this evaluation. These Ci values and rankings provide

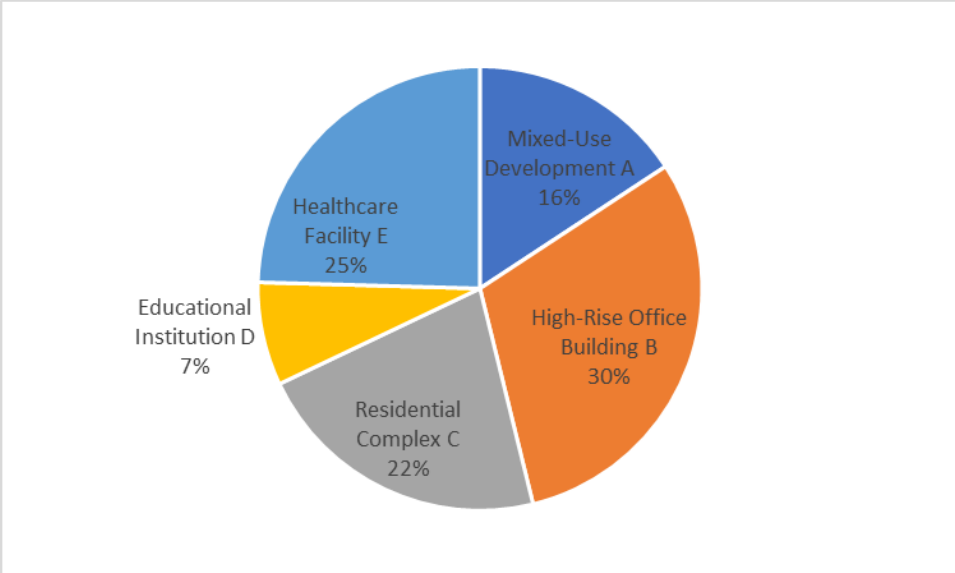


**FIGURE 5.** RANK

a comparative understanding of each project's performance, assisting decision-makers in identifying the most optimal architectural projects based on their proximity to the ideal solution.

## 4. CONCLUSION

The assessment of architectural projects using the TOPSIS method across energy efficiency, aesthetic appeal, community impact, and accessibility provides valuable insights into their overall effectiveness and suitability across varied urban contexts. Each criterion significantly influences the sustainability, attractiveness, social impact, and practicality of architectural designs, shaping decisions that resonate deeply within communities and industries. Among the evaluated projects, High-Rise Office Building B emerges as a standout performer in energy efficiency, demonstrating a strong commitment to reducing environmental impact. This positions it favorably in environments prioritizing sustainability metrics, despite scoring slightly lower in aesthetic appeal and community impact. In contrast, Residential Complex C excels in aesthetic appeal and community impact, showcasing designs that enhance livability and community cohesion, particularly crucial in residential developments emphasizing quality of life and social integration. Healthcare Facility E demonstrates excellence in both energy efficiency and aesthetic appeal, essential qualities for healthcare environments aiming to optimize efficiency without compromising patient comfort and well-being. This underscores its role not only as a functional facility but also as a contributor to urban aesthetics and sustainability goals. Mixed-Use Development A exhibits balanced performance across all criteria, reflecting its adaptability and versatility in mixed-use urban settings where diverse needs must harmoniously coexist. Educational Institution D, while strong in accessibility, faces challenges in other metrics, highlighting opportunities for improvement in aesthetic design and community engagement strategies. This underscores the importance of integrated planning that enhances both physical accessibility and overall aesthetic appeal to create conducive learning environments. Establishing ideal benchmarks (A+ and A-) provides a structured framework for evaluating project performance, aiding decision-makers in identifying strengths and areas for improvement. Projects closer to the A+ benchmarks signify optimal performance across all evaluated criteria, while those closer to A- benchmarks indicate significant opportunities for enhancement. The TOPSIS method proves invaluable in objectively evaluating architectural projects, offering a holistic approach to decision-making that considers diverse stakeholder interests and urban sustainability goals. By leveraging these insights, stakeholders can make informed decisions that not only meet functional requirements but also contribute positively to the built environment, enhancing urban quality of life and sustainability.

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