

Article

Strategic Approaches to Design Teams for Construction Quality Management and Green Building Performance

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Abstract: Buildings exert a profound influence on the environment, with the design phase recognized as the pivotal determinant of a building's overall performance. Green building design, in particular, introduces heightened complexity, where the attributes of the design team play a pivotal role in shaping performance outcomes. Consequently, the characteristics of the design team emerge as crucial factors in the enhancement of both green building design performance and client attributes. This study aims to empirically examine a model formulated to gauge the extent to which Effective Design Team Attributes contribute to the enhancement of performance in designing green buildings and influencing client attributes. To achieve this objective, a comprehensive questionnaire survey was administered to professionals within the architecture and engineering domains actively engaged in the design and consulting sectors of the building industry. The collected data underwent meticulous scrutiny for authenticity and dependability using the WINSTEPS 5.2.5 software before undergoing subsequent analysis. Statistical analyses were conducted using SPSS version 19, with Principal Components Analysis (PCA) and the Structural Equation Modeling (SEM) approach implemented through Amos version 18 to derive the most robust model. The findings underscore the pivotal role of an adeptly managed design team in significantly improving both the performance of green building designs and the qualities of clients. Rasch's analysis confirmed the validity of our 5-point Likert scale for Design Green Building Performance (DGBP), Effective Design Team Attributes (EDTA), and Client Qualities (CQ). All items demonstrated excellent reliability, separation, and discrimination, ensuring robust data quality. Dimensionality tests revealed the appropriateness of response categories, indicating satisfactory scale performance. The Effective Design Team Model, validated through Principal Components Analysis (PCA), exhibited a satisfactory fit, supported by significant chi-square statistics, high goodness-of-fit indices, and acceptable root mean square residual values. Client attributes displayed a strong association with effective design team management, validating key model elements. The intricacies inherent in the design process can be mitigated by adopting the green design charrette approach. Consequently, the establishment of an effective design team, coupled with green design leadership, active participation, and clarity in roles and responsibilities, emerges as a potent strategy for elevating the performance level of green building designs.

Keywords: green design; design team attributes; performance; clients' qualities; design charrette-integration



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1. Introduction

The design phase stands as a critical element significantly influencing the performance of the built environment. Consequently, it becomes imperative to construct, design, and manage this environment in a manner that enhances its quality [1]. Among the key sectors experiencing growing interest, the domain of green buildings emerges prominently. Designing and evaluating green buildings have garnered substantial attention from researchers

over recent decades. Green building projects are characterized by their unique features, encompassing diverse details and involving varied stakeholders, ranging from consultants and contractors to material suppliers, local communities, and governmental bodies [2]. Coordinating these involved entities within the project implementation's context poses a considerable challenge. Current understanding lacks comprehensive insights into the design and evaluation of green buildings, with previous studies predominantly focusing on technical aspects and insufficiently highlighting holistic interactions among diverse stakeholders. Literature results indicate a significant correlation between the understanding of key stakeholders and their levels of knowledge, positions, and practices. Despite growing interest, the design and evaluation of green buildings still face limitations and gaps in comprehension [3]. While some studies have explored the technical aspects of green buildings, few have examined the organizational and human interactions that influence the design process. This gap underscores the need for research that integrates stakeholder perspectives and interdisciplinary interactions to enhance green building design practices. The research underscores the urgent need to bridge these gaps and enhance our understanding of the perspectives of diverse stakeholders regarding the design and evaluation of green buildings. Moreover, the findings highlight variations in viewpoints among different stakeholders regarding the design and evaluation of green buildings. Therefore, exploring their positions and practices is crucial for achieving a deeper understanding of these dynamic interactions [4]. While stakeholder interaction is pivotal for establishing sustainable working methods, the roles and involvement of stakeholders change throughout various stages of the project life cycle. Decisions made during the conceptual design phase have a substantial impact on the overall project performance [5]. However, the interdisciplinary interaction among stakeholders within the process tends to be overlooked. Construction projects involve individuals with diverse backgrounds, skills, knowledge, and orientations, and organizing work efficiently in teams with diverse skills and knowledge proves more effective than individual efforts [3]. Several groups of professionals play different roles in construction projects, with a high level of fragmentation in the division of tasks and responsibilities among the professionals that integrate the teams (architects, engineers, and surveyors, among others) [6]. It is known that the effectiveness levels of design teams in the construction industry are directly related to teamwork, and this is reinforced in multidisciplinary design teams where individual team members have specific competencies [7]. Furthermore, the success of construction projects heavily relies on client performance. Client performance stands as a fundamental variable influencing the overall project success, with the quality of client representatives potentially affecting the performance of the design team. Despite the pivotal role of clients as essential elements in construction projects, research regarding the impact of client characteristics and design team members on the performance of green building design has been neglected for an extended period. In light of the above, the primary problem addressed in this research is the lack of a comprehensive understanding of how design team attributes influence the performance of green building designs and client attributes. Despite the recognized importance of green buildings, there is limited knowledge of the effective management of design teams to optimize green building outcomes. This research aims to contribute valuable insights into understanding stakeholder interactions in green building design projects. By emphasizing organizational and human interactions, the research seeks to enhance practices and decision-making based on more comprehensive and effective foundations, ultimately improving coordination among stakeholders and ensuring the effective achievement of green building design objectives.

2. Literature Review

2.1. Building Performance

To date, extensive research has examined the advantages of sustainable construction for users, clients, and communities. Hu and Skibniewski [8] suggested that sustainable construction could yield economic benefits by saving energy and enhancing environmental conditions. The built environment and construction sector are widely recognized for their

significant environmental impacts [9], with buildings consuming about 40% electricity, 30% water, and producing substantial waste. A comprehensive approach to high-performance building design is essential to improve energy efficiency, indoor environmental quality, water efficiency, material use reduction, and site sustainability [10]. Over the past two decades, there has been notable growth in designing high-performance buildings, also referred to as green or sustainable building design [11,12]. Waste reduction during the planning and design stages is often overlooked despite its importance in mitigating waste generation. To enhance environmental building performance, a broader understanding of sustainability is required, as traditional design processes may not be environmentally friendly. High-performance building design typically involves several stages, including early design, preliminary design, design development, detailed design, and construction documentation [10]. During early design (or conceptual design), architects and clients establish initial design strategies without detailed building performance analysis by system engineers. Subsequent stages, such as preliminary and detailed design, involve heating and cooling load calculations and building performance simulations by system engineers. Increasing evidence indicates that GBs can be cost-effective, with lower or no additional cost, when integrated design and resource-efficient approaches are applied [13]. However, constraints from the conceptual design stage may limit improvements in later design stages. The project life cycle typically comprises conception, planning, execution, and termination stages [5], emphasizing primary goals, customer needs, and resource requirements in the initial stages and detailing materials, construction processes, modifications, and maintenance in later stages. Decisions made in the conceptual design stage significantly impact the final building performance. Integrated building design integrates design and performance analysis across various stages, including conceptual design, using Building Information Modeling (BIM) throughout the building's lifecycle, from design through construction to operation [10].

2.2. Client Roles and Attributes

Given that client performance significantly impacts the overall success of a project, the quality of interaction with clients is a crucial aspect in achieving the project's outlined objectives [14]. Attaining these goals requires a profound understanding by clients regarding project requirements and the ability to effectively articulate them to other stakeholders, ensuring a clear definition of the scope and technical specifications of the work to be accomplished [14]. In the context of financing, clients must ensure the provision of adequate funding for the project, in addition to committing to timely payments and obtaining necessary approvals to ensure the smooth flow of financial operations. Furthermore, clients must make swift and informed decisions to expedite project progress. One of the challenges facing the implementation of "green" innovations in the construction sector is the lack of demand from clients, as indicated in the literature review [1]. If a project can be completed on time or even earlier than the completion date, the overhead costs, labor costs, and interest costs will be reduced. Simultaneously, early completion enables clients to make more profits as revenue can be earned earlier [15]. On the other hand, studies [1,16–20] focus on factors influencing the characteristics of the design team (DTA) during the design process of green buildings. They highlight the impact of client characteristics on the quality levels of design team features. As client organizations are often diverse, decision-making internally becomes complex. Team–client consensus can significantly influence project performance, making effective management skills, including a comprehensive management system, a crucial necessity as clients collaborate and coordinate with other stakeholders [13]. Regarding client experience, Alinaitwe's research [21] affirms that over 90% of construction clients oppose training on green design principles in their companies, revealing a lack of knowledge and experience among client representatives during the green building design process. This emphasizes the need for clients to carefully consider training to enhance awareness of green design challenges. Lastly, emphasizing the importance of client support for contractors by providing timely information, determining

site readiness, adjusting project duration, etc., is essential to ensure project completion within the specified timeframe [22]. Client behavior, encompassing integrity, discipline, effective coordination, commitment, empathy, respect, and trust, is a fundamental factor influencing project success. Confirming client commitment is a necessary first step towards completing a green building project [4].

2.3. Design Team Performance

The design and assessment of green buildings have emerged as a primary focus for researchers over the past few decades [3]. Numerous experiments have revealed that implementing green building initiatives through the evaluation of current operational efficiency contributes to waste reduction, enhances drivetrain performance, and saves financial resources. Presently, modern construction projects, particularly green buildings, have witnessed an increase in complexity and scale, involving various stakeholders such as consultants, contractors, material suppliers, the general public, government institutions, and others [2]. Coordinating all these parties in the context of project implementation poses a significant challenge. Typically, in the early stages of green building design, significant emphasis is placed on contemplating environmental ideas and their impacts [9]. The early stage of green building design is considered a critical moment for evaluating major environmental impacts, especially when selecting building form and envelope characteristics [23,24]. Furthermore, research indicates that decisions made in the early stage play a significant role in determining project performance [1]. To aid decision-making, building simulation is widely used in the late design stages, but its application is still limited in the early stages, in which design decisions have a major impact on final building performance and costs [25]. Therefore, improving project performance relies on selecting the appropriate design team equipped with the knowledge and resources necessary to translate green building performance goals into practical designs [24,26]. Based on previous research, the lack of understanding by the design team of integrated multi-disciplinary processes is a major obstacle to the effective implementation of green design processes. [27] emphasizes the importance of effective team management and interaction. Several studies show that good organization and effective communication can enhance the performance of design teams [1,24,28–30]. In summary, the presence of an effective design team is of vital importance for achieving excellent performance, whether in terms of time, cost, or environmental sustainability requirements. Design team characteristics are fundamental variables that play a role in determining team performance in early design stages, reflecting a range of prominent variables: skill; experience; communication; collaboration; innovation; and procurement. To achieve effective integration between design tasks, procurement processes, and construction, careful coordination and management of the design team are imperative [31]. Design teams face significant challenges, with the lack of necessary resources for developing, enhancing, and evaluating project performance and programs being a major impediment [32]. The importance of providing efficient technologies and effective decision-making tools for design teams involved in green building design has been emphasized [28]. Factors influencing construction costs have been classified into three main categories: project characteristics (such as building size and location); design team characteristics (such as the experience of the design firm); and external factors (such as climatic conditions) [8]. It appears that decisions related to sustainable building design have a fundamental impact on its final cost, although they represent a relatively small percentage, not exceeding 10%. Thus, the understanding and consideration of the influence of the design team are somewhat limited and calculated [33].

Effective communication within design teams is strongly emphasized, with team leaders who can empower and encourage team members to communicate is a vital aspect. Additionally, individual readiness, emotions, participation, and an interest in improving communication skills are deemed necessary for achieving effective communication among teams. The effective use of Information and Communication Technologies (ICTs) is presented as a key strategy to enhance the efficiency of design and construction teams [34]. To

support high-performance green design, the design team needs precise guidance to identify sustainable goals in the early stages of design. Team success is vital, as every decision in this stage directly influences project performance [4]. Design teams consist of individuals with diverse backgrounds and orientations, hence the need for careful organization and guidance to ensure their effective collaboration. Design charrette techniques are considered an effective means to promote communication and collaboration within design teams [35].

The study highlights the importance of team management characteristics in improving customer satisfaction and the performance of green building design. These characteristics must be carefully examined to ensure the success of design teams in achieving outstanding performance. From the literature review, sustainable design, charrette/integration, leadership and decision-making effectiveness, communication efficiency, and conflict resolution were chosen to be explored. This gave rise to the research question, “To what extent do the attributes of effective design team management moderate the client’s qualities and the performance of design green buildings?”.

3. Materials and Methods

3.1. Theoretical Framework

This investigation scrutinized the impact of client characteristics and design team attributes on the performance of green building designs. The conceptual model, delineated in (Figure 1), incorporates two endogenous variables. The first, Client Qualities (CQ), encompasses three sub-variables: Managing Design Process (MDP); Client Representative Quality (CRQ); and Client Commitment (Cco). Simultaneously, the exogenous variable is the resultant factor, Design Green Building Performance. However, the second endogenous variable is Effective Design Team Management attributes (EDTM), comprising sub-variables designated as Design Green Charrette (DGC), Design Team Leadership Effectiveness (DTlead), and Design Team Communication Effectiveness (DTcomu). Energy Efficiency, Indoor Air Quality, Sustainable Site and Management, Materials and Resources, Water Efficiency, and Environmental Innovations (EI) are the six sub-measurement variables that make up the third variable, Design Green Building Performance (DGBP), which is modeled after the Green Building Index (GBI). It is noteworthy that the EDTM variable serves as an intervening factor, posited to exert a moderating influence on the relationship between client characteristics and the performance of green building designs.

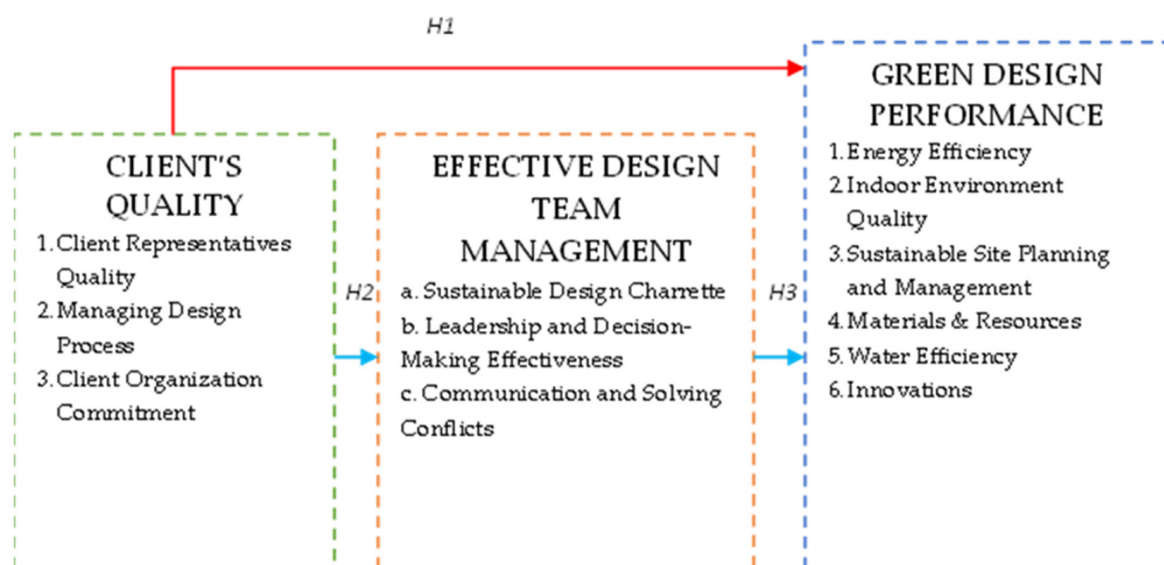


Figure 1. Research theoretical framework.

The novelty of this work lies in its empirical examination of the model formulated to gauge the extent to which effective design team attributes contribute to the enhancement of

green building performance and client attributes. This study employs a comprehensive methodology, including a questionnaire survey, statistical analyses using SPSS and Amos, and validation through Rasch analysis and PCA. The unique contributions of this research include:

1. A validated model demonstrating the significant impact of design team management on green building performance and client attributes;
2. Insights into the role of client characteristics and their interaction with design teams in achieving green building objectives;
3. Practical recommendations for improving green building design practices through effective team management and stakeholder collaboration.

3.2. Hypothesis

Three hypotheses are presented in the study:

H1: *Client/client representative quality affects performance levels in the design of green buildings.*

H2: *The level of design performance of green buildings is influenced by the attributes of the design team's quality.*

H3: *Efficient design team Management Characteristics bridge the gap between client characteristics and the design performance level of green structures.*

3.3. Research Methodology

An in-depth triangulation method was used in this study to harmonize the quantitative and qualitative methods of data collection. The research unfolded in three pivotal stages. The initial phase encompassed an exhaustive literature review, validated by a preliminary questionnaire survey. Subsequently, the second stage involved the application of semi-structured interviews for comprehensive data acquisition. Semi-structured interviews were conducted to gain in-depth insights from professionals in the architecture and engineering domains actively engaged in green building design and construction. The experts involved in this study possess extensive backgrounds in architecture, engineering, and sustainable construction. They include professionals with advanced degrees and significant experience in green building design and project management, ensuring a high level of expertise and insight. The specific questions asked during these interviews were designed to explore key themes such as the attributes and effectiveness of design teams, the challenges and best practices in managing green building projects, and the impact of client roles and attributes on project outcomes. The qualitative data collected from these interviews were transcribed and analyzed using thematic analysis. This involved coding the data to identify recurring themes and patterns, which were then systematically categorized to provide a comprehensive understanding of the factors influencing design team effectiveness and green building performance. The final phase constituted a quantitative approach, employing a questionnaire survey to gather information for subsequent statistical analysis. This study specifically validated three variables—Design Green Building Performance (DGBP), Client Qualities (CQ), and Effective Design Team Management (EDTM). To gauge the efficacy of green building design from the perspective of professionals, a survey packet was disseminated among engineers and architects affiliated with design consulting firms. A total of 274 survey forms were distributed, yielding a response rate of 37.1%, with 102 valid responses. The collected data underwent Rasch modeling through the WINSTEPS program to scrutinize validity and reliability. Subsequently, the data were inputted and analyzed using SPSS version 19. Principal Components Analysis (PCA) and the Structural Equation Modeling (SEM) approach, implemented through Amos version 18, were employed to estimate the optimal model.

4. Results

4.1. Validity and Reliability of Data

To examine the underlying structure or the structure of interactions between the variables, Rasch analysis was used. When a theoretical framework is based on a literature study as opposed to theories for which factor analysis is more suited, the Rasch test is the appropriate test. Before analysis, Linacre evaluated the 5-point Likert scale's performance in accordance with the standards (2006). Each category had more than 10 observations. The results for DGBP, EDTA, and CQ in Table 1's rating scale category function indicated no category disordering. Also, the monotonic advance criterion served to distinguish between the observed average measures and the category measure. Observing that each category's Outfit MNSQ values were similar to infit MNSQ values but were less than 2.00 indicated that each label contained measurement information as opposed to noise from the data. The use of the response categories was expected and intended, as shown by the threshold estimations rising with the category label. These data suggested that the rating scale categories for the DGBP, EDTA, and CQ variables were actually satisfactory.

Table 1. The key reliability and validity criteria for the attributes of successful design teams.

Total Variance in Observations			Category Measures			Threshold Estimates		
DGBP	DT	CQ	DGBP	DT	CQ	DGBP	DT	CQ
−1.78	−1.74	−3.52	−3.01	−2.99	−4.75			
−0.93	−0.87	−1.93	−1.38	−1.37	−2.5	−1.67	−1.65	−3.58
−0.16	−0.13	−0.33	−0.1	−0.08	−0.04	−0.81	−0.8	−1.38
0.61	0.6	1.01	1.35	1.33	2.5	0.49	0.52	1.29
1.31	1.28	2.6	3.23	3.19	4.83	1.99	1.93	3.66
Rasch Principal Components Analysis (RPCA)								
						DGBP	DT	CQ
Total variance in observations						68.80%	58.20%	20%
Variance explained by measures						65.10%	63.90%	64.90%
Unexplained variance in 2nd contrast						12.20%	13.10%	22.10%
Reliability and Separation index								
			Model RMSE	Mean	Adj-SD	Separation		Reliability
Behavior measures								
DGBP			0.26	0.11	1.09	3.73		0.95
DT			0.27	0.11	1.04	3.35		0.92
CQ			0.66	0.17	1.6	2.11		0.82
Item measures								
DGBP			0.12	0.13	0.61	4.73		0.96
DT			0.12	0.14	0.63	4.95		0.96
CQ			0.16	0.49	1.18	7.04		0.98

4.1.1. Reliability and Separation Index

Table 1 shows that all variables' item difficulty measures had very high reliability (0.96, 0.96, and 0.98). This indicated that other comparable samples from similar populations might easily reproduce the item difficulty ordering. The item separation index was extraordinarily high, well above the minimum acceptable value of 2.00. The SD was within the allowed range. The item measure RSME ranged from 0.12 to 0.16, which is regarded as excellent. These statistics, when viewed collectively, show good item-to-item separation.

4.1.2. Dimensionality Test of Variables

As shown in Table 2, all items for the DGBP with a five-category response model had acceptable outfit MNSQ statistics of between 0.60 and 1.40; the lowest outfit was 0.66, and the highest was 1.37, with the exception of item 1 in the CQ variable and item 18 in the DGBP variable, indicating that the items were not redundant, with the possibility that high values indicated a lack of homogeneity with other items in the subscale. All items had PTMEA correlations that ranged from moderate to extremely high (0.24 to 0.81) and were higher above the correlation's crucial threshold of 0.20. Positive correlation values showed that all items had good discrimination since they were all systematically associated in the same direction, assessing the same latent variable called “DGBP, EDTA, and CQ.”.

Table 2. Item Statistics: misfit order and item correlations.

Variables	MNSQ				PTMEA	
	Outfit		Infit		Lowest	Highest
	Lowest	Highest	Lowest	Highest		
DGBP	0.66	1.37	0.67	1.46	0.46	0.81
EDTA	0.67	1.35	0.67	1.38	0.48	0.76
CQ	0.7	1.63	0.71	1.29	0.24	0.62

4.2. Effective Design Team Model

In order to validate the variables found in the literature review and investigate the connections between the design performance of green building variables and measuring variables of client qualities and effective design team management attributes, a Principal Components Analysis (PCA) was carried out using AMOS version 18. Figure 2 illustrates the model that was tested.

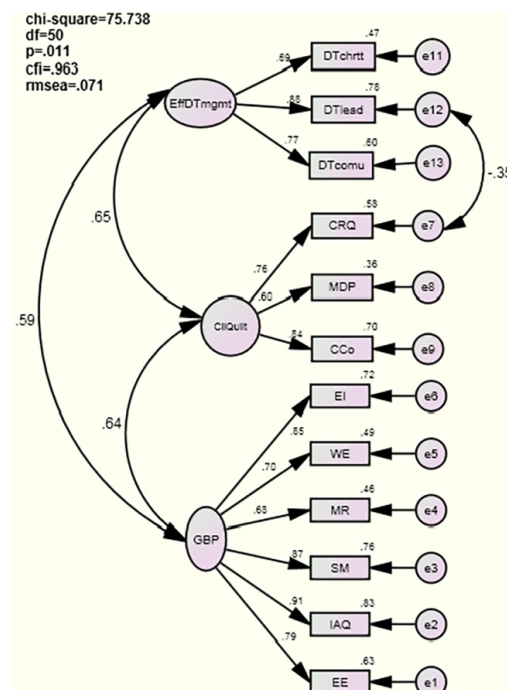


Figure 2. Principal Components Analysis.

The likelihood ratio chi-square statistic tool ($\chi^2 = 75.738$, 50 df) had a statistical significance level of $p = 0.0011$, which is higher than the threshold level of 0.05, indicating a satisfactory fit. The goodness-of-fit index (GFI) was greater than 0.90 with a value of 0.963. The Normed Fit Index (NFI), which was over 0.90, yielded 0.96. Given the quite strong

correlations in the initial correlation matrix, another metric, the root mean square residual (RMSR), showed that the average residual correlation was 0.071, which is acceptable. The incremental fit and parsimonious fit indices indicate that the model was appropriate when all measurements were within acceptable ranges.

A loading greater than 1.0 was used to test the AMOS estimates for the measurement model, as shown in Table 3. The outcome demonstrated that there were no inaccurate estimates. The extent to which the specific indicators represent the hypothesized constructs was then used to gauge the overall model's fitness. The AMOS output likelihood ratio chi-square, goodness-of-fit index, Normed Fit Index, and root mean square residual fit metrics were examined for four general model fit assumptions.

Table 3. Principal Components Analysis (PCA) results.

Fit Measures	Recommended Measures	Result
χ^2	$p > 0.05$	0.011
CFI	> 0.90	0.096
RMSEA	0.04–0.08	0.071
NFI	> 0.90	0.902

Figure 3 shows that all factor loadings for samples range from 0.60 to 0.91, indicating that all items chosen for the research had high factor loadings and had the proper internal consistency. The client attributes had the highest association with effective design team management (0.65), while the client representative quality had the lowest correlation with good leadership (-0.35).

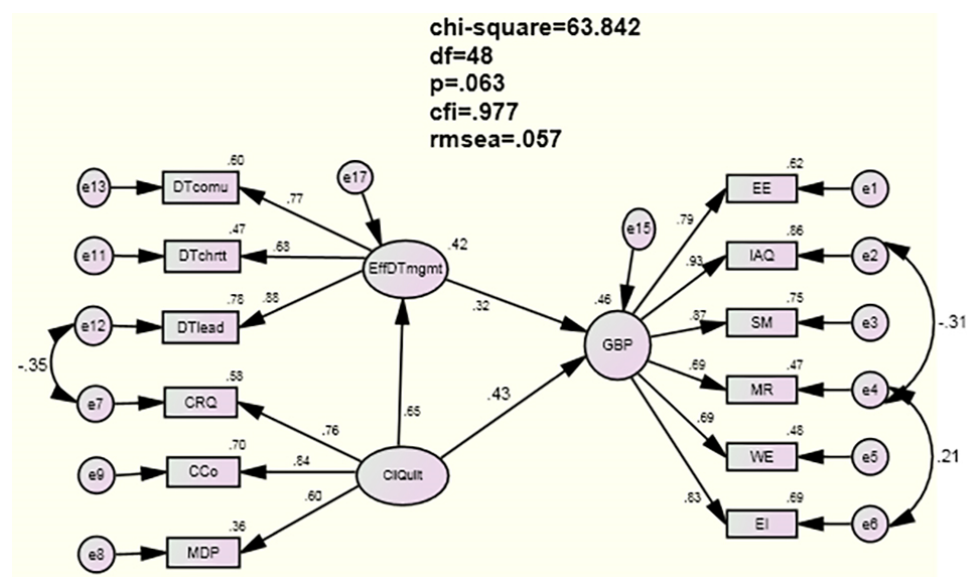


Figure 3. Effective design team model.

Also, the degree of convergence between the model's two higher-order latent exogenous elements (customer characteristics and efficient design team management) was investigated. More evidence of discriminating between client characteristics and elements that contribute to effective design team management might come from a minor connection.

Discrimination between the two higher-order components would be demonstrated by a statistically significant difference in χ^2 for the model. The inter-correlations between the six latent components were then examined using a test of six correlated factors. Stronger correlations between the three components for effective design team management than between the three elements for client attributes offered even more proof of discrimination and supported Hypotheses 1 and 2. By looking for correlations between the model's

Outputs and CQ variables, Hypothesis 3 was put to the test. A meaningful association between the given EDTA, CQs, and GDP components was demonstrated by significant correlations ($p < 0.05$), which supported the corresponding hypothesis.

5. Discussion

5.1. Building an Effective Design Team to Enhance Performance Level of Design Green Buildings

Understanding how to create productive teams is crucial for improving an organization's performance. It includes elements of the organizational setting that support the effectiveness of teams, including selection criteria, the composition of teams, member diversity, education, and training, as well as characteristics of individual team members, such as personality and skill, and activities related to teamwork, such as communication and conflict resolution. When teams are properly utilized by organizations, they grow practical tactics that boost output. To accomplish this, associations gain from improving their capacity for making decisions, increasing individual participation and involvement, and offering opportunities for development, as well as providing opportunities for individuals to improve their performance, which is accomplished by creating efficient teams.

The definition of team effectiveness includes member conduct, attitude, and team performance. Performance, attitude, behavior, team member styles, and corporate culture all have a role in how effective a team is. Performance efficiency is attaining the desired result while employing an economic strategy, as opposed to performance effectiveness, which is achieving the exact result that was anticipated. As a result, we should concentrate on team performance, which may be separated into the two broad categories of effectiveness and efficiency.

It takes a lot of dedication to create a successful team, especially when it comes to setting and managing clear, agreed-upon goals, managing member involvement and trust, and being prepared to share information and risk. Team dynamics can influence efficacy with regard to this problem. One key factor in determining team efficiency is the interpersonal relationships among team members. Effective team design strategies should, therefore, concentrate on team dynamics and interpersonal interactions in addition to the allocation of human resources.

Certain traits of an effective team enable its members to work more effectively and productively. Effective teams, for instance, are those in which members share a shared identity, set of goals, objectives, and leadership, as well as openly discuss achievements and failures. Determining team goals and defining their direction from the start, along with good leadership among an integrated team and the use of appropriate resources, is therefore necessary to achieve improved performance of green design projects.

Team cognitive complexity and the process of knowledge integration are key determinants of team performance in knowledge-intensive jobs. To effectively contribute to the performance of the team, team members should have both task and team competencies. Effective teams should also consist of individuals who can work together, cooperate, and make choices quickly and effectively. Even if the complexity of current building projects varies, they always require the skills of different people to be coordinated and properly managed as a team. The importance of design management is becoming increasingly acknowledged in the successful execution of complex construction projects, particularly due to the greater intricacy of green design processes. Many of the quality and effectiveness issues encountered during the design process are caused by inadequate design management. Poor design process performance is significantly impacted by poor design management.

5.2. Using Green Design Charrette Approach to Enhance Integration during Green Design Process

In an effort to make their practices even more "green", numerous design professional bodies are developing associations of design team members and early communication channel activation to provide all project stakeholders a chance to have an impact on the project. But as the need for green design grows, it seems that a new kind of charrette is emerging. Others refer to it as a High-Performance Design Charrette or Sustainable

Design Charrette, while others refer to it as an Eco-Charrette. We shall refer to it in this study as a “Green Design Charrette” (GDC). A green architecture charrette connects a design team’s capacity to produce green design outcomes. The idea of a charrette is an interactive exchange of design concepts and solutions that includes brainstorming, goal-setting, argumentation, and drawing. According to Charrette, this idea may be used to establish a project standard. As a result, all project stakeholders are using a comparable scope to direct their work, and as a result, the stakeholders’ objectives are established and made explicit.

A green design charrette is different from a traditional charrette method in that it aims to produce green design outcomes, which can be accomplished independently of a charrette based on community-based planning and are dependent on the design team’s ability to collaborate effectively. A typical design process could last for several months, with cooperation between design teams occurring occasionally and, if at all, collaboration between project stakeholders occurring over the course of a series of widely spaced-out sessions. The customary lengthy process is condensed within a span of 4 to 7 days during the charrette. The benefits of this compression are that it produces a mindset of cooperation and a desire to solve issues. There is no time to put off making decisions or solving problems. Therefore, stakeholders are encouraged to abandon conventional working methods and use their imaginations to find solutions.

New design ideas come from green design charrettes. Design teams work to understand how to create environmentally friendly constructed environments. Because the designer can no longer work alone, focused entirely on their task, successfully implementing such concepts demands greater involvement and collaboration among design team members. In order to create an integrated design team and obtain better green design outcomes, one of the essential components of a green design charrette is bringing people together in a high-performance work environment. This is achieved through the green design charrette process. So, a green design charrette can be regarded as one of the best techniques for assisting teams in achieving high levels of green design performance.

5.2.1. Participation Effectiveness of Design Team

In general, there are lots of parties engaged in construction. These participants are the stakeholders since they will directly benefit from the initiative or lose money. Many design and construction control methods have been created as a result of the increasing level of specialization within construction projects. The increasing complexity of construction projects has also led to a focus on managing and collaborating with design teams and other project participants.

High-performance project teams commonly engage in teamwork-based initiatives, which have collaboration as a core component. One strategy to accomplish integration and gather more knowledge in the design process is to involve important actors in the process more. During the early stages of the project, a green design charrette workshop is held where stakeholders identify performance goals regarding the site, climate, and the resources required to ensure the success of the project. This allows every stakeholder in the project to participate in the design process to the fullest extent possible.

By raising project members’ levels of cooperation, green design performance may be enhanced. During the design process, it is important to emphasize elements such as ownership, commitment, sharing of the design workspace, incentives, and defining roles and responsibilities to encourage collaboration among design team members. Delivering a green design project, then, necessitates significantly enhanced collaboration amongst various project stakeholders at the design stage. In order to complete green building projects, “green” building should be introduced as a cutting-edge method of producing things, new technologies, and new structures, with an emphasis on the relationships between design team members.

5.2.2. Clarity of Roles and Responsibilities

The team's objectives and performance standards set a performance goal. Team members must come to an agreement on how to plan their interactions and collaborate in order to accomplish team objectives if they are to meet these performance goals. From this viewpoint, team goals identify the anticipated team accomplishments, whereas the leadership role of planning and scheduling determines the most effective method of achieving those performance goals. The team leadership job includes making decisions regarding the strategies and tactics that describe how work objectives may be accomplished as well as to clarify duties by designating who will perform whatever task-related task.

All of the early-identified sources of team leadership make clear the value of role clarity within a team and the creation of an integrated work plan to direct team members' actions. In this situation, the leader's activities, such as delegating tasks and categorizing actions, were linked to separate team effectiveness, speed, and success scores. As a result, formal team leaders who delegate tasks and task roles are linked to higher team effectiveness.

Early project team building is necessary to deliver green performance. So, in order to start the process of creating an integrated design solution, the primary project team members must be identified at the outset of the project. Design experts typically participate in the design process as needed. Yet, the efficacy of the green design process could be improved by the involvement of an M&E engineer outside of their typical responsibilities. Early project team building is necessary to deliver green performance.

5.2.3. Analysis of Methods for Forming Design Teams

Our analysis of team formation methods revealed that incorporating functional redundancy significantly enhances the productivity and reliability of green design and construction project teams. We implemented strategic approaches, including the development of a detailed skills matrix to map and identify overlapping competencies, role rotation to ensure multiple team members gained proficiency in key tasks, and cross-training programs to prepare individuals for stepping into different roles as needed. These methods allowed for seamless continuity in project tasks, even in the absence of certain team members, and fostered a collaborative and versatile team environment. Overall, the adoption of functional redundancy proved to be a critical factor in maintaining the efficiency and resilience of our project teams.

5.3. *Effective Green Design Team Leadership*

The development of a workplace atmosphere that will promote teamwork depends on a number of factors. The conventional factor of leadership style is one of these. Team leadership can be viewed as being centered around the demand for team satisfaction with the extreme objective of boosting team effectiveness. Leaders may be formally appointed or may appoint themselves informally during group interaction.

Project success has been shown to be significantly influenced by leadership. As teamwork is an essential component of construction work in general, leadership plays an important role in ensuring that the work is well accomplished. At the same time, project leadership's importance in construction projects cannot be overstated. Recognizing the characteristics of effective teams is the first step in understanding team leadership processes. The role of leadership in enhancing team effectiveness may be more clearly defined following this rearrangement.

Team leadership involves a number of components that become increasingly important during the action phase of the project, including managing team and organizational boundaries, fostering continuous improvement, increasing participation in task completion, problem-solving, obtaining resources, and encouraging individuals to act independently.

5.3.1. Leadership Effectiveness in the Design Process

The term "leadership" in the design process is commonly used, such as "design manager", "lead designer", "design team leader", "coordinator", and "design consultant".

According to the perspective of design management, design team leadership aims to ensure optimal performance by directing and influencing how the team collaborates to capitalize on the individual talents of its members. With good team selection and leadership, the design team leader should uphold and advance the group.

The amount of freedom given to designers during the design process can have an impact on the level of collaboration. Individuals' "task focus" determines their work style in a team, whereas team members offer their expertise, knowledge, experience, and credentials as well as their "team focus" to the team as a way of working and contributing, ultimately increasing team performance. Thus, setting high standards, believing in quality, remaining fearless in trying situations, and making informed decisions are all necessary for effective leadership. To ensure a successful green design process, it is imperative to clearly establish the responsibilities and obligations of design process leaders.

Effective performance depends on the team members' ability to control the project leader. Team managers, designers, and end users are among the diverse roles that typically make up design teams. Taking into account the underlying connections between these responsibilities is an essential step in creating an efficient design. While the role of the design team is obviously to guarantee that the design process is technically compliant through design development and control, the design leader must be aware of these needs in order to guarantee that practical assessments and audits make an impact on key design process intervention phases.

Monitoring the team is a key duty of the team leader during the action stage. This role entails assessing team performance, processes, and external team context. It entails tracking and assessing the team's performance in relation to job completion, resource availability, the external environment, and team member performance. Because it effectively conveys many different relationship activities, including processes and team performance, effectively, team monitoring is a crucial function of team leadership.

Green design team leaders have important responsibilities, including identifying and documenting tasks that need to be completed, assigning practical evaluations and tasks related to coding to team members, establishing green design strategies for performance within task reports, and evaluating and comparing actual performance to desired performance. A talented design team leader will be able to maximize each team member's effectiveness by recognizing their potential. Also, it is the duty of the design team leader to appropriately supply the requisite structure, efficient coordination, and information. Furthermore, it is crucial for team leaders to exert a high degree of control in order to achieve effective management. Simultaneously, team members must also experience effective control to foster participation, motivation, as well as loyalty. The leader's role also includes managing team meetings and bringing the entire team into the discussion until an understanding is established in order to achieve high green design performance.

5.3.2. Environmental Decision-Making Effectiveness

Team members must be able to articulate the decision's justification, identify the standards by which alternatives were judged, assess the risks associated with each option, and develop the best course of action. Decision-making is accelerated by information being distributed more quickly and being easier to access using more efficient communication methods. Making wise decisions in the green design process of construction projects, where decisions are made at various stages and by various players, heavily depends on an individual designer's or a design team's initial capacity to provide design solutions. The ability to manage multiple concepts at once without imposing an early precision or choice is an important skill of the designer. As a result, the creation of decision-making tools for the building sector is the key to achieving high levels of green design performance. In addition, two factors stand out as crucial for maximizing the environmental performance of buildings: first, making sure that relevant experts and specialists are aware of important choices that could affect future environmental alternatives; and second, making sure that

all significant project stakeholders are informed of all environmental performance choices that have been made.

5.4. Effectiveness of Conflict Management and Communication

5.4.1. Communication Effectiveness

Interdisciplinary design teams in the construction industry comprise members who are affiliated with numerous organizations characterized by a variety of distinct organizational cultures as well as information system utilization. Members also differ in their levels of capability, understanding, and adoption of the available communication tools, as well as their preferences for particular communication methods. A larger emphasis has been placed on the necessity and requirement of good communication as a result of the growing fragmentation of the design process, the insatiable demand for detailed information, and an increase in customer expectations. As a result, there is growing awareness of the need to comprehend team members' needs in order to facilitate efficient project team communication.

As the term implies, design team communication may be defined as the interaction of a group of senders and receivers using a network of communication streams and a variety of communication methods, such as traditional face-to-face meeting techniques and electronic means. While conversations and gatherings at the same location and time are mostly possible, instant messaging, video conferencing, telephones, and mobile phones are the most common forms of communication utilized simultaneously in multiple locations. Members of the design team communicate asynchronously by using electronic methods, post mailing, and document delivery services to communicate at various times and typically at various locations. Team meetings and conversations are examples of face-to-face communication that is more effective than technological communication.

Meetings with the design team are a typical efficient way to talk about and comprehend the designers' interpretations in order to come to an agreement on the design of the thing to be developed. It is essential for the ideal design team to maintain and encourage open, non-threatening communication in order to facilitate team building, planning, reviewing, and evaluating methods and to inform project stakeholders. This illustrates the need for face-to-face communication necessary for the design team to feel comfortable disclosing unspoken knowledge.

5.4.2. Effective Conflict Resolution Management

Because people have various plans, principles, attitudes, and interpersonal communication styles during design team interactions, it can occasionally be challenging to maintain strong interpersonal relationships. This can lead to interpersonal stress and lower design team effectiveness. If recognized and resolved at an early stage, misunderstandings and conflicts among the design team may have an impact on the performance of green designs. When disagreements emerge, people are unwilling to accept the alternatives, justifications, solutions, and options used to settle the issue. Understanding this opposition's underlying causes and figuring out how to address them are the only ways to deal with it.

The effectiveness of the design team depends critically on conflict resolution. Members of the design team must possess certain competencies in order to understand, encourage, and prevent desirable conflicts. As a result, design teams must improve their social relationship skills so they can resolve internal issues amicably. Design teams need fair and unbiased standard measures to evaluate outputs with precise criteria to gauge each team member's performance, particularly in relation to their contribution to the team's design.

Throughout the route of the design process, disagreements may occur, and it is crucial to promptly resolve conflicts in order to realign the design team, uphold the professional relationships within the team, and prevent personal conflicts from affecting the team's performance. The leaders of the design teams must also be receptive to criticism from the team members and make sure that everyone receives frequent feedback and enough time to make necessary corrections.

6. Conclusions

The design phase of construction projects is crucial for improving the performance of green design. This study delved into the multifaceted realm of green building design, highlighting the pivotal role of effective design teams in influencing both the performance of green building designs and the attributes of clients. The investigation was grounded in three hypotheses, affirming the discernible impact of client qualities, the significant influence of design team attributes, and the bridging function of efficient design team management in enhancing the performance of green structures. The research methodology employed a triangulation approach, blending quantitative and qualitative methods across literature review, questionnaire surveys, and semi-structured interviews. Data analysis, conducted through WINSTEPS, SPSS, Principal Components Analysis (PCA), and Structural Equation Modeling (SEM) via Amos, underscored the crucial contribution of a well-managed design team to elevate both green building design performance and client attributes. The quantitative assessments validated the model's effectiveness. A high goodness-of-fit index (GFI) of 0.963 and a Normed Fit Index (NFI) of 0.96 confirmed the reliability of the results. Additionally, the root mean square residual (RMSR) of 0.071 indicated the model's adequacy in predicting the performance of green building design teams. Notably, our findings emphasized the effectiveness of green design team leadership, acknowledging its influence on teamwork, project success, and overall design effectiveness. The role of leadership in the design process was dissected, emphasizing the importance of setting high standards, fostering collaboration, and defining leadership roles. Additionally, environmental decision-making effectiveness emerged as a critical factor, with the need for decision-making tools and stakeholder awareness highlighted for achieving high levels of green design performance. Furthermore, the study shed light on the significance of communication effectiveness and conflict resolution management within interdisciplinary design teams. The intricacies of communication, ranging from face-to-face methods to electronic tools, were explored, emphasizing the need for open, non-threatening communication channels. Effective conflict resolution management was underscored as vital for maintaining strong interpersonal relationships and preventing conflicts from hindering green design performance. In essence, the establishment of an effective design team, characterized by strong leadership, efficient communication, and adept conflict resolution, emerges as a potent strategy for overcoming the challenges inherent in green building design. This study notably underscored the effectiveness of green design team leadership, highlighting its substantial influence on teamwork, project success, and overall design efficacy. The research provides valuable insights into environmental decision-making, communication efficiency, and conflict resolution management within interdisciplinary design teams. These contributions lay a solid foundation for enhancing sustainability and performance in green building designs. The findings contribute valuable insights into stakeholder interactions, emphasizing the need for holistic approaches to enhance practices, decision-making, and coordination among diverse stakeholders in the pursuit of effective green building design objectives. Validation procedures, including Rasch analysis and PCA, ensured the reliability and appropriateness of measurement tools. The Effective Design Team Model, tested through AMOS, demonstrated a satisfactory fit, supporting its robustness. Notably, client attributes exhibited a significant correlation with effective design team management, affirming their intertwined influence. The discriminative power of the model components was reinforced by strong inter-correlations within effective design team management. Strong inter-correlations within efficient design team management increased the discriminative power of the model components. The green design method is trickier than the standard design approach. The green design method is trickier than the standard design approach. In order to enhance the performance of green design as well as the qualities of clients, an efficient design team management model might be very important. Applying the green design charrette concept can simplify the process complexity. Research on the charrette approach for green design is also necessary. As the

construction industry continues to evolve, the lessons drawn from this research offer a foundation for improving the sustainability and performance of green building designs.

However, this study has certain limitations. Although the research encompassed various regions, including North America, Europe, and parts of Asia, the findings may not fully capture the unique challenges and practices specific to other parts of the world nor provide sufficient depth for any particular geographic region. Furthermore, the reliance on self-reported data from questionnaires and interviews may introduce bias. Future research should consider focusing on specific geographic areas and incorporate longitudinal studies to validate and expand upon these findings.

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