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Customer satisfaction in construction projects: Impact of property type and income

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A B S T R A C T

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In this research, which examines the factors affecting customer satisfaction in construction projects, the convenience sampling method was preferred, and data were collected from participants aged 18 and over by face-to-face survey method. Smart PLS statistical software was used to analyse the data with a structural equation model. According to the results of the analyses, cost-effectiveness and lead time stand out as factors affecting customer confidence. Customer confidence directly affects customer satisfaction. In addition, quality perception has a strong effect on customer satisfaction. According to the results of multiple group analysis, customer satisfaction varies according to different buyer segments. While quality perception, cost-effectiveness and lead time are at the forefront for those who buy a property for commercial use, customer confidence has a more decisive role for those who buy a property for personal use. In addition, groups with lower incomes prioritise cost-effectiveness and customer confidence, while groups with higher incomes attach more importance to lead time.

1. Introduction

One characteristic that makes the construction sector and construction projects important is that this sector has an important role in the global economy. This study aims to explore the relationships between factors such as lead time, cost-effectiveness, quality perception and customer confidence in projects in the construction sector and ultimately to reveal the factors affecting customer satisfaction. In addition to these factors, the research will also examine whether there is a difference between the dimensions of the research according to whether the customers purchase the property types for commercial or personal use and according to the income groups of the customers. Understanding the dynamics involved in the research and the roles of project managers such as contractors and civil engineers in these dynamics is important for improving customer experiences and fostering long-term relationships and loyalty, which are essential for the sustainability of construction firms in a competitive market (Durdyev et al., 2018; Hussain et al., 2019; Othman, 2015).

The importance of this study lies in its potential to fill the gaps in the literature on the specific factors that influence customer satisfaction in construction projects. Previous research has identified various factors contributing to customer satisfaction, such as service quality and project performance. However, there remains a lack of comprehensive models that integrate these factors within the construction context (Astana, 2023; Rahman & Alzubi, 2015; Shebob et al., 2013). Using structural equation modelling (SEM), specifically the Partial Least Squares (PLS-SEM) approach, an advanced SEM model, this study aims to provide a robust framework for analysing the relationships between lead time, cost-effectiveness, quality perception and customer confidence (Durdyev et al., 2018; Hussain et al., 2019; Othman, 2015). This methodological choice is advantageous for predictive research models and early-stage theory development. This method provides a detailed view of how variables interact (Asamoah et al., 2021). Another distinctive feature of this study is its focus on the interaction between lead time and cost efficiency as antecedents of customer confidence and the effects of quality perception and customer confidence on customer satisfaction. This multifaceted approach reveals the complex nature of customer satisfaction in construction projects

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where on-time lead and cost management are crucial for building confidence and ensuring customer satisfaction (Forcada et al., 2017; Haverila & Twyford, 2021).

The study acknowledges that customer confidence is a by-product of the project and a key component that influences overall satisfaction and loyalty in light of the literature reviewed later in the study (Durdyev et al., 2018; Haverila & Twyford, 2021). By examining these relationships, the research aims to provide awareness that can guide academic discourse and practical applications in the construction industry. In addition, the findings of this study are expected to have important implications for construction project managers and stakeholders. By identifying the key factors shaping customer satisfaction, targeted strategies can be developed for practitioners to improve project lead, optimise costs and improve perceptions of quality. This can lead to increased customer loyalty, customer satisfaction and repeat purchases, which are crucial for the long-term success of construction firms (Othman, 2015; Rahman & Alzubi, 2015; Shebob et al., 2013). This study also aims to provide a framework that can be adapted and applied to various contexts, thus going beyond the scope of construction projects (Astana, 2023; Durdyev et al., 2018).

This study employs a quantitative research method with a correlational research design to investigate the factors influencing customer satisfaction in construction projects. Using a face-to-face survey, researchers collected data from participants selected through the convenience sampling method. This study, conducted in a cross-sectional framework, analyzes data collected over a specific period. Structural equation modelling (SEM) with the Partial Least Squares (PLS-SEM) approach tests the relationships between variables. Additionally, multiple group analyses assess the impact of these variables across different customer segments. The study develops a unique model that is tested in the analysis phase. This research contributes to academic literature and practical applications in the construction industry by adopting a rigorous methodological framework. The findings enhance theoretical knowledge, help businesses improve customer satisfaction in an increasingly competitive market, and offer actionable strategies for practitioners to build long-term customer relationships (Durdyev et al., 2018; Hussain et al., 2019; Othman, 2015).

2. Conceptual Framework

A construction project can be defined as a temporary endeavour undertaken to create a unique product, service or result. When it comes to civil engineering, we typically think of the design, construction, and maintenance of infrastructure such as buildings, roads, bridges, and other facilities. The cooperation of various stakeholders such as civil engineers, contractors and clients is important for the successful realisation of construction projects in ensuring that the projects achieve their objectives in terms of quality, cost and time efficiency (Coşkun & Sancar, 2021; Pujari, 2023).

Civil engineers are primarily responsible for the planning and supervision of construction projects. Engineers use advanced computational tools and modelling techniques to ensure structures can withstand various pressures, such as environmental factors and operational demands (Pujari, 2023). Beyond design, engineers' roles are also related to project management. Engineers coordinate timelines, budgets and resources to ensure that projects are delivered on time and within financial constraints (Haglund, 2024). On the other hand, contractors are responsible for the actual execution of the construction work. Contractors manage the logistics of material delivery, labour allocation and site management, which are crucial to maintaining efficiency and cost-effectiveness throughout the project lifecycle. The interaction between civil engineers and contractors is crucial as effective communication and cooperation can significantly affect project outcomes and client satisfaction (Coşkun & Sancar, 2021; Haglund, 2024).

This study's main variables of interest are lead time, cost efficiency, quality perception, and customer confidence, which affect customer satisfaction. Lead Time is the time it takes to complete a construction project, an important dimension of customer satisfaction. Delays can lead to increased costs and dissatisfaction among customers. In order to avoid this situation, project teams must adhere to timelines (Shehu, 2021). Cost efficiency covers the project's financial management. Financial management is responsible for using resources effectively to minimise waste and control expenses during the project (Lixiang, 2022). Projects completed on time and within budget will likely increase customer confidence, a vital antecedent of overall customer satisfaction (Guo et al., 2016; Okereke et al., 2022). Quality perception is another important variable as it reflects the client's assessment of the quality of the construction project, such as materials used, workmanship and adherence to specifications. High-quality results fulfil contractual obligations and promote customer trust and confidence, leading to repeat purchases and positive word-of-mouth (Ismail et al., 2019). Confidence can be built through consistent lead quality work, on-time project completion, and transparent communication throughout the project lifecycle (Coşkun & Sancar, 2021; Okereke et al., 2022).

The relationships between these variables can be illustrated through a structural equation model, which allows for examining direct and indirect effects between constructs. For example, effective lead time management and cost efficiency can strengthen customer confidence and ultimately lead to higher customer satisfaction (Asmar et al., 2013). This model illustrates the importance of integrating various project management practices, such as Building Information Modelling (BIM) and lean construction techniques, to optimise project lead and enhance customer experiences (Purwanto et al., 2024; Yuan, 2023).

Logistics has a non-negligible role in construction projects. Effective logistics management ensures that materials and resources are available when needed. Effective logistics is crucial for maintaining project schedules and controlling costs (Haglund, 2024). Integrating advanced geospatial technologies and BIM technologies can significantly improve logistics planning and execution, enhancing overall project performance (Harahap, 2024; Yuan, 2023).

3. Literature Review

Customer satisfaction in construction projects is affected by lead time, cost efficiency, quality perception and customer confidence factors. Lead time is one of the determinants of customer satisfaction in construction projects. Williams et al. (2015) suggest that an on-time project lead is a key success factor that significantly influences customer satisfaction as it reflects the contractor's overall project management effectiveness and reliability. Durdyev et al. (2018) presented a model that suggests the importance of project lead capabilities. In this model, it is stated that effective planning and execution are directly related to customer satisfaction. In addition, according to the study conducted by Forcada et al. (2017), since customers perceive on-time lead as an indicator of quality and efficiency, it can be stated that projects that manage to prevent schedule time overruns tend to increase customer satisfaction (Forcada et al., 2017).

Cost efficiency also plays an important role in shaping customer satisfaction. Research by Ashill et al. (2022) suggests that cost management is an integral part of project success as it affects customers' perceived value and satisfaction. Rahman and Alzubi (2015) suggest that clients evaluate contractor performance based on the quality of the final product and adherence to budget constraints.

Quality perception is another factor affecting customer satisfaction in construction projects. In their proposed construction customer satisfaction model, Durdyev et al. (2018) define service quality as a multidimensional construct that significantly affects customer satisfaction. This is also supported by the study by Hussain et al. (2019), which reveals that many quality factors, such as workmanship and material quality, directly affect customer satisfaction. Farini and Nugroho's (2019) study on the construction industry suggests that perceptions of price fairness regarding work quality significantly affect user satisfaction.

Research on customer confidence suggests that trust in contractors and project managers can increase customer satisfaction by fostering a sense of reliability and assurance (Alshihre, 2015). Alshihre (2015) states that project managers can build customer confidence through effective communication and continuity. Alshihre (2015) states that the success of construction projects lies in endeavouring to complete projects on time and within budget, together with effective management of operation, maintenance, and life cycle costs. Regarding customer satisfaction, the same study concluded that timely completion of projects, quality-based services and impressive design are key factors for customer satisfaction in the construction industry and that project managers are the key to best practices necessary for customer satisfaction in the construction industry.

The roles of civil engineers and contractors are important in influencing satisfaction. David (2024) states that effective project management is necessary to ensure customer expectations are met, affecting customer satisfaction. The joint efforts of civil engineers and contractors in managing project timelines, costs and quality standards are essential to achieve favourable customer outcomes. Nzekwe-Excel et al. (2010) argue that in order to improve project satisfaction in the construction industry, the cooperation of construction clients and project participants is necessary based on recognising and accepting the needs and desires of each participant. As stated by Coşkun and Sancar (2021), the most important stakeholder is the customer, and customer satisfaction is the most important success criterion for the project. Coşkun and Sancar's study examined the difference in customer satisfaction perspective between architects and civil engineers. It should also be considered that customer needs should be met most effectively with the cooperation of architects, civil engineers and contractors, and all efforts should be integrated for this purpose.

In the rest of the study, the relationships between the research dimensions will be analysed, and the research model and hypotheses will be formed.

3.1. Impact of lead time and cost effectiveness on customer confidence

Research shows that on-time lead and cost efficiency affect customer confidence in businesses operating in products and services. Saleem et al. (2017) determined that customer satisfaction has a mediating role in the effect of service quality on customer confidence and that effective lead and cost management are necessary to increase customer loyalty. In addition, customer perspectives on confidence may vary according to the product or service type and income levels. According to researches, customer expectations and confidence levels differ in various market segments. For example, high-income customers may have different and higher expectations of service quality and lead than low-income customers, as they generally seek premium services and faster responses (Milan et al., 2015). This result is supported by Azza and Norchene's study, which suggests that social and physical aspects of service encounters influence customer confidence and loyalty and that customer demographics play an important role in shaping confidence perceptions. Studies show that the service or product offered can affect customer confidence. For example, research on e-commerce websites by Fang et al. (2014) found that confidence is significantly influenced by the customer's perceived effectiveness of organisational functioning, which can vary according to the nature of the service provided. This result may indicate that in construction projects with high risks, customers may emphasise organisational confidence-building mechanisms such as transparency in lead times and cost management. This may differ depending on the complexity of the project and the client's financial capacity and income.

3.2. Impact of Customer Confidence on Customer Satisfaction

Confidence and satisfaction affect customer loyalty and customer retention. In services such as construction projects and engineering, confidence is especially important due to the high-risk nature of these services in every aspect. Setiawan et al. (2020) found that consumer confidence in the airline industry increases customer satisfaction. Similarly, Dewi (2024) suggests that customer confidence significantly affects customer satisfaction in her research on beauty clinics. Studies conducted in many sectors show that customer confidence significantly and positively affects satisfaction (Kartika et al., 2024; Azzam, 2024). The nature of the service or product can shape the dynamics of confidence and satisfaction. However, in the construction sector, where projects are complex and long-term, establishing confidence through consistent quality and reliability can provide higher levels of satisfaction among customers (Dananjoyo et al., 2022; Forsythe, 2016; Kärnä et al., 2009). In construction projects, customers who trust contractors may be more likely to express satisfaction with completed projects, leading to repeat purchases and positive referrals to other prospects.

3.3. Impact of Quality Perception on Customer Satisfaction

In construction projects, customers' perception of quality is influenced by effective quality management practices, listening to customer expectations, and proper project execution. Quality in construction is different from other industries due to its unique and non-repetitive nature and requires specific management strategies to meet specific customer requirements (Willar et al., 2022). Studies show that customers are increasingly quality-conscious, making quality an important parameter to measure contractor performance and competitiveness in a mature market such as construction (Zaray et al., 2022). Implementation of robust quality control measures throughout the construction process is essential to ensure that projects meet established standards and thereby increase customer satisfaction and confidence (Stransky & Matějka, 2019; Wang et al., 2013). Factors such as the experience of construction site personnel, consistency in design documentation, and financial stability of contractors also play important roles in shaping customers' perceptions of quality (Shaawat, 2023; Kareem & Ulutagay, 2022). Integrating advanced technologies and systematic quality management approaches can lead to improved project outcomes and higher customer satisfaction (Ljevo et al., 2017; Miao, 2023). Studies show that perceived service quality significantly affects customer satisfaction. Research conducted by Gong and Yi (2018) emphasizes the moderating role of customer income in the relationship between service quality and customer happiness, suggesting that higher perceived service quality leads to increased customer satisfaction, especially in higher-income groups. Lee's (2013) study emphasizes that perceived value increases the effect of service quality on customer satisfaction, indicating that customers with higher perceived value are more likely to express satisfaction with the services received. In the context of construction projects, the quality of the physical environment and service quality are primary determinants of customer satisfaction. For example, the study of Zadkarim et al. (2011) emphasizes environmental quality as an important factor affecting customer satisfaction in the apartment sector and the importance of both tangible and intangible aspects of service delivery. In addition, according to the results obtained from the low-income sample in the same study, customer satisfaction was affected by customer cost and product quality more than other structures.

In contrast, in the high-income sample, customer satisfaction was affected by product and service quality more than other structures (Zadkarim et al., 2011). Hoe and Mansori's (2018) study examined the Malaysian engineering sector. It revealed that various dimensions of product quality, such as performance and reliability, are necessary to increase customer satisfaction and loyalty. Customers' perspectives on satisfaction may vary depending on income and property or service type. For example, the findings from Grazhdani and Merollari's (2015) study show that demographic characteristics such as age and income shape customers' perceptions of service quality. Studies such as this suggest that higher-income customers have different expectations and satisfaction levels than lower-income customers, which may affect the overall level of satisfaction with construction projects or engineering services. Kihan and Shin (2010) also suggest that customer satisfaction may vary depending on the type of service or product offered. The literature suggests that perception of quality can significantly affect customer satisfaction in construction projects and engineering services. Demographic factors such as income and type of service play important roles in directing customer perspectives.

4. Research Model and Hypotheses

As a result of the literature review, hypotheses and the research model in Figure 1 were created.

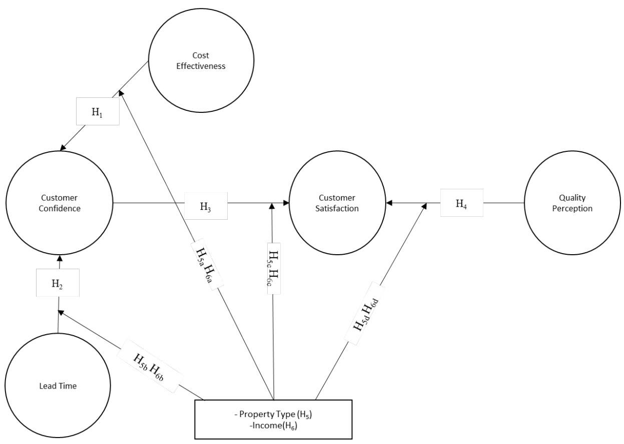

Fig. 1. Research Model

H_1: *Cost-effectiveness in construction projects significantly and positively affects customer confidence.*

H_2: *Lead time in construction projects significantly and positively affects customer confidence.*

H_3: *Customer confidence in construction projects significantly and positively affects customer satisfaction.*

H_4: *Quality perception in construction projects significantly and positively affects customer satisfaction.*

H_{5a}: *The effect of cost-effectiveness on customer confidence in construction projects varies by property type.*

H_{6a}: *The effect of cost-effectiveness on customer confidence in construction projects varies by income level.*

H_{5b}: *The effect of lead time on customer confidence in construction projects varies by property type.*

H_{6b}: *The effect of lead time on customer confidence in construction projects varies by income level.*

H_{5c}: *The effect of customer confidence on customer satisfaction in construction projects varies by property type.*

H_{6c}: *The effect of customer confidence on customer satisfaction in construction projects varies by income level.*

H_{5d}: *The effect of quality perception on customer satisfaction in construction projects varies by property type.*

H_{6d}: *The effect of quality perception on customer satisfaction in construction projects varies by income level.*

5. Research Methodology

This study utilizes Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach in Smart PLS to test the proposed hypotheses. Data were gathered through a face-to-face survey employing the convenience sampling method. This non-probability sampling technique selects participants based on practical factors such as accessibility, geographical proximity, availability, or willingness to participate (Etikan et al., 2016). A key advantage of this method is its capacity to enable efficient and cost-effective data collection, particularly in contexts where resources are limited, making it a practical approach for empirical research (Bilici, 2024).

In PLS-SEM analysis, determining an appropriate sample size is essential to ensure the robustness and validity of the findings. Various methodological guidelines and established heuristics within the literature assist researchers in estimating the minimum sample size required for reliable and meaningful statistical analysis. A widely accepted rule is the "tenfold rule", which suggests that the minimum sample size should exceed ten times the number of indicators or paths to any latent variable in the model (Kock & Hadaya, 2016). Since PLS-SEM is designed to handle smaller sample sizes compared to traditional covariance-based SEM, this method is appropriate for studies with limited data (Varma, 2019; Alfiansyah, 2024). According to this rule, if a model contains five latent variables with 20 indicators out of the total sample, a sample size of at least 200 is recommended (Kock & Hadaya, 2016). In addition, in the literature, samples with 200 or more participants are considered significant and sufficient for structural equation modelling (Bilici, 2024; Siahaan & Thiodor, 2022; Sivo et al., 2006). According to these explanations, the number of participants who met the tenfold rule in this study was 50. However, for the study to be evaluated as a large sample, the number of participants exceeded 200 and 231 participants were reached. Therefore, 231 participants met the requirements regarding the sample size and can be considered a large sample. There are two sections in the study survey form. In the first section, the participants were asked demographic questions and the type of real estate purchased from the project. In the second section, scale statements adapted from different sources were directed to the participants. Relevant literature measured dimensions such as quality perception, lead time, cost-effectiveness, customer confidence and satisfaction. The SERVQUAL model developed by Parasuraman et al. (1988) was used to evaluate quality perception. Some of the questions regarding lead time were adapted from Pinto and Slevin's (1988) study on project management, while another part of the lead time questions and statements regarding the cost-effectiveness dimension were adapted from Love et al. (2004) rework management model. In the customer confidence dimension, Morgan and Hunt's (1994) study within the framework of relationship marketing theory was used. Oliver's (1980) customer satisfaction model was taken as a reference in the customer satisfaction dimension. These scales in the literature were adapted to a context specific to the construction sector and structured to serve the research purposes. The data collected from the participants were analyzed using PLS-SEM with the Smart PLS program version 4.1.0.9.

5.1. Research Ethics

The researcher secured approval from the Bursa Uludağ University Social and Human Sciences Research and Publication Ethics Committee to ensure ethical compliance. The committee granted approval in its session numbered 2024-12, with decision number 23, on December 27, 2024. Following this approval, researcher collected survey data between December 27, 2024, and January 27, 2025. This study complied with the rules of research and publication ethics. In this study, research and publication ethics rules were followed.

6. Analysis Results

The analysis began with a frequency analysis of demographic variables and a measurement model assessment for reliability and validity. Finally, Structural Equation Modeling (SEM) was applied to test the research model.

6.1. Demographic Distributions of Survey Participants

Table 1 presents the demographic distribution of the survey participants and the distribution of the categorical question regarding the type of property purchased.

Table 1
Demographics of Participants

Characteristics		N	%
Gender	Male	129	55.84%
	Female	102	44.16%
Age	18-25	36	15.58%
	26-35	67	29.00%
	36-45	69	29.87%
	≥ 46	59	25.54%
Education	High school and below	85	36.80%
	Associate degree	38	16.45%
	Bachelor’s degree	63	27.27%
	Master’s and Doctoral degree	45	19.48%
Working Status	Non-working (unemployed, retired, student, housewife, and others)	76	32.90%
	The Public Sector	59	25.54%
	The Private Industry	96	41.56%
Income (Turkish Lira / TRY)	≤ 30,000	41	17.75%
	30,001 – 60,000	63	27.27%
	60,0001 – 90,000	79	34.20%
	≥ 90,001	48	20.78%
Marital Status	Single	93	40.26%
	Married	138	59.74%
Property Purchased from the Project	Housing (Apartment, Villa, Residence)	180	77.92%
	Commercial Area (Office, Shop, Warehouse etc.)	51	22.08%
Total		231	100.00%

According to Table 1, the majority of the participant profile is male (55.84%), while the rate of females is 44.16%. The largest groups in age distribution are those between the ages of 36-45 (29.87%) and 26-35 (29.00%), and the most active customer base in the sector is the middle-aged group. Regarding education level, high school graduates and below constitute the largest group, with 36.80%, while the total rate of undergraduate and graduate graduates is 46.71%. Regarding employment status, private sector employees (41.56%) constitute the largest group, while the rate of unemployed individuals is 32.90%. In terms of income level, those with an income between 60,001 TL - 90,000 TL (34.20%) have the highest share. In the marital status distribution, the rate of married individuals (59.74%) is higher than singles. When property preferences are examined, the majority of participants purchase housing (apartment, villa, residence) (77.92%), while the rate of those purchasing commercial space is lower (22.08%).

6.2. Measurement Model Analysis

The PLS-SEM method is prominent in many research areas due to its numerous advantages. PLS-SEM can handle complex models with small sample sizes and non-normal data distributions. This feature makes PLS-SEM more suitable for studies that aim to predict outcomes rather than verify existing theories (Hair et al., 2014; Shiau et al., 2019). PLS-SEM allows reflective and formative constructs to be included in the model, allowing researchers to model and understand various relationships between latent and observed variables without strict assumptions about the data distribution (Hair Jr. et al., 2021; Rosihaza, 2023). Another advantage of PLS-SEM is its ability to estimate models with many indicators and constructs (Ali et al., 2018). PLS-SEM is robust against common method biases and multicollinearity that can often distort results in traditional covariance-based (CBS-SEM) SEM approaches (Kock, 2011; Kock, 2015). The iterative approach of the method maximizes the explained variance of endogenous constructs, making this method a powerful tool for theory development and practical applications (Mu & Zhao, 2024; Rosihaza, 2023).

There are metrics in PLS-SEM, each serving a different purpose. The first of these, Cronbach's Alpha, should ideally be above 0.7. This value indicates acceptable internal consistency. The Composite Reliability (CR) value should exceed 0.7. This value indicates that the constructs are measured reliably. Average Variance Extracted (AVE) must be at least 0.5. An AVE value above 0.5 indicates that the structure explains more than half of the variance of its indicators (Ahakwa et al., 2021; Hair et al., 2017). Finally, factor loading weights must be above 0.6, considered the minimum threshold to determine the significance of the indicators according to their respective structures (Ahakwa et al., 2021).

Statements Qualperc1, Qualperc2, Qualperc3, Time2, and Time3, which factor loadings below the 0.6 threshold, were excluded from the scale. Following removing these items, the data presented in Table 2 satisfied the threshold values established for the metrics employed in PLS-SEM. The reliability and validity of the constructs were verified through Cronbach’s Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) values. Furthermore, the factor loading weights confirmed that all indicators contributed statistically significantly to their respective constructs.

Table 2
Results of the Measurement Model Analysis

Dimensions, Expressions and Abbreviations	Factor Loading	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Cost Effectiveness				
The project's total cost was in line with the budget set at the beginning. I was not charged an extra fee to complete the remaining work in the project. (Costeff1)	0.948	0.704	0.798	0.580
The cost of the project was as economical as I expected. (Costeff2)	0.607			
There was no unexpected increase in the cost of the project. (Costeff3)	0.712			
Customer Confidence				
I have always trusted the civil engineering team and another working team of the project. (Custrust1)	0.790	0.793	0.855	0.547
The project managers and responsible engineers fulfilled everything they said they would. (Custrust2)	0.631			
I feel a sense of confidence in this project. (Custrust3)	0.771			
I trust the information shared about the project and the civil engineers involved. (Custrust4)	0.631			
I believe that the decisions taken by project managers and civil engineers are made based on honesty. (Custrust5)	0.848			
Quality Perception				
During the project, I received quick answers to my questions from civil engineers and other relevant people. (Qualperc4)	0.696	0.738	0.803	0.578
The commitments made during the project were fulfilled. (Qualperc5)	0.787			
The civil engineers and other employees I have been in contact with during the project are professionals and experts in their fields. (Qualperc6)	0.793			
Customer Satisfaction				
I am satisfied with this project in general. (Satisf1)	0.678	0.859	0.907	0.712
The results of the project satisfied my expectations. (Satisf2)	0.888			
I would like to work with the same company and civil engineers again on a similar project. (Satisf3)	0.896			
I am satisfied with the quality of engineering and other services provided throughout the project. (Satisf4)	0.892			
Lead Time				
The project was completed within the specified time frame. (Time1)	0.612	0.717	0.840	0.644
I received regular information about the progress of the works during the project time period. (Time4)	0.882			
The communication of the civil engineers and other employees with the client during the project lead period was effective and adequate. (Time5)	0.904			

The Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT) were applied to evaluate discriminant validity in PLS-SEM. The Fornell-Larcker criterion stipulates that the square root of a construct's AVE should exceed its correlations with other constructs, thereby demonstrating that each construct is empirically distinct (Dzin & Lay, 2021; Nhung et al., 2024; Panahi, 2023). The HTMT criterion posits that the ratio of average correlations between different constructs (heterotrait) to average correlations within the same construct (monotrait) should not exceed 0.90, depending on the research context (Roemer et al., 2021; Wicaksari, 2024). Empirical studies affirm that constructs conforming to the Fornell-Larcker criterion and maintaining HTMT ratios below the designated threshold demonstrate discriminant validity (Hayat et al., 2023; Zahid & Rao, 2022). The results of these analyses are detailed in Table 3 and Table 4.

Table 3
Fornell and Larcker Criterion Discriminant Validity Results

	Cost Effectiveness	Customer Confidence	Customer Satisfaction	Lead Time	Quality Perception
Cost Effectiveness	**0.761**				
Customer Confidence	0.396	**0.739**			
Customer Satisfaction	0.150	0.655	**0.844**		
Lead Time	0.292	0.715	0.522	**0.803**	
Quality Perception	0.121	0.674	0.758	0.690	**0.760**

According to the results of the Fornell-Larcker criterion in Table 3, it can be stated that the square root of the AVE value is higher than the other values in the column in which it is located and that discriminant validity is provided according to this criterion.

Table 4
HTMT Criterion Discriminant Validity Results

	Cost Effectiveness	Customer Confidence	Customer Satisfaction	Lead Time	Quality Perception
Cost Effectiveness					
Customer Confidence	0.469				
Customer Satisfaction	0.252	0.774			
Lead Time	0.345	0.889	0.620		
Quality Perception	0.284	0.829	0.897	0.892	

The discriminant validity analysis based on the HTMT criterion in Table 4 indicates that all values remain below the 0.90 threshold. These findings confirm that the constructs capture distinct theoretical phenomena, establishing discriminant validity. The structural equation model developed for this study is illustrated in Fig. 2.

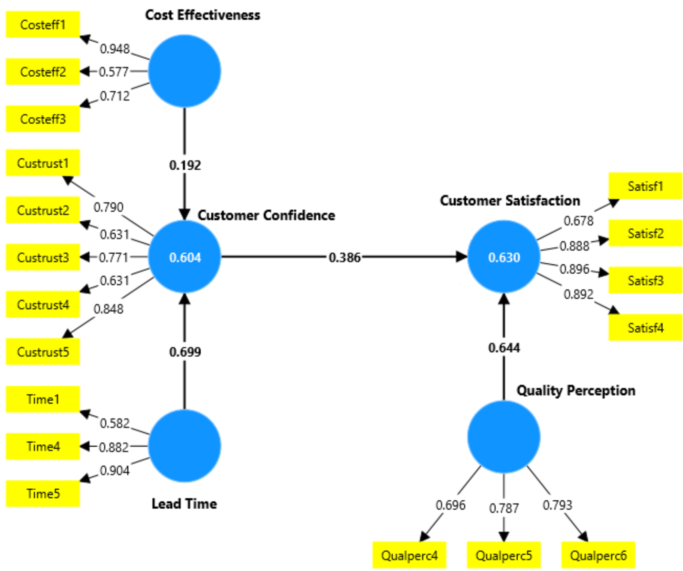

Fig. 2. Measurement Model Analysis Results

R^2 and f^2 values were computed to assess the research model's explanatory power, while linearity and path coefficients were determined using the PLS algorithm. The model's predictive accuracy was evaluated by calculating the Q^2 statistic through PLSpredict analysis. Additionally, bootstrapping analysis was conducted to test the statistical significance of the PLS path coefficients. This procedure involved generating 5000 subsamples from the dataset to compute dimension-specific t-values, ensuring the robustness of the estimates. The findings from the structural equation model analysis are presented in Table 5.

Table 5

Structural Equation Model Analysis Result

Hypothesis	Paths	Standardized β Coefficient	Standard Error	t Value	P Value	Result
H_1	Cost Effectiveness→ Customer Confidence	0.202	0.062	3.121	0.002	Accept
H_2	Lead Time→ Customer Confidence	0.693	0.050	13.928	0.000	Accept
H_3	Customer Confidence→ Customer Satisfaction	0.400	0.109	3.554	0.000	Accept
H_4	Quality Perception→ Customer Satisfaction	0.636	0.093	6.939	0.000	Accept

According to Table 5, all hypotheses were accepted. According to the results, it was determined that cost-effectiveness has a positive and significant effect on customer confidence ($\beta = 0.202$, $p = 0.002$, $t>1.96$). This result shows that providing cost-effective solutions increases customer confidence, but this effect is relatively lower than other variables. It is seen that the effect of lead time on customer confidence is quite strong ($\beta = 0.693$, $p = 0.000$, $t>1.96$). According to this result, timely project completion affects customer confidence the most. It was determined that quality perception strongly and significantly affects customer satisfaction ($\beta = 0.636$, $p = 0.000$, $t>1.96$). Customers are more satisfied with projects with high-quality standards, and material quality and workmanship directly affect this satisfaction. It was also revealed that customer confidence positively affects customer satisfaction ($\beta = 0.400$, $p = 0.000$, $t>1.96$). This result shows that customers' confidence in the company and the project increases their overall satisfaction, but it is not as strong a determinant as their perception of quality. When evaluated in general, it can be stated that construction companies that want to increase customer satisfaction in the construction sector should primarily focus on on-time lead of the project, high-quality standards, and processes that reinforce customer confidence.

Some essential criteria exist to evaluate model quality and predictive power in PLS-SEM. The first of these criteria, the R^2 value, shows the proportion of the variance in the dependent variable explained by the independent variables. For this value, values above 0.67 are considered significant, 0.33 moderate, and 0.19 weak (Keerio, 2023; Khan et al., 2022). The Q^2 value evaluates the predictive relevance of the model. Any value greater than zero for the Q^2 value indicates that the model can effectively estimate the internal structures (Muzafar et al., 2023). The f^2 value measures the effect size of the independent variable on the dependent variable with threshold values of 0.02 (small), 0.15 (medium) and 0.35 (large) (Khan et al., 2022). For the last criterion, the Variance Inflation Factor (VIF), values exceeding 5 indicate problematic multicollinearity (Özdemir et al., 2019). Collectively, these metrics provide a comprehensive assessment of the model performance in PLS-SEM. Table 6 shows the R^2, f^2, Q^2 and VIF values calculated for the model.

Table 6
R^2, f^2, Q^2 and VIF values

Paths	R²	f²	Q²	VIF
Cost Effectiveness → Customer Confidence	0.604	0.086	0.582	1.093
Lead Time → Customer Confidence		1.130		1.093
Quality Perception → Customer Satisfaction	0.630	0.500	0.543	2.244
Customer Confidence → Customer Satisfaction		0.137		2.933

According to Table 6, the R^2 value of the model explaining customer confidence was found to be 0.604. This value shows that the independent variables (cost-effectiveness and lead time) explain 60.4% of the variance in customer confidence. According to Cohen (1988), R^2 values above 0.33 are moderate, while values above 0.67 provide strong explanatory power. Based on this, it can be stated that the model explains customer confidence at a rate close to high. The R^2 value of the model explaining customer satisfaction was 0.630, indicating that customer confidence and quality perception explain 63% of the change in customer satisfaction.

The Q^2 values measuring the predictive relevance of the model were found to be 0.582 for customer confidence and 0.543 for customer satisfaction. A Q^2 greater than zero indicates that the model has good predictive power. When the f^2 values determining the effect size are examined, the effect of lead time on customer confidence is 1.130, indicating that this effect size is quite high.

The f^2 value calculated for cost-effectiveness is 0.086, indicating a small effect. While the effect of customer confidence on customer satisfaction has a small and medium effect of 0.137, the effect of quality perception on customer satisfaction has a strong effect of 0.500. Finally, when the VIF values used to evaluate the multicollinearity problem are examined, it is seen that the highest VIF value is 2.933. The fact that the VIF is below 5 indicates that there is no problem in terms of multicollinearity. In summary, it can be stated that the model has a high power to explain the dependent variables, its predictive relevance is strong, and it does not have a multicollinearity problem.

6.3. Multi-Group Analysis by Property Type

In this section, whether the property type in the research model lead to statistically significant differences and, in case of differences, the magnitude and direction of these effects are analyzed. In order to test the H_5 hypothesis in the research model, a multi-group analysis was conducted. Accordingly, the sample data were categorized into two distinct groups.

The first group comprised participants who purchased housing property from the project (N=180), while the second group comprised those who acquired commercial property (N=51). The results of this analysis, which compares participants' responses across these two categories, are presented in Table 7.

Table 7
Results of Multi-Group Analysis by Property Type

Hypothesis	Paths	Standardized β Coefficient (Commercial)	Standardized β Coefficient (Personal)	Difference Between Path Coefficients (Commercial vs Personal)	p Value (Commercial vs Personal)
H_{5a}	Cost Effectiveness → Customer Confidence	0.369	0.062	0.307	0.000
H_{5b}	Lead Time→ Customer Confidence	0.852	0.105	0.747	0.000
H_{5c}	Quality Perception → Customer Satisfaction	0.290	0.038	0.252	0.000
H_{5d}	Customer Confidence → Customer Satisfaction	0.219	0.806	-0.587	0.000

According to the results of the multi-group analysis, according to the real estate type in Table 7, the relationships in the model differed between the participants who purchased housing and commercial use areas. It can be stated that the "Cost Efficiency → Customer Confidence" relationship considered within the scope of the H_{5a} hypothesis has a lower effect for housing buyers (β=0.062) and a stronger effect for commercial buyers (β=0.369). The difference between the two groups is 0.307, which is statistically significant (p=0.000). In the "Lead Time → Customer Confidence" relationship examined within the scope of the H_{5b} hypothesis, the effect coefficient (β=0.852) is quite high for commercial buyers. At the same time, this value is calculated as (β=0.105) for housing buyers. The difference is (0.747), and with a significance level of p=0.000, it can be stated that this relationship differs between the groups. Within the framework of hypothesis H_{5c}, it was determined that the "Quality Perception → Customer Satisfaction" relationship showed a significant difference between housing buyers (β=0.038) and commercial buyers (β=0.290) (difference=0.252; p=0.000). Finally, within the context of hypothesis H_{5d}, it was determined that the "Customer Confidence → Customer Satisfaction" relationship was quite strong for housing buyers (β=0.806) while it was weaker for commercial buyers (β=0.219). This situation shows that customer confidence is a more determining factor in housing buyers' satisfaction. The difference between the two groups was negative (-0.587), and the significance level was calculated as (p=0.000). According to these results, while quality perception, cost-effectiveness and lead time have a more important role for commercial buyers, the effect of customer confidence on customer satisfaction is more evident for housing buyers.

6.4. Multi-Group Analysis by Income

In order to test the H_6 hypothesis in the research model, a multi-group analysis was conducted. It was investigated whether the relationships between the five dimensions in the research model differed according to the income level variable. For this purpose, the data from the sample were divided into two groups that were as homogeneous as possible. One group consisted of participants with an income of 60,000 TL and below (N=104), and the other group consisted of participants with an income of 60,000 TL and above (N=127). The results of this analysis, which compares participants' responses across these two categories, are presented in Table 8.

Table 8

Results of Multi-Group Analysis by Income

Hypothesis	Paths	Standardized β Coefficient (Over 60.001)	Standardized β Coefficient (Under 60.000)	Difference Between Path Coefficients (Over 60.001 - Under 60.000)	p Value (Over 60.001 - Under 60.000)
H_{6a}	Cost Effectiveness → Customer Confidence	0.008	0.288	-0.280	0.000
H_{6b}	Lead Time→ Customer Confidence	0.886	0.516	0.370	0.000
H_{6c}	Quality Perception → Customer Satisfaction	0.177	0.483	-0.306	0.314
H_{6d}	Customer Confidence → Customer Satisfaction	0.075	0.548	-0.473	0.000

In order to test the H_6 hypothesis in the research model, the relationships that differ according to income level were examined within the scope of the multi-group analysis. The participants were divided into two groups with income levels of 60,000 TL and below and 60,001 TL and above, and the path coefficients were compared. According to Table 8, the “Cost Effectiveness → Customer Confidence” relationship considered within the scope of the H_{6a} hypothesis had a higher effect in the low-income group (β=0.288). At the same time, it remained at a very low level in the high-income group (β=0.008). The difference between the two groups was -0.280, which is statistically significant (p=0.000). This result shows that cost-effectiveness is a more important determinant of customer confidence for individuals in the low-income group.

In the “Lead Time → Customer Confidence” relationship analyzed within the framework of the H_{6b} hypothesis, the effect coefficient (β=0.886) was stronger in the high-income group compared to the low-income group (β=0.516). The difference between the two groups is 0.370, which is statistically significant (p=0.000). This result shows that high-income individuals prioritize lead time when creating customer confidence.

In the “Quality Perception → Customer Satisfaction” relationship examined within the scope of hypothesis H_{6c}, the difference between the two groups was not statistically significant (p=0.314). This situation shows that the income level does not significantly differentiate the effect of quality perception on customer satisfaction.

Finally, the “Customer Confidence → Customer Satisfaction” relationship analyzed within the scope of hypothesis H_{6d} is stronger in the low-income group (β=0.548) compared to the high-income group (β=0.075). The difference between the two groups (-0.473) is statistically significant (p=0.000). This finding reveals that the satisfaction levels of low-income customers are more affected by customer confidence.

When the obtained results are evaluated in general, it is seen that the income level differentiates the effect of the determinants on customer confidence and satisfaction. While cost-effectiveness and customer confidence are more important factors for the low-income group, lead time is more decisive in customer confidence for the high-income group.

7. Conclusion, Discussion and Recommendations

This study on customer satisfaction in construction projects has revealed significant results regarding customer confidence and factors affecting satisfaction. The analysis results show that cost-effectiveness, lead time and quality perception are important determinants of customer confidence, with lead time emerging as the most effective factor (β = 0.693, p = 0.000). This result shows how important it is to complete the project on time in promoting customer confidence, which is essential for long-term relationships in the construction industry. Furthermore, the effect of customer confidence on customer satisfaction (β = 0.400, p = 0.000) shows that confidence is a key element in increasing overall customer satisfaction. The results also reveal that quality perception significantly affects customer satisfaction (β = 0.636, p = 0.000), emphasizing the necessity of high-quality standards in construction projects to meet customer expectations.

Multiple group analysis reveals the nuanced dynamics of customer satisfaction among different buyer segments. For commercial real estate buyers, perception of quality, cost-effectiveness, and lead time play more important roles. In contrast, for residential buyers, the impact of customer confidence on satisfaction is more pronounced. In addition, income level affects the perception of these determinants; low-income groups prioritize cost-effectiveness and customer confidence, while high-income groups place more importance on lead time. These results suggest that customer satisfaction strategies in construction should be tailored to the specific needs and expectations of different market segments. The construction industry should recognize that customer confidence is not a by-product of service delivery but a crucial component that can significantly increase customer satisfaction. The strong impact of lead time on customer confidence suggests that project managers should prioritize effective planning and resource allocation to ensure on-time project completion. This result is consistent with the literature emphasizing the importance of on-time lead as a key factor in customer satisfaction and loyalty in construction projects (Alshihre, 2015; Durdyev et al., 2018; Othman, 2015). The significant impact of quality perception on customer satisfaction reinforces the need for construction firms to invest in quality and quality management systems. High-quality materials and workmanship are also important to meet customer expectations and minimize defects that may negatively affect customer satisfaction (Budinata & Susetyo, 2022; Hussain et al., 2019). The results are consistent with studies advocating continuous improvement in quality management practices to increase customer satisfaction in construction projects (Neyestani, 2016; Tabish & Jha, 2012). The differentiation by buyer segments and income levels influenced by these factors suggests that construction firms should adopt a more segmented approach to customer satisfaction strategies. Tailoring services and communication to meet the specific needs of commercial and residential buyers and considering customers' income levels may lead to more effective engagement and satisfaction outcomes. This result is consistent with the findings of Haverila and Twyford, who emphasize the importance of understanding customer value perceptions in project management (Haverila & Twyford, 2021).

Businesses devote significant resources to accessing what customers think about them and making sense of this data (Seren & Altıntaş, 2023). This study provides meaningful data to companies doing construction projects. Based on the findings of this study, construction companies should first implement sound project management practices that prioritize on-time lead. This can be achieved through better planning, resource allocation, and risk management strategies to reduce potential delays (Forcada et al., 2017; Rani et al., 2021). Training project managers and teams on effective planning techniques and schedule adherence can increase customer confidence and satisfaction. Second, a strong focus on quality management is essential. Construction companies should adopt comprehensive quality assurance protocols that cover all stages of the construction process, from material selection to final inspections. Participating in regular training and development programs to enhance employees' skills in quality workmanship can lead to better project outcomes and higher customer satisfaction (Ogwueleka, 2013; Neyestani, 2016). Third, it is crucial for construction companies, and especially civil engineers, to engage with stakeholders actively throughout the project lifecycle. This includes providing feedback at various project stages and being responsive to customer concerns and suggestions. Establishing open communication channels and encouraging customer interaction can help build trust and meet customer expectations (Nzekwe-Excel, 2012; Milion et al., 2017). Additionally, firms should consider implementing customer satisfaction surveys after project completion to gain awareness and identify areas for improvement. Finally, construction firms should segment their customer satisfaction strategies to consider their customers' diverse needs. Understanding the specific priorities of different buyer groups, such as commercial and residential buyers and varying income levels, will help firms adapt their approaches to maximize satisfaction (Carter et al., 2014; Osman, 2015). This segmentation can lead to more personalized and targeted service offerings. This can lead to customer loyalty, positive word-of-mouth, and repeat purchases.

This study has some limitations. First of all, the geographical scope and representativeness of the sample during the data collection process are limited. The fact that the study was limited to a specific region and construction projects makes it difficult to generalize the findings. In addition, although lead time, cost-effectiveness, quality perception and customer confidence were considered among the factors affecting customer satisfaction in order not to create very long surveys, other important variables such as after-sales services, brand reputation and environmental sustainability could not be included in the model considering the reluctance of the participants to answer long surveys. In addition, the study's cross-sectional design is insufficient in terms of examining the long-term effects between the variables. Considering that customer satisfaction may change over time, especially due to the nature of construction projects, future researchers recommend a longitudinal analysis. From a measurement perspective, since variables such as customer satisfaction and quality perception are subjective, different perceptions may emerge among individuals, and responses may be subject to social desirability bias. From a methodological perspective, the Partial Least Squares (PLS-SEM) model used in the study offers advantages, especially for predictive research models. However, it may not provide as strong model fit tests as traditional covariance-based SEM (CB-SEM). However, external factors were not fully taken into account in the study. While economic fluctuations, inflation, interest rates, and exchange rates can affect customer satisfaction and cost-effectiveness, these factors are difficult to model. Furthermore, regulatory changes in the industry, environmental factors, or extraordinary circumstances such as crises may limit the generalizability of the research findings. Considering all these limitations, it is recommended that future studies address these shortcomings with longer-term data, larger sample groups, and different methodological approaches.

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