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Comparative Analysis of Cost Estimating Software Use in Construction: Basis for Developing a Residential Cost Estimator (RCEst)

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Abstract:

Living in this modern era, the advent of technology has hit the point where these technologies have become vital tools in the construction industry. The adaptation of new Computer-Aided Cost Estimating Software (CACES) is essential for enhancing cost estimation efficiency. This study aimed to develop customized CACES by thoroughly analyzing respondent perceptions of Stack, PlanSwift, and Methvin. The effective use of graphical statistics, respondents' narratives, and quantitative assessments were utilized to understand how these estimation software options differ. Various aspects of the software are considered as factors such as accuracy, ease of use, unique functionalities, and the learning curve**.** Theresearchers aimed to find the most fitting software for calculating costs, focusing on residential projects in Pampanga. Findings of the comparative analysis showed that the three existing CACES are intricate due to their foreign origin,leading to estimation discrepancies and non-compliance with local regulations. Thus, the Residential Cost Estimator (RCEst) was developed, focusing on digitalizing cost estimation for residential projects. RCEst was pilot tested by professional engineers which showed exceptional acceptability based on user interface, functionality, and performance.The findings of the study can aid residential construction firms' long-term development, fostering economic growth and technological advancements in the construction industry.

Keywords **—Construction, Cost estimates, Computer-Aided Cost Estimating Software, Residential Cost Estimator.**

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I. INTRODUCTION

Nowadays, it has reached the point that technology is a vital tool in the construction industry, in which speed and efficiency constantly improve. While scientific inquiry tries naturally and systematically to understand how things are done in nature, technology focuses on fulfilling human needs. Technology has improved the efficiency of various construction stages, including pre-construction, design for construction, actual construction, operation, and management. Modern technology has impacted every aspect of human life including the construction industry.

The construction industry is a significant sector that drives economic growth and development. However, compared to other industries, it faces several problems. Construction projects are complex and estimating their cost is challenging. Among the most usual challenges encountered in many construction projects is the occurrence of cost overruns from estimate to actual. The most common causes of cost overruns often occur due to factors like scope creep, rework, construction delays and selecting the lowest bidder can lead to cost overruns. Other factors can be incomplete designs, changes in scope, specifications, delays in design delivery, site issues, changes in prices, increase in material prices and lack of teamwork. These issues can lead to increased costs, project hold-ups, lower productivity, loss of earnings, or even damage to business relationships.

The Philippines industry faces several challenges and difficulties, chief among them is the poor technology adoption leading to huge productivity lags. For most developing countries, the most concerning element impacting the success of building projects is the lack of a unified which can put neither client nor project manager ahead in terms of cost monitoring. Another factor unfavorable to the cost of construction projects and directly affecting a project's success: poor scope definition, unreasonable time schedules written into contracts, incorrect activity cost estimates, schedule changes unforeseen when bidding was submitted, poor work breakdown structures, project manager inexperience and lack of proper training.

In the life cycle of a construction project, cost management is critical since it defines the project's success, as well as, whether it will be completed on time and under budget. *Construction cost estimation involves all project expenses within a particular scope - both direct and indirect costs - that must be forecast and figured out.* It is an important stage in cost management for construction projects. Construction projects need effective and proper cost monitoring and management from the inception if the project must be delivered on time, within budget and in quality. Furthermore, the success of any construction project must depend upon cost effectiveness estimation.

Amidst the global trends advocating the integration of digital technologies to boost productivity, the Philippine Construction Industry's adoption of such innovative technologies is lagging global standards. Most construction firms still rely on the traditional methods of cost estimation, which rely heavily on manual calculations, are often time-consuming, error-prone, and heavily reliant on the expertise of individual estimators. This technique may associate with contractors and clients getting inconsistent estimates and financial losses.

On the contrary, modern technology such as Cost Estimating software (CES) address the shortcoming of traditional estimation method. It gives more stable approach for estimating construction costs. The CES has automated tools that are timesaving due to estimators can input data quickly and come up with reliable cost predictions. In addition, construction firms can maximize operations, lessen human error and increase profitability.

In the construction industry, cost estimation is important collaborative effort between different organizations such as Quantity Surveyors (QS) and Contractors. QS concerned from the project planning to end phase where they estimate cost and deal with contracts. While contractors concentrate on focusing process which is based on cost then later during construction. Usually, their collaboration guarantees in approaching the estimation and control of costs in construction project.

To boost estimator performance, they need new Computer-Aided Cost Estimating Software

(CACES). It can increase the efficiency of the cost estimation process. It is useful in fast error identification and reduces overall costs with the help of time saving and reduction of waste. Even though CACES has supported manual data calculation, not all places in the Philippines have it, as most available options are often foreign-made software. This lack of access poses challenges for local construction firms, especially smaller ones. Often, they struggle with the high costsand restricted access to these expensive software tools.

Considering these challenges, this study highlights the importance of creating locally customized CACES that aims to meet the specific needs of the Philippine construction industry. To develop the customized CACES, it will thorough examine and use relative analysis of three chosen software: Stack, Plan Swift, and Methvin. The study aims to understand how different these estimations based on the different software results, considering factors such as (a) accuracy, (b) ease of use, (c) unique functionalities, and (d) the learning curve. Through this analysis, researchers aim to find the most fitting software to calculate construction project costs, focusing on residential projects mainly.

The proposed software, called Residential Cost Estimator (RCEst), will serve as a useful tool enabling stakeholders to generate estimates costs for diverse projects. This capability can contribute to win more bids and boost profits. Moreover, fostering collaboration between local software developers and construction industry experts will be instrumental in creating the RCEst. Implementing a collaborative approach will ensure that RCEst is technically aligned with local construction firms' real-world needs and challenges.

Furthermore, the study provides immediate benefits to residential construction firms and can contribute to the sector's long-term development. Embracing digitalization in Pampanga's construction industry can foster technological advancements, economic growth, and ramp up competition.

A. Background of the Study

In recent years, there has been an increase in the need for efficient and cost-effective performance in the construction industry. The rapid speed of modernization technology has led to significant impacts on market trends. With the growing influence of Information Technology (IT) industry developments, globalization in construction, and the increase in the demand for quality and productivity, the need for integration in construction projects becomes more critical. Given the Philippines' status as a developing country, increased investment in the construction industry is necessary to foster progress and advancement [25].

In construction, the estimator is central to generate an in-depth cost analysis for a construction project and to assist the developer in making informed decisions. Construction estimate refers to computing the overall expenditure required for a construction project, encompassing direct expenses (materials and labor) and indirect expenses (equipment depreciation and office worker salaries) [26].

The Philippine construction industry grapples with cost overruns and project delays that leads to uncertainty for building contractors, owners, and other stakeholders [27]. Cost estimators extensively depend on published cost and productivity data to prepare estimates. It is a prevailing practice within the construction industry to manually input historical data from prior projects to construct cost estimates [11]. Traditional cost estimation needs more accuracy, consistency, and comprehensiveness. This task becomes time-consuming for construction estimators utilizing traditional approaches such as manual or semi-automatic processes [28].

Reliable estimation results help project managers make more accurate predictions about project costs, the time needed for different stages of the project, and the resources or assets that will be required. However, it will have damaging impact on project delivery if the cost estimation in the project has any inaccuracy.[29]. A project with vague evaluation will face difficulties with budget, delivery timelines, resource need and leading to project failure. Therefore, accuracy in estimation is crucial since it decides the success of the project [30].

In retaliation to construction delays arising from ineffective cost estimation, there is a convincing need to comprehend the technological

advancements that lead to developing of CACES. It offers an opportunity to improve efficiency of cost estimation in construction industry. Several studies highlight embracing Machine Learning (ML) models to upgrade the estimation process which result in more reliable outcomes. This technique is attainable for developing the proposed customized software due to its capability to learn from historical data and adapt to the several variances in software project development. It comprises complete databases that hold resource cost data in which allow timely updates at the onset of estimation. This model holds to the refine organizational capabilities and determine competitiveness in the global market. Moreover, the CACES used probabilistic cost simulation and computer vision techniques to examine the productivity and potential cost outcomes[29].

The proponents used typical CES application in the Philippines like Planswift. Moreover, they also used Methvin and Stack that are web-based software that is accessible in the market. The PlanSwift specializes in aiding construction projects by facilitating quantity takeoffs and estimating costs directly from digital blueprints, making it simple to optimize your workflow [31]. Methvin provide a more comprehensive set of takeoff and estimating tools, along with enhanced reporting and analytical capabilities [32] Furthermore, Stack estimating software enables professional contractors of all sizes and trades to conduct on-screen takeoffs and estimates [33].

The researchers utilized the widely recognized Hypertext Preprocessor language as their primary programming framework for the development of RCEst. PHP is a major programming language having a vast global user base involving millions of web developers creating web applications and web sites. Its popularity can be attributed to the fact that it is open source, easy to learn, runs on multiple platforms and has an extensive number of pre-built functions as well as libraries [34]. Also, the proponents used the book entitled, *"Simplified Construction Estimate"* by Max B. Fajardo Jr. and "Estimating Bill of Materials" by Vicente A. Tagayun for the formulas needed to code the RCEst.

Pampanga is known as one of the most competitive housing markets in the Philippines. Massive infrastructural development and decentralization activities enhance the region's competitiveness as a preferred investment site outside Metro Manila [35]. The project's location significantly influences the project manager's decisions about project planning. The study focuses the important role of managerial competencies in ensuring that budgets are aligned with the specific conditions and challenges that helps to the successful completion of construction projects.

Through this study, the researchers seek to contribute valuable insights and recommendations to the construction industry andto aid professionals in making informed decisions regarding cost estimation for vertical structure projects. Moreover, it addresses the need for reliable cost estimates by utilizing software analysis, optimizing data processes, and creating customized CACES designed explicitly for vertical structures.

B. Review of Related Literature and Studies

Construction is the process or method of building or creating something. Common examples include roads, buildings, and bridges. Construction is when people and activities involved in building structures [1]. Characterizes construction as an exciting, multi-faceted trade spanning many industries [2]. Within these subsets, two main types of construction are prevalent today: (a) Horizontal (heavy civil) construction and (b) Vertical construction. Horizontal construction projects encompass roads, railways, bridges, transmission facilities, electric lines, fiber optics, pipelines, sewers, and waterlines. Conversely, vertical construction projects include buildings, surface projects (such as parking areas), subsurface, and structure projects (building foundations and site work). In horizontal construction, a significant amount of land space is required due to the usually larger width and length of these structures than their height. In contrast, vertical construction primarily involves structures constructed and built upwards, stretching vertically [3].

Building construction is utilized to execute these types of structures, particularly vertical onesencompassing the physical activities at the

construction site. These activities include unloading plants, machinery, materials, cladding, fixture installation, fitting of installations, formwork, and external finishing. This phase comprises a series of routine tasks carried out by skilled individuals, demanding a significant amount of time and meticulous effort, necessitating careful management. The building construction process can be categorized into three phases: pre-construction, construction, and post-construction. Before commencing a project, the client must collaborate with the design team and contractor to formulate a comprehensive project plan, commonly called construction planning [4]. There are various important aspects to consider in construction planning such as cost control. Construction companies should accurately estimate project for effective planning. The project managers play an important role in observing expenses by making a detailed budget. [5].

Fundamental to this process are construction estimates, which predict a structural project's overall costs. These estimates are vital in determining a project's viability, defining its scope,and allocating the necessary budget [6]. However, cost estimation is rife with challenges that may lead to inaccuracies, such as inadequate review of the work, failure to update material and supply costs, and overlooking labor costs [7]. Furthermore, incorrect cost estimation can result in severe consequences, including (1) significantly reduced project margins, (2) numerous delays in project completion, (3) potential shelving of the project; (4) organizational decisions to discontinue the project; (5) compromised quality of deliveries; and (6) diminished overall client satisfaction [8].

To lessen the difficulties in cost estimation and increase efficiency, the CES for software for cost estimation has emerged. Furthermore, CES systems have greatly improved customization, enabling professional in construction industry to specific tasks programs to create reliable estimates [9].

B.1. Comparative Analysis of CACES

Multiple studies have evaluated the comparative effectiveness of several CACES programs. CACES programs can generate accurate cost estimates. Nevertheless, the research reveals that the accuracy of cost estimates differs based on the input quality.[10]. Furthermore, it can enhance the efficiency of estimation and can reduce the cost overruns [11].

The study emphasized CACES increase accuracy by integrating automating calculations. It offers collaboration and real time updates that enhances the decision-making process[10]. Furthermore, a comparative study of several CES highlights the importance of evaluating accuracy, ease of use, unique functionalities to choose the most effective tool [12].

However, the journey with CACES is not devoid of challenges. Focus on the various difficulties encountered in cost estimating, mainly the learning curve that arises from software implementation. It is vital to comprehend these problems to customize software solutions that cater to the requirements of vertical structure projects [13]. Building on this idea, introduced a theoretical framework that focuses on creating customized CACES in their study. The authors highlight the significance of comprehending project prerequisites and integrating domain-specific characteristics into the development process [14].

B.2.1Accuracy

Assessing the effectiveness of software cost estimation models poses a significant challenge. The absence of a generally accepted standard for evaluation and the occasional inconsistencies among existing measures hinder the process. Nevertheless, assessment criteria for estimation models usually revolve around two attributes: estimation accuracy and estimation consistency [15].

Accuracy is defined as thecloseness of the measured value to a standard or true value[16]. The accuracy can be evaluated through two distinct approaches: the difference measure and the ratio measure. The difference measure quantifies the discrepancy between the estimated value and the actual value, while the ratio measure assesses the relative correctness of the estimated value concerning the true value.

The study used both difference and ratio measures to assess the accuracy of software cost

estimation models. For the Difference Measures of Accuracy: Mean of absolute errors (MAE), Root mean square error (RMSE), Coefficient of determination (R^2), and Mean of residues (MR). For Ratio Measures of Accuracy: Average of relative errors (ARE), Mean of the magnitude of relative errors (MRE), Root mean square of relative errors (RMSRE). However, investigation reveals that the ratio measure is a more appropriate choicethan the difference measure for assessing software cost models [15].

Furthermore, consistency is another vital characteristic of an estimation model in addition to accuracy. The study conducted to assess the level of consistency employed by the correlation coefficient, specifically the Standard Deviation Ratio (SDR), between observed and estimated values. This measure evaluates the linear association between the agreement of two quantities: the actual values and estimates. The higher the correlation coefficient value, the more stable the relationship between the observed values. By examining the correlation coefficient between estimated and actual values, one can determine the extent to which the proposed approach is reliable, accurate, and precise [17].

B.2.2Ease of Navigation

A software that is user friendly is a technical solution that perform the tasks of individuals with nominal effort. The ease of navigation greatly affects how organizations incorporate a document management system (DMS) and other components [18].

Prioritizing it will give several benefits for business. One of the advantages is enhancing adoption rates making user more responsive to software that is easy to operate. It promotes productivity and enabling staff to complete tasks more efficiently. Furthermore, it enables businesses to adapt to the ever-evolving business environment by simplifying processes. Making it easier for companies to maintain their competitive advantage [18]. In selecting software solutions, it is important to prioritize accessibility for non-technical users and aligning it to the need of organization [19].

B.2.3 Unique Functionalities

Features refer to the functional components utilized within a system to accomplish a specific set of activities or operations. Functionality refers to the way those features achieve the intended purpose.Moreover, construction CES that offers a range of valuable features and functionalities can empower construction companies to boost productivity and profitability [20].

One key feature is access to a comprehensive cost database, enabling accurate budgeting and forecasting. This tool allows contractors to estimate project costs based on historical data, ensuring they adhere to budget constraints during pre-construction.Additionally, it provides material and labor estimation functionality as a valuable feature. This functionality ensures optimal resource allocation throughout the entire construction project lifecycle by adequately staffing projects without overpaying employees or underestimating resource requirements. Ithighlights the importance of users' in-depth knowledge of each approach to assist in selecting the most suitable functions for CES. [14].

B.2.4 Learning Curve

The term 'learning curve' encompasses all three terms—learning, progress, and experience curves—depending on the level at which the phenomenon is observed (individual, group, firm, industry) [21]. The learning curve is applied throughout the construction process to analyze whether the project is feasible. It explains how repeated task execution enhances a worker's proficiency, resulting in faster completion times [22].

Learning curve theory can forecast the cost and time for repetitive activities, typically in time units. The cumulative number of units produced is the standard measure of experience in the learning curve formula. Therefore, the estimate is calculated by summing the total number of products throughout each period [21]. In the study, they adopted the one-factor learning curve to examine project costs and to generate feasibility study conclusions. In addition, the feasibility learning curve model suggests a direct correlation between an increase in the total construction area and a decrease in the project's unit area cost. The

learning rate quantifies the influence of cumulative construction area on the cost per unit area. A greater learning rate shows an important reduction in cost per unit area as construction area increases[23].

C. Synthesis

The construction planning is known as intricate process that involves many factors such as the construction project type (horizontal or vertical), budget control, and cost estimation. In their relevant studies, [4], [7], and [8] examine the difficulties and solutions related with crucial aspects of construction planning. They discovered that collaboration early between the client and contractors was important for the success of the project[4].

On the other hand, they reviewed the investigated the difficulties in cost estimation especially the possibility of inaccuracies[7]. They emphasized that possible consequences of inaccuracies on overall quality, timelines, and project margins [8]. Moreover, these differences highlight the crucial roles of construction planning in pre-construction phase.CACES appearing as a transformative aid to the issues associated with construction planning while enabling users reliable and precise estimation for effective project management.

Various studies have examined the efficacy of several CACES which shows evidence of its advantages. The studies suggest that CACES can produce accurate cost estimates but also can differ depending on the input quality and software used [10]. In addition, it can improve the effectiveness of the estimation for construction projects. It helps to improve decision making process by real time updates, reduce the possibility of cost overruns, and collaboration [10].

Conversely, studies have shown that the problems associated with the use of CACES including the learning curve linked with implementation of the software. It found that these difficulties can be conquer by selecting the proper software for the project needs [13]. Moreover, findings suggest a theoretical framework that can use for creating new CACES which emphasized the significance of knowing the project needs [14] . In general, the study shows that CACES is an evolving area of innovation. However, construction firms must consider the most recent development in CACES when making decisions about the processes of project management.

The comparative analysis of CACES including four key parameters namely: accuracy, ease of use, unique functionality, and the learning curve. Difficulties in assessing CES models emerge due to the need for commonly accepted standard. They emphasized accuracy and consistency as vital qualities that that evaluate through difference and ratiomeasurement[24]. Their study revealed that ratio measures are more suited for evaluating cost models. Evaluate consistency using the correlation coefficient (SDR) and emphasized the importance of stability in estimated values [17].

Prioritizing user-friendliness in terms of ease of navigation can enhance adoption rate and productivity [18]. Highlighted the significant ofaccessibility for non-technical users which align the software with organizational needs[19].

Moreover, CES has unique features that make it differ from other programs. These features contain a wide range database of costs, material and labor estimates, and the capacity to allocate resources most efficiently [20]. It explained how features can be used for specific tasks, while [14]highlighted the significance of users understanding about the different functions and selecting the best ones.

Furthermore, [21] and [23]examine the learning curve applied all through the construction process to evaluate the feasibility of the project. They suggest the software learning curve in analyzing execution of repeated task and its impact on worker competence [21]. Simultaneously, they used one-factor learning curve to review project costs and feasibility learning curve model to determine a correlation between unit area cost and construction area [23].

II. METHODOLOGY

A. Methodological Framework

Research Methodology refers to the discussion of the methods chosen and utilized in a research investigation. This analysis also incorporates the theoretical principles that provide additional

information into strategies for planning and application. This chapter addresses the procedures and methods employed to gather and analyze data for the study. This chapter will present the following:

(1) research design, (2) system design, (3) research locale, (4) research instruments, (5) data collection methods, (6) data analysis, and (7) research ethics.

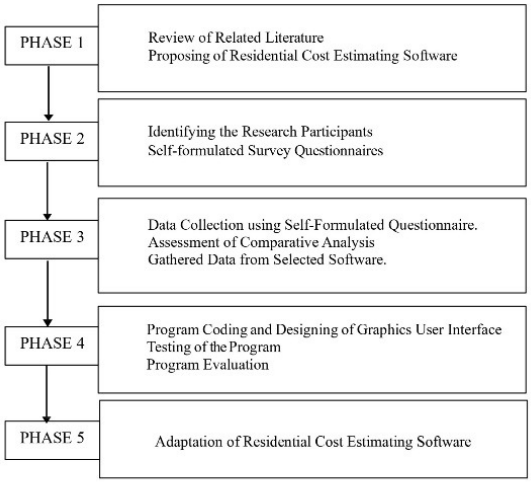

Fig.1. Methodological Framework

The figure above illustrates the phases of work the researchers followed during the conduct of this study.

Phase 1 of the framework outlines the acquisition of information. Online materials, including articles, published journals, and relevant literature, were utilized to comprehensively understand the necessity of digitizing the project cost estimation in the construction industry, leading to the proposal of RCEst.

Phase 2 outlines the course of the study's progression. The researchers employed a Convenience Sampling method to select their research participants. This phase also involves the development of self-formulated research questionnaires.

In Phase 3, the researchers created self-formulated questionnaires and distributed them to the designated respondents for data collection. Descriptive analysis was applied to interpret the data findings and conduct data analysis. This phase highlights the inclusion of data gathered through a comparative study of selected software.

The aim of Phase 4 is to demonstrate the coding and design stage of the software. The primary functions of the software are based on the essential features required by the RCEst. Only relevant questions are included in the survey questionnaire, which has been reviewed and assessed by various experts in the field.

Lastly, Phase 5 would determine whether the CACES application could support the construction industry's transition toward digitalization and provide stakeholders with an alternative application for their work in alignment with evolving industry trends. Moreover, collecting data through self-developed research questionnaires would determine the degree of approval and effectiveness.

B. Research Design

This research utilized a mixed method approach of quantitative and qualitative research methods in tackling the objective effectively. The researchers used a correlational and descriptive research method to comprehensively analyze the three chosen software: Stack, Plan Swift, and Methvin. The correlational approach primarily focuses on understanding the relationship of the variables of CACES for vertical structure, like accuracy, ease of navigation, unique functionalities, and learning curve.

In contrast, the descriptive method focused on analyzing the user experience to provide a detailed analysis of the CACES feature. This study also utilized a survey questionnaire distributed to the respondents to gather information needed to complete the research objectives that include determining desirable features and functionalities from the three-software incorporated into the customized CACES**.**

This research employed a validated survey instrument presented in a four-point Likert scale format. Participants selected for the study were directed to mark their responses in designated spaces and choose from options like strongly agree, agree, disagree, and strongly disagree. The survey aims to assess variations in estimates derived from three software choices— Stack, PlanSwift, and Methvin—used for cost estimation in construction projects. The survey is divided into sections, focusing on aspects such as:

i. Accuracy – this section of the survey questionnaire primarily centers on the precision of the specific cost estimation system intended for use in construction projects, with a specific emphasis on vertical structures;
ii. Ease of Navigation – convenience and the simplicity of the user experience when employing the system, particularly in the context of estimating construction projects;
iii. Unique Functionalities- primarily discusses the innovativeness and uniqueness that the system provides to its users, emphasizing how distinct and convenient these exclusive functions operate, particularly in the realm of cost estimation; and
iv. Learning Curve – The final part of the survey questionnaire primarily addresses users' experiences in terms of the ease or difficulty encountered in learning and utilizing the system for cost estimation.

Furthermore, the survey questionnaire contains a structured interview with open-ended questions, allowing the participants to provide valuable insight into their experience using the different CACES. It enables them to provide in-depth answers and suggestions as well as to foster a deeper understanding of their preference, challenges, and perspectives about the positive and negative of the different CASES. The researchers would test the reliability of the survey questionnaire using Cronbach's Alpha to determine the consistency and trustworthiness of the survey questionnaire.

The researchers employed a purposive sampling method to select respondents from the province of Pampanga. A *purposive sampling* is a non-probability sample that is determined based on a population's characteristics and the study's [36]. In this study, the researchers used purposive sampling to identify construction stakeholders in Pampanga who are involved in vertical structure projects and have experience with CACES. With the use of this sampling approach, the study's sample population closely follows the researchers' intended audience.

The researchers employed data-gathering procedures to determine the appropriate sample size, including a review of a similar study conducted in Pampanga [37]. Based on this study, the researchers would conduct a sample of 30 respondents. The study's respondentsconsisting of quantity surveyors, project managers, and contractors are primarily comprised contracting companies involved in ongoing projects in the Pampanga area. The company serves prominent enterprises, non-profit organizations, and academic institutions as its clients. The research would focus on the province of Pampanga, specifically in Bacolor and San Fernando area, where rapid development is substantial. The focus group comprises firms currently operating in the said location.

The target population of this study includes quantity surveyors, project managers, site engineers, office engineers and contractors who are currently based and operating in the Province of Pampanga. The researchers selected Pampanga as the study location, considering it is a significant construction hub in the Philippines, home to several large infrastructure projects, as well as a thriving commercial and residential construction sector. Pampanga has a high level of construction activity and unique cost-related factors that make it an ideal location to study the use of CACES in residential structure projects. In a nutshell, the construction industry significantly contributes to the province's economic growth.

The researchers employed a frequency percentage distribution using a descriptive interpretation of the original data to be gathered from the respondents. The findings would be determined using a four-point Likert scale to evaluate the participants' level of agreement with the question provided.

Table.1. Verbal Interpretation of Mean by Levels of Agreement

Response Category	Range Interval	Desc
4	3.25 – 4.00	
3	2.50 – 3.24	
2	1.75 – 2.49	
1	1.00 – 1.74	

The researchers utilized the widely recognized Hypertext Preprocessor language as their primary programming framework for the development of RCEst. PHP is a major programming language having a vast global user base involving millions of

web developers creating web applications and web sites. Its popularity can be attributed to the fact that it is open source, easy to learn, runs on multiple platforms and has an extensive number of pre-built functions as well as libraries [34]. Also, the proponents used the book entitled, *"Simplified Construction Estimate"* by Max B. Fajardo Jr. and "Estimating Bill of Materials" by Vicente A. Tagayun for the formulas needed to code the RCEst.

This study used Statistic Packages for Social Sciences (SPSS), a powerful tool for analyzing statistics. SPSS plays a crucial role for data analysis process to reduce the chances of making mistakes during manual data analysis. This tool helps researchers to perform detailed analyses based on the obtained data through this study.

C. Program Features

The RCEst was developed as cost estimation software to provide a direct and easy way to estimate costs among Residential Construction Firms in the Province of Pampanga. The researchers aimed to provide an avenue for stakeholders to perform their estimates effectively by applying current technological advancements.

Fig. 2.2 Admin Login for Web Interface

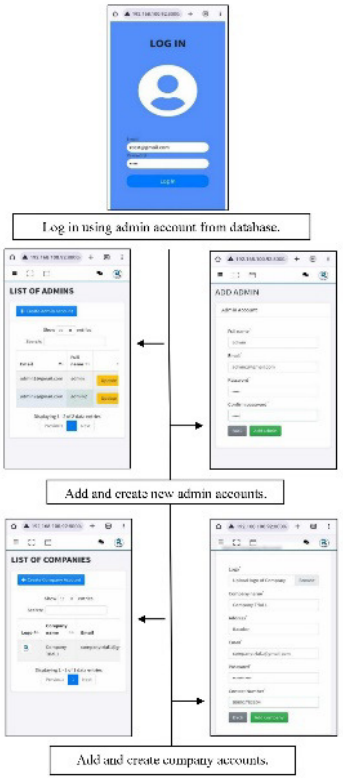

Fig. 2.3 Admin Login for Mobile Interface

Figures 2.2 and 2.3 illustrate the login function for application's administrator. The administrator must log in using email account and password from database. The main administrator has an option to create new admin account for the client/company of their choice. Also, it has an option to add or create company accounts, uploading the company's logo, address, email and contact details.

2.9.2 Web and Mobile Device Functionality for Company/Owner Interface

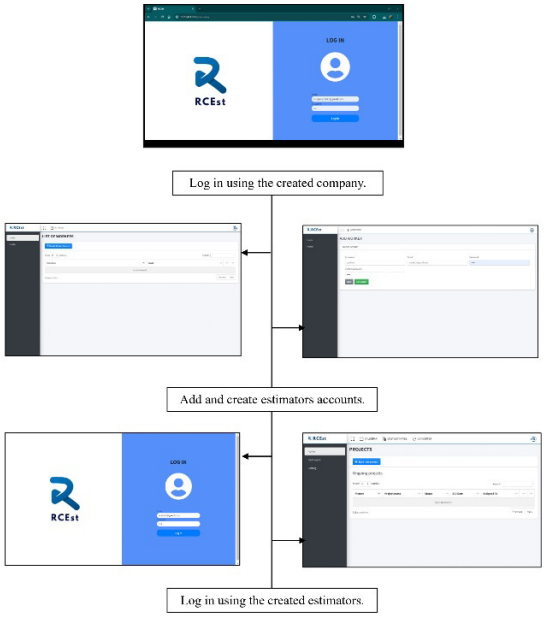

Fig. 2.4 Company Login for Web Interface

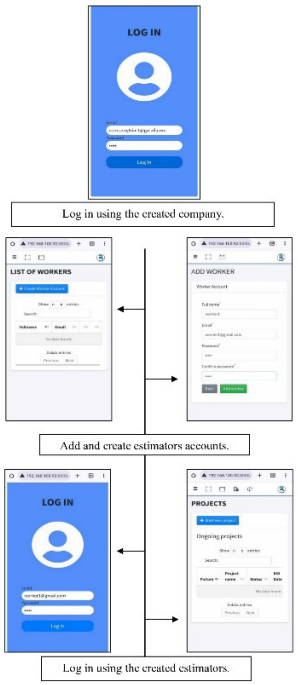

Fig. 2.5 Company Login for Mobile Interface

Figures 2.4 and 2.5 present the process of how the company can access the RCEst Residential Cost Estimator using web or mobile devices. The company representative may start by logging into the account created by the administrator. After logging in, the representative can now add or create estimators/workers account under its company. The estimators/worker may now start to log in the application using the account created by the company's representative under their consent.

2.9.3 Web and Mobile Device Functionality for the Application Dashboard

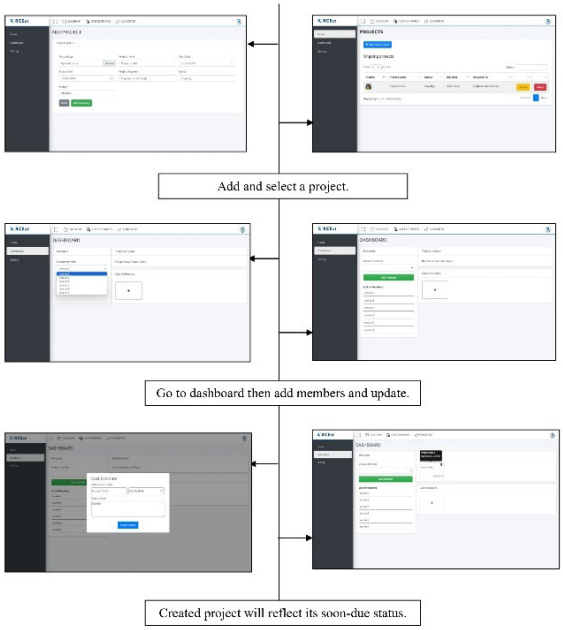

Fig. 2.6 Application Dashboard for Web Interface

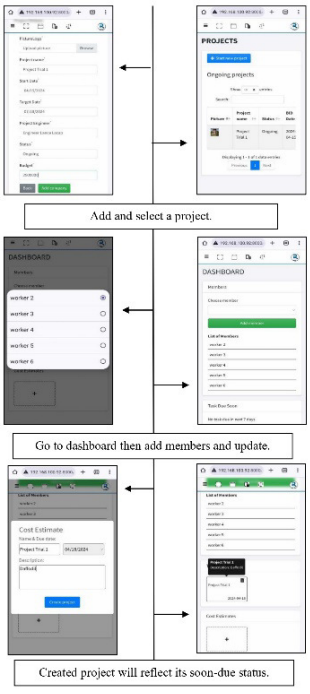

Fig. 2.7 Application Dashboard for Mobile Interface

Figure 2.6 and 2.7 shows the worker interface of RCEstand the dashboard. The worker/estimators can add or select project and input the project details such as: start and target end date, project engineer, project's status, and project's budget. Under the dashboard, worker can add members and the created project would reflect its soon-due status to make the workers/estimators updated.

2.9.4 Web and Mobile Device Functionality for the Calendar and Events

Fig. 2.8 Calendar and Events for Web Interface

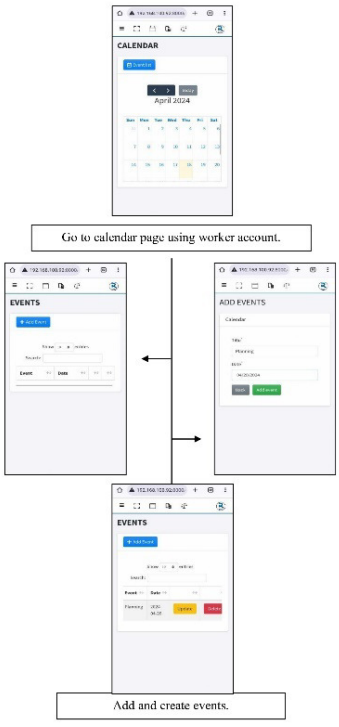

Figure 2.9 Calendar and Events for Mobile Interface

Fig. 2.9 Calendar and Events for Mobile Interface

Figures 2.8 and 2.9 explain the calendar features under worker accounts. The workers/estimators can create an event on specific date such as company's agendas, meetings, and gatherings.

2.9.5 Web and Mobile Device Functionality for the Cost Estimate Feature

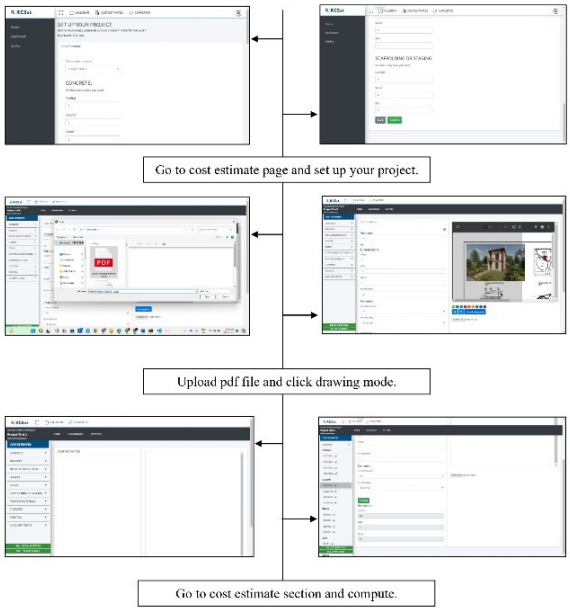

Fig. 2.10 Cost Estimate Feature for Web Interface

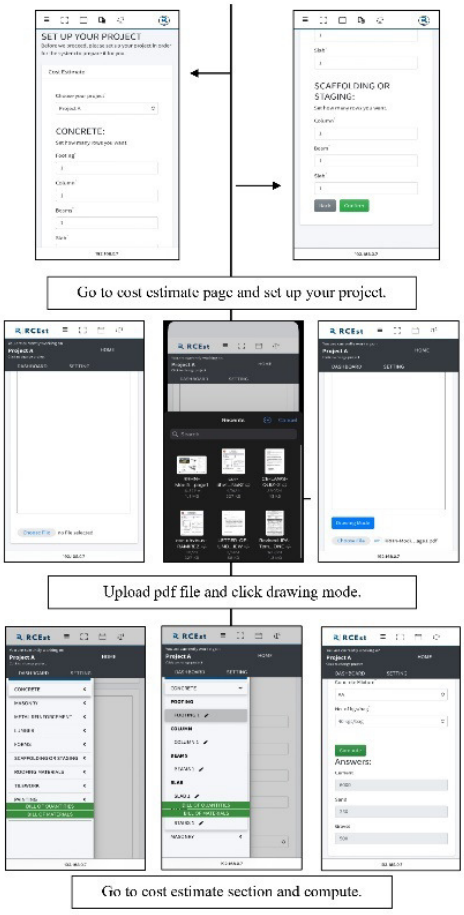

Fig. 2.11 Cost Estimate Feature for Web Interface

Figures 2.10 and 2.11 present the cost estimate feature for web or mobile device interface. The user can set up project estimate in cost estimate page. RCEst Residential Cost Estimator offers the estimation for construction needs such as concrete, masonry, metal reinforcement, scaffolding, roofing materials, lumber, tile works, painting and more. Estimator/workers can also upload a PDF file of the project/blueprint. It has a drawing mode where it can assist the users on checking for the important details that need to input in the RCEst estimator.

2.9.6 Web and Mobile Device Functionality for the BOQ and BOM

Fig. 2.12 BOQ and BOM for Web Interface

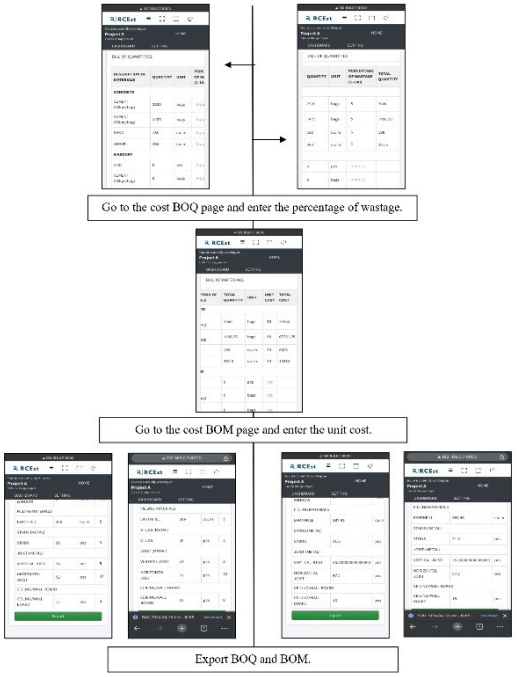

Fig. 2.13 BOQ and BOM for Mobile Interface

Figures 2.12 and 2.13 show how to export the Bill of Quantities (BOQ) and Bill of Materials (BOM) of the projects. After the estimation of construction materials and supplies, users should go to the BOQ page and enter the of wastage. Consequently, click the BOM page below and enter the unit cost to get the overall cost of the estimated

materials. Users can now export and save it in their device in an EXCEL file by percentage clicking the "Export" function.

2.9.7 Web and Mobile Device Functionality for the Guideline and Converter

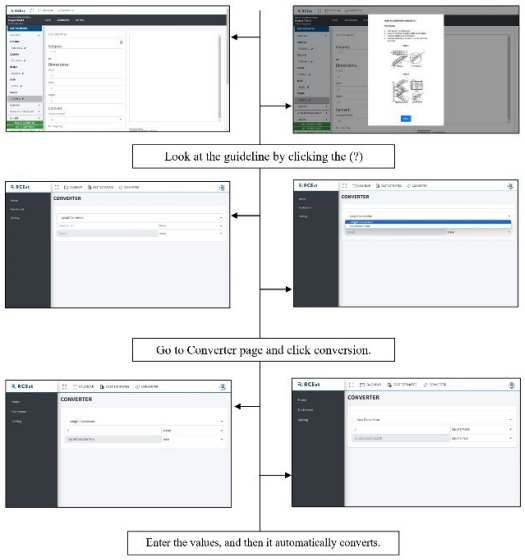

Fig. 2.14 Guideline and Converter for Web Interface

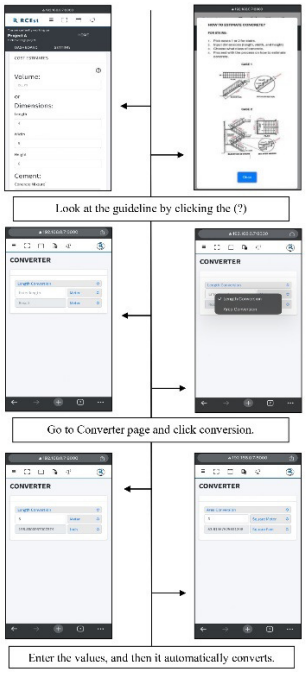

Fig. 2.15 Guideline and Converter for Mobile Interface

Figures 2.14 and 2.15 display the guideline and converter functions in web and mobile device interface. RCEst Cost estimates has an "How to Function" in guiding the users inputs while estimating. This function can be seen by clicking (?) on the upper right side of the cost estimate's page. Converter is also present in aiding the workers/estimators in converting units such as meters, kilometers, inches, and feet. The users can access the Converter in just clicking the converter page and tap the conversion then input the values, and it automatically converts instantly.

III. RESULTS AND DISCUSSION

The findings reported by the respondents comprised the construction stakeholders within the companies in the Province of Pampanga. Table 3.1 shows the respondents' general information or demographic profile, which includes age, years of work experience, position/s held and workplace location. The researchers got a total of thirty (30) respondents.

Table 3.1. Descriptive Statistics for the Demographic Profile of the Respondents (n = 30)

Category	Item	Frequency	Percentage
Age	18-25 years old	9	30.00
	26-35 years old	16	53.33
	36-45 years old	2	6.67
	46-50 years old	2	6.67
	51 years old above	1	3.33
Years of Work Experience	< 3 years	8	26.67
	3-5 years	11	36.67
	6-10 years	8	26.67
	11-15 years	2	6.67
	>15 years	1	3.33
Stakeholders/ Positions held	Quantity Surveyor	10	33.33
	Project Manager	1	3.33
	Site Engineer	10	33.33
	Office Engineer	5	16.67
	Contractor	4	13.34
Locality of work/s	San Fernando	20	66.67
	Bacolor	10	33.33

Table 3.1 depicts the descriptive statistics of the demographic profile of the respondents. The researchers primarily asked about the age of the respondents, where the majority, or 53.33%, are in the 26-35 age bracket. Moreover, nine out of 30 participants are 18-25 years old, while 6.67% are from the 36-45 age group and 46-50 years old. Lastly, one participant is 51 years old and above.

Meanwhile, the researchers also determined the respondents' years of work experience. 11 out of 30 participants have 3-5 years of work experience,

while 8 or 26.67% have worked for less than three years and 6-10 years. 6.67% of the participants have already worked for 11-15 years, while 1 participant worked for almost 15 years and above.

Of all the positions held, 10 have already been working as a Quantity Surveyor and Site Engineer, with a percentage of 33.33. Moreover, five have worked as Office Engineers, while four have experience working as Contractors and only one Project Manager.

Moreover, the researchers also asked for the locality/s of their work experience in the Province of Pampanga. 20 out of the 30, or 66.67% of respondents, said they have already handled construction projects in the City of San Fernando, while 33.33% or ten worked in the Municipality of Bacolor.

Table 3.2. Descriptive Statistics of Methvin in Terms of Accuracy of Cost Estimates (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. Accuracy of Cost Estimates						
I find the software closely aligns with the actual costs for vertical structure projects.	5	5	0	0	3.50	Strongly Agree
I observe that the cost estimates generated by the software are consistent with actual project costs.	3	7	0	0	3.30	Strongly Agree
I would rate the accuracy of cost estimates obtained from the software as accurate.	3	7	0	0	3.30	Strongly Agree
I rarely encounter any discrepancies between the software's estimates and actual cost.	1	9	0	0	3.10	Agree
I am satisfied with the accuracy of the cost estimation software.	6	3	1	0	3.50	Strongly Agree
			Overall		**3.34**	**Strongly Agree**

Table 3.2 shows the descriptive statistics on the accuracy assessment in estimates obtained from present cost estimation software in construction projects. Under Methvin's accuracy of cost estimates, the data gathered shows that the software closely aligns with the actual cost for vertical structure projects, with an average of 3.50. Out of 10 respondents, five strongly agreed, while the remaining agreed. It also shows that respondents strongly agreed about software consistency in actual project cost, with an average index of 3.30. Also, respondents strongly favor the software's accuracy in cost estimates. In addition, respondents agreed that they encountered rare discrepancies between the software estimates and the actual cost, with an average mean of 3.10. Furthermore, the software's accuracy in cost estimation strongly satisfied its users with a mean of 3.50. Overall, Methvin's accuracy in cost estimates got positive feedback with a mean index of 3.34.

Table 3.3. Descriptive Statistics of Methvin in Terms of Ease of Navigation (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
B. Ease of Navigation						
I easily understand the features and tools of the cost estimation software.	0	5	4	1	2.40	Disagree
I have no difficulty comprehending the features and tools of the software.	0	3	6	1	2.20	Disagree
I rate the ease of navigation of the software options as easy.	1	4	3	2	2.40	Disagree
I find that the software is applicable to my understanding.	1	7	2	0	2.90	Agree
I completed the work quickly using the software.	1	5	4	0	2.70	Agree
			Overall		**2.52**	**Agree**

Table 3.3 displays the descriptive statistics on assessing the user-friendliness of present cost estimation software in construction projects. Under Methvin's ease of navigation, the data gathered shows that the respondents had difficulty understanding the software's features and tools. It got a total index of 2.40, where its verbal interpretation is disagreed. It also shows that the respondents had trouble comprehending the software's features and tools. Also, respondents rated the software's options as uneasy, with a mean of 2.90. In addition, respondents completed their work quickly, with an index of 2.70. In conclusion, Methvin claimed a 2.52 mean index for its navigations and tools, which are hard to use and understand.

Table 3.4. Descriptive Statistics of Methvin in Terms of Level of Unique Functionalities (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
C. Level of Unique Functionalities						
I find the software is innovative and distinctive in offering features and tools.	4	6	0	0	3.40	Strongly Agree
I am impressed by how many unique features this construction software has.	3	7	0	0	3.30	Strongly Agree
I find the software has a several unique features that are useful for estimating.	3	7	0	0	3.30	Strongly Agree
I am satisfied with the unique features and tools available in the software.	4	5	1	0	3.30	Strongly Agree
I observed that the software's innovative functions bring huge satisfaction to users and can estimate much better.	4	6	0	0	3.40	Strongly Agree
			Overall		**3.34**	**Strongly Agree**

Table 3.4 presents the descriptive statistics on assessing the distinctive functionalities of present cost estimation software in construction projects. Under Methvin's unique functionalities, the data gathered shows that the respondents find the software innovative and distinctive in offering features and tools. It got a total index of 3.40, with a strongly disagreed verbal interpretation.

Respondents are also strongly amazed by its unique features and for having several special functions. Respondents were also very satisfied with the software's availability of unique features, with a mean of 3.30. Moreover, the software's innovative functions bring massive satisfaction to the respondents, and they strongly agree that it is excellent in cost estimation. As a result, Methvin's 3.34 mean index shows exceptionality in its unique functionalities.

Table 3.5 Descriptive Statistics of Methvin in Terms of Learning Curve (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
D. Learning Curve						
I find it rewarding to learn software's functionalities when I first started using it.	2	5	3	0	2.90	Agree
I find it easy to get started with the software without much prior experience.	0	3	5	2	2.10	Disagree
I find that the software provides intuitive guidance for new users.	0	3	7	0	2.30	Disagree
I find that using the software will allow me to continue developing skills and expertise in cost estimating.	1	6	3	0	2.80	Agree
I observed that the learning curve becomes less steep as I continue to explore what the software can offer.	0	4	6	0	2.40	Disagree
		Overall			**2.50**	**Agree**

Table 3.5 shows the descriptive statistics on assessing the learning rate of present cost estimation software in construction projects over time. Under the learning curve of Methvin, the data gathered shows that the respondents found the software fulfilling to learn when they started using it. The seven respondents among the 10 agreed with a total index of 2.90. However, they disagreed about its ease of use without prior knowledge. Thus, it is advantageous to have an early understanding of the software. Also, it got a total index of 2.30, where its verbal interpretation disagreed with its aids in providing intuitive guidance for new users.

On the contrary, respondents agreed that the software allows for continuous development of its users' skills and expertise in cost estimating. Additionally, they disagreed that the learning curve could not achieve gradual progress for constantly exploring the software, with a mean of 2.40. Consequently, Methvin's rate of its user's progress in gaining experience or new skills got a 2.54 total index, which was perceived as neutral.

Table 3.6: Descriptive Statistics of Stack in Terms of Accuracy of Cost Estimates (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. Accuracy of Cost Estimates						
I find the software closely aligns with the actual costs for vertical structure projects.	5	5	0	0	3.50	Strongly Agree
I observe that the cost estimates generated by the software are consistent with actual project costs.	3	7	0	0	3.30	Strongly Agree
I would rate the accuracy of cost estimates obtained from the software as accurate.	2	7	1	0	3.10	Agree
I rarely encounter any discrepancies between the software's estimates and actual cost.	2	8	0	0	3.20	Agree
I am satisfied with the accuracy of the cost estimation software.	1	8	1	0	3.00	Agree
		Overall			**3.22**	**Agree**

Table 3.6 shows that the data analysis provides insights into the performance of cost estimation software for construction projects. Considering Stacks's accurate estimates of costs, the data gathered shows in the table that the software is generally well-aligned with actual costs for vertical structure projects. With a mean rating of 3.50, they indicate strong agreement among respondents. Additionally, respondents observed consistency between the software's estimates and actual project costs, reflected in a mean rating of 3.30, which indicates a strongly agreed. Moreover, respondents rate the accuracy of the software's cost estimates as generally accurate, with a mean rating of 3.10, indicating that most respondents agreed. They also observe rare discrepancies between the software's estimates and actual costs, indicating a satisfactory level of accuracy with a mean rating of 3.20, falling into the agreed category. Furthermore, a mean rating of 3.00 indicates an agreed category among respondents regarding respondents' satisfaction with the accuracy of the cost estimation software. In summary, the data indicates that respondents had overall positive feedback regarding the accuracy of the Stack's cost estimation.

Table 3.7. Descriptive Statistics of Stack in Terms of Ease of Navigation (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
B. Ease of Navigation						
I easily understand the features and tools of the cost estimation software.	1	5	4	0	2.70	Agree
I have no difficulty comprehending the features and tools of the software.	0	5	4	1	2.40	Disagree
I rate the ease of navigation of the software options as easy.	0	4	3	3	2.10	Disagree
I find that the software is applicable to my understanding.	1	5	4	0	2.70	Agree
I completed the work quickly using the software.	0	5	5	0	2.50	Agree
		Overall			**2.48**	**Disagree**

Table 3.7 displays the data analysis and provides insights into the performance of the cost estimation software for construction projects. Considering how the Stack's Ease of navigation varies across different aspects, the data gathered shows in the table that the Stack generally quickly understands the features and tools of the cost estimation software—with a mean rating of 2.70, indicating that the majority agreed. Also, respondents observed that they have no difficulty comprehending the software's features and tools, reflected in a mean rating of 2.40, which indicates a disagreement. In addition, respondents rated the ease of navigation of the software options as easy, with a mean rating of 2.10, indicating that most respondents disagreed. They also found that the software applied to their understanding, indicating a satisfactory level of ease of navigation with a mean rating of 2.70, falling into the disagreed category. On the other hand, a mean rating of 2.50 indicates an agreed category among respondents regarding respondents' ability to complete their tasks quickly using Stack. In conclusion, the data indicates that respondents had quite a hard time using and understanding the ease of navigation of Stack's cost estimation.

Table 3.8. Descriptive Statistics of Stack in Terms of Level of Unique Functionalities (N = 10)

Item	Frequency				Mean	Verbal Interpretation
C. Level of Unique Functionalities	SA	A	D	SD		
I find the software is innovative and distinctive in offering features and tools.	5	5	0	0	3.50	Strongly Agree
I am impressed by how many unique features this construction software has.	4	6	0	0	3.40	Strongly Agree
I find the software has a several unique features that are useful for estimating.	5	5	0	0	3.50	Strongly Agree
I am satisfied with the unique features and tools available in the software.	4	6	0	0	3.40	Strongly Agree
I observed that the software's innovative functions bring huge satisfaction to users and can estimate much better.	5	5	0	0	3.50	Strongly Agree
		Overall			3.46	Strongly Agree

Table 3.8 presents the data analysis and provides insights into the performance of the cost estimation software for construction projects. Considering Stack's unique functionalities of present cost estimation software in construction projects, the data gathered shows that Stack is generally innovative and distinctive in offering features and tools, with a mean rating of 3.50, indicating that the majority strongly agreed. Respondents were also impressed by how many unique features Stack has reflected in a mean rating of 3.40, which indicates a strongly agreed. In addition, respondents found the Stack to have several unique features useful for estimating, with a mean rating of 3.50, indicating that most respondents strongly agreed. They were also satisfied with Stack's unique features and tools, with a mean rating of 3.40, which fell into the strongly agreed category. On the other hand, a mean rating of 3.50 indicates a strongly agreed category among respondents regarding the Stack's innovative functions that bring immense satisfaction to users and can be estimated much better. As a result, the data indicates that Stack's is outstanding, given its unique features.

Table 3.9. Descriptive Statistics of Stack in Terms of Learning Curve (N = 10)

Item	Frequency				Mean	Verbal Interpretation
D. Learning Curve	SA	A	D	SD		
I find it rewarding to learn software's functionalities when I first started using it.	1	3	6	0	2.50	Agree
I find it easy to get started with the software without much prior experience.	1	1	6	2	2.10	Disagree
I find that the software provides intuitive guidance for new users.	0	3	5	2	2.10	Disagree
I find that using the software will allow me to continue developing skills and expertise in cost estimating.	0	4	4	2	2.20	Disagree
I observed that the learning curve becomes less steep as I continue to explore what the software can offer.	1	2	7	0	2.40	Disagree
		Overall			2.26	Disagree

Table 3.9 shows the data analysis and provides insights into the performance of the cost estimation software for construction projects. With a mean rating of 2.50, they indicate that the majority agreed. Moreover, respondents find that Stack's is to get started with little prior experience, which is reflected in a mean rating of 2.10, indicating a disagreement. In addition, respondents find Stack provides intuitive guidance for new users, with a mean rating of 2.10, indicating that most respondents disagreed. They found that using Stack will allow them to continue developing skills and expertise in cost estimating with a mean rating of 2.20, falling into the disagreed category. A mean rating of 2.40 indicates a disagreement among respondents regarding the learning curve becoming less steep as they continue to explore what Stacks can offer.

Table 3.10: Descriptive Statistics of Planswift in Terms of Accuray of Cost Estimates (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. Accuracy of Cost Estimates						
I find the software closely aligns with the actual costs for vertical structure projects.	2	7	1	0	3.10	Agree
I observe that the cost estimates generated by the software are consistent with actual project costs.	0	8	2	0	2.80	Agree
I would rate the accuracy of cost estimates obtained from the software as accurate.	3	6	1	0	3.20	Agree
I rarely encounter any discrepancies between the software's estimates and actual cost.	1	8	1	0	3.00	Agree
I am satisfied with the accuracy of the cost estimation software.	3	7	0	0	3.30	Strongly Agree
			Overall		**3.08**	**Agree**

Table 3.10 shows the descriptive statistics on assessing the Planswift accuracy in cost estimation. Respondents agreed that Planswift closely aligns with the actual costs for vertical structure projects (Mean: 3.10), observes consistency with actual project costs (Mean: 2.80), and rarely encounters discrepancies between estimates and actual costs (Mean: 3.00). Additionally, they rated the accuracy of cost estimates obtained from Planswift as accurate with a mean of 3.20. Furthermore, the respondents were strongly satisfied with the accuracy of the cost estimate for Planswift, with an average of 3.30. The assessment indicates respondents agreed that Planswift provides reasonably accurate cost estimates, with an average index of 3.08.

Table 3.11. Descriptive Statistics of Planswift in Terms of Ease of Navigation (N = 10)

Item	Frequency				Mean	Verbal Interpretation
B. Ease of Navigation	SA	A	D	SD		
I easily understand the features and tools of the cost estimation software.	1	2	7	0	2.40	Disagree
I have no difficulty comprehending the features and tools of the software.	0	4	6	0	2.40	Disagree
I rate the ease of navigation of the software options as easy.	1	4	5	0	2.60	Agree
I find that the software is applicable to my understanding.	0	5	4	1	2.40	Disagree
I completed the work quickly using the software.	0	2	6	2	2.00	Disagree
			Overall		**2.36**	**Disagree**

Table 3.11 presents the descriptive statistics on assessing Planswift's user-friendliness. Respondents disagreed that they quickly understood the software's navigation, encountered no difficulty comprehending its features and tools, and found that the software applied to their standing; all three statements had the same average of 2.40. Additionally, respondents were dissatisfied with the speed of completing work using Planswift, with an average of 2.00. However, users rated the ease of navigation of the software options as easy, with an average mean of 2.60. Users expressed dissatisfaction with the ease of navigation of Planswift, with an average index of 2.36.

Table 3.12. Descriptive Statistics of Planswift in Terms of Level of Unique Functionalities (N = 10)

Item	Frequency				Mean	Verbal Interpretation
C. Level of Unique Functionalities	SA	A	D	SD		
I find the software is innovative and distinctive in offering features and tools.	1	9	0	0	3.10	Agree
I am impressed by how many unique features this construction software has.	3	4	3	0	3.00	Agree
I find the software has a several unique features that are useful for estimating.	3	5	2	0	3.10	Agree
I am satisfied with the unique features and tools available in the software.	5	4	1	0	3.40	Agree
I observed that the software's innovative functions bring huge satisfaction to users and can estimate much better.	2	7	1	0	3.10	Agree
			Overall		**3.14**	**Agree**

Table 3.12 shows the descriptive statistics on assessing the Planswift's distinct functionalities. Respondents found the software innovative and distinctive in offering features and tools, and it has several unique features that are useful for estimating; both statements have the same average of 3.10. Moreover, users were impressed by the variety of unique features it provides (Mean: 3.00). Furthermore, they expressed satisfaction with the unique features and tools available in the software, having the highest mean of 3.40. Respondents were also satisfied with Planswift's innovative function and agreed that they can estimate much better (Mean: 3.10), attributing them to enhanced accuracy in estimation. Planswift offers a range of unique features and tools, as reflected by the average index of 3.14.

Table 3.13. Descriptive Statistics of Planswift in Terms of Learning Curve (N = 10)

Item	Frequency				Mean	Verbal Interpretation
D. Learning Curve	SA	A	D	SD		
I find it rewarding to learn software's functionalities when I first started using it.	1	6	3	0	2.80	Agree
I find it easy to get started with the software without much prior experience.	1	2	6	1	2.30	Disagree
I find that the software provides intuitive guidance for new users.	2	7	1	0	3.10	Agree
I find that using the software will allow me to continue developing skills and expertise in cost estimating.	0	4	5	1	2.30	Disagree
I observed that the learning curve becomes less steep as I continue to explore what the software can offer.	1	6	3	0	2.80	Agree
			Overall		**2.66**	**Agree**

Table 3.13 presents the descriptive statistics on assessing the learning rate of the software Planswift over time. Respondents found out that learning the software's functionalities was rewarding when they first started using it. They observed that the learning curve became less steep as they continued to explore the software; both statements have the same statistical mean of 2.80. In addition, users agreed that the software provides intuitive guidance for new users (Mean: 3.10). However, respondents disagreed that they found it easy to get started with Planswift without much prior experience, with the lowest mean of 2.30. They also disagreed that using Planswift would allow them to continue developing their skills and expertise in cost estimating, with an average rating of 2.30. The learning curve associated with Planswift varies among users; some found learning rewarding, and others encountered challenges, with an average index of 2.66.

Table 3.14. Assessing the Differences in Estimates Obtained from the Three Software Options for Cost Estimation in Construction Projects.

Variable Tested	Test Statistics	p-value	Interpretation
Accuracy	2.070	0.355	There is no significant difference
Ease of Navigation	3.969	0.137	There is no significant difference
Unique Functionalities	2.515	0.284	There is no significant difference
Learning Curve	2.423	0.298	There is no significant difference

Note: Test at 0.05

Table 3.14 shows the differences in estimates obtained from the three software options for cost estimation in construction projects in terms of accuracy, ease of navigation, unique functionalities, and learning curve. Based on the result, using Kruskal-Wallis H Test, the obtained p-value for the parameter "Accuracy, p = 0.355", "Ease of Navigation, p = 0.137", "Unique Functionalities, p = 0.284", and "Learning Curve, p = 0.298". Since the obtained p-values are greater than 0.05, then we failed to reject the null hypothesis. Therefore, there are no significant differences in estimates obtained from the three software options for cost estimation in construction projects in terms of accuracy, ease of navigation, unique functionalities, and learning curve.

Furthermore, this can be interpreted that the accuracy of cost estimates provided by each software is comparable.Moreover, users find all three software options equally easy (or difficult) to navigate. Lastly, the effectively use each software are roughly the same.

Table 3.15. Narratives of Stakeholders on their Preference Between the Traditional Method and Cost Estimate

Participants	Narrative Extracts	Initial Coding
1	(1) (2) I do prefer the cost estimate software because it has advanced features that could make work would be completed within a shorter period of time compared to using the traditional method.	(1) Advantages of cost estimate software: Efficiency, accuracy, consistency, ease of updating, time-saving features, ability to identify potential savings, ease of collaboration. (2) Time-saving aspect: Especially beneficial for projects with tight schedules, as work estimation can be done in a shorter period. (3) Preference for certain project types: Particularly for residential/building projects, where the ability to quickly measure and collaborate is important. (4) Flexibility and adaptability: Preference for software that can be updated based on current standards and user experience.
2	(1) Overall, cost estimate software offers numerous advantages over traditional methods, including efficiency, accuracy, and consistency. However, the best approach may involve a combination of traditional methods and software tools depending on the specific needs and requirements of a project.	
3	(4) I prefer the cost estimate software rather the traditional one. The software makes the estimation easier with its feature that you will just click and know the almost measurement and quantities you need.	
4	(2) If time should be considered, especially for a tight schedule, I would prefer cost estimate software since work estimation can be done in shorter period of time.	
5	(4) I prefer cost estimate software since the software can be updated based on the current standards and the experience of the users. Estimating can also be faster once the user gets used to it.	
6	(3) (4) I prefer the cost estimate software when dealing with residential/building projects. The ability to quickly measure and highlight what is being measured gives me the flexibility to keep track of what was already estimated and what is left to do. The software also gives me the opportunity to easily collaborate with any peers and clients. Measurements are also easy to understand.	
7	(1) I prefer the cost estimate software for ease of use and accuracy.	
8	(1) (2) I prefer cost estimate software. It can lessen the time you'll consume in estimating projects. It can also help to identify potential savings and can be used to help plan budgets.	
9	(4) I prefer cost estimate software because of the innovative features that can make the work done easily.	

The respondents' narratives emphasize several aspects of CES that offers perspective on its benefits and functionality.

Firstly, proponents agreed on the advantages and efficiency of CES, they highlight how the estimation process makes it quicker compared to traditional methods. Participants acknowledge the CES for its timesaving. It was valuable for them to perform estimation faster, especially with tight schedules. This aspect increases productivity making the team to meet deadline effectively.

Moreover, theyfocus on the relevance of considering the project specific needs when selecting between the CES and traditional method. While CES offers several benefits, others suggested the hybrid approach which combines both software-based and traditional method. Also, they like how

user-friendly the interface which enable them to navigate the software faster.

Furthermore, participants highlighted the ability of the software to communicate among the users, real-time update and shared access to project data that enable efficient teamwork.

Table 3.16. Narratives of Stakeholders on the Necessary Tools and Functions in a Cost Estimating Program for Residential Projects

Participants	Narrative Extracts	Initial Coding
1	(1) I think the function that is necessary in the software are complete set of commonly used materials with their prices.	(1) Essential functions: Complete set of commonly used materials with their prices, take-off function, area computation, availability of materials, and material cost. (2) Desirable features for efficiency: Ability to use the software simultaneously with others for collaboration, and automation function for complex scenarios. (3) Ease of use and integration: Ability to export estimated quantities to Excel, capability of collaboration with other estimators, use of software online or offline. (4) Accessibility: Ability to use the software offline or online. Moreover, accessibility with mobile devices.
2	(1) I think the take-off function is necessary in a cost estimating program. It plays an important role in the process of cost estimation by providing accurate and detailed information about the materials and resources required for a project.	
3	(1) (2) If there is also updated rate of prices connected through the app as this will lessen the works. Another one if you can use it while other people can also estimate with you at the same time.	
4	(1) Some functions that are necessary in a cost estimating program are the area computation, availability of materials and material cost.	
5	(2) Having the capability of collaboration with other estimators is also a plus.	
6	(3) The ability to export the estimated quantities to an excel spreadsheet is also important.	
7	(2) Automation function (if else) for complex scenarios, auto-detect plan features for counting fixtures, collaboration function.	
8	(4) The ability of the software that can be used whether online or offline.	
9	(1) Accurate measurements, updated labor, and material cost.	
10	(4) The software is accessible with mobile devices, so users can access it anywhere by just using a phone.	

The stakeholders' narratives present perspective on its advantages, functionality and their contentment with CES.

Participant 1 highlights the need of extensive database of usually used materials and their prices. Participant 2 focus on the significance of the take-off function that is necessary for detailed estimation. Participant 3 emphasize the importance of updated price rates and collaboration among the users. Similarly, Participant 4 highlights functions such as the availability of material and area computation that is essential for accurate estimation. Participant 5 focus the importance of collaboration with other estimators. Moreover, Participant 6 focus on exporting capabilities and simplifying the estimation process. Participant 7 highlights on function such as automation and collaboration. Participant 8 stresses the essential of using the software either online or offline. Participant 9 stated the significant of accurate measurements and the material cost. Finally, Participant 10 recommend that software could access with mobile devices. Overall, the data provides an extensive understanding among participants of the necessary functions of the cost estimating software.

Table 3.17. Narratives of Programmers Regarding Their Ideal Ui Design, Tools, Functions, And Discrepancy Handling for Their Preferred Software Design

Participants	Narrative Extracts	Initial Coding
1	(1) (2) A clean and intuitive interface that prioritizes ease of use for all stakeholders.	(1) Interface design priorities: Clean, intuitive, prioritizing ease of use. (2) User-centered design approach: Incorporating feedback from stakeholders, catering to diverse needs, user-friendly, visually appealing, efficient in delivering functionalities. (3) Data input and display: Clear and structured input data, user-friendly display of cost estimates, customizable views or filters, use of tables or graphs for clarity. (4) Usability enhancements: Neutral colors, organized layouts, intuitive design elements, minimalist design, clear color scheme, contrasting colors for important elements, consistency throughout the interface, ample white space, logical grouping of features. (5) Navigation improvements: Clear menu structures, intuitive navigation tools, search bar, breadcrumb navigation, customizable dashboard, keyboard shortcuts, tooltips for guidance. (6) Error handling and validation: Clear error messages, guidance for correction, real-time validation checks.
2	(1) (2) (4) Certainly! The ideal user interface design for the software would prioritize intuitive navigation, and clear layout. It should cater the needs of stakeholders by being user-friendly, visually appealing, and efficient in delivering desired functionalities. Incorporating feedback from stakeholders throughout the design process would ensure that the interface meets their specific requirements and enhances overall usability and satisfaction.	
1	(4) (5) Input data should be clear and structured, with cost estimates displayed in a user-friendly format.	
2	(3) (4) Certainly! The software should provide clear input fields for users to enter cost estimates and options for specifying categories. Displaying cost data through tables or graphs would be ideal, allowing for easy understanding and quick identification of key information. Customizable views or filters would enhance user flexibility.	
1	(2) (4) Neutral colors, organized layouts, and intuitive design elements enhance usability.	
2	(1) (4) For me, a clean and minimalist design with a clear color scheme and intuitive layout would enhance usability. Using contrasting colors for important elements and maintaining consistency throughout the interface would make navigation easier. Additionally, incorporating ample white space and logical grouping of related features would reduce cognitive load and improve overall user experience.	
1	(2) (5) Clear menu structures and intuitive navigation tools would help improve ease of movement within the software.	
2	(4) (5) A search bar, breadcrumb navigation, and customizable dashboard would help. Keyboard shortcuts and tooltips for guidance would also make navigation easier.	
1	(3) (6) Provide clear error messages and prompts for correcting discrepancies or invalid inputs.	
2	(3) (6) The software should display clear error messages, offer guidance for correction, and provide real-time validation checks.	

Table 3.18. The Acceptability of RCESt to Stakeholders in Terms of User Interface.

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. User Interface						
The RCEst is intuitive and easy to navigate.	6	4	0	0	3.60	Strongly Agree
The RCEst is visually consistent and coherent across all its pages/screens.	7	2	1	0	3.60	Strongly Agree
The RCEst's layout of buttons and menus is logical and facilitates smooth navigation.	5	5	0	0	3.50	Strongly Agree
The RCEst's interface design aids in my understanding of the cost estimating process.	3	6	1	0	3.20	Agree
The RCEst adapts well to different screen sizes/resolutions.	4	5	1	0	3.30	Strongly Agree
		Overall			**3.44**	**Strongly Agree**

Table 3.18 shows the acceptability of RCEst to stakeholders, in terms of User Interface. Based on the result, the statements "The RCEst is intuitive and easy to navigate" and "The RCEst is visually consistent and coherent across all its pages/screens" exhibit the highest weighted mean of (3.60) with a

verbal interpretation of (Strongly Agree). However, the statement "The RCEst's interface design aids in my understanding of the cost estimating process" exhibits the lowest weighted mean of (3.20) with a verbal interpretation of (Agree). The overall weighted mean for the parameter "User Interface" is (3.44) with a verbal interpretation of (Strongly Agree).

Table 3.19. The Acceptability of RCESt to Stakeholders in Terms of Functionality.

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
B. Functionality						
The RCEst provides the necessary features required for cost estimation.	4	6	0	0	3.40	Strongly Agree
The RCEst is user-friendly with easy-to-use functionalities.	4	3	2	1	3.50	Strongly Agree
The RCEst has clear and well-labeled input fields for easy understanding.	4	6	0	0	3.40	Strongly Agree
The RCEst provides helpful features that guide me through unfamiliar tasks.	6	4	0	0	3.60	Strongly Agree
The RCEst's innovative functions bring me huge satisfaction	4	5	1	0	3.30	Strongly Agree
			Overall		**3.44**	**Strongly Agree**

Table 3.19 shows the acceptability of RCEst to stakeholders, in terms of Functionality. Based on the result, the statement "The RCEst provides helpful features that guide me through unfamiliar tasks" exhibits the highest weighted mean of (3.60) with a verbal interpretation of (Strongly Agree). However, the statement "The RCEst's innovative functions bring me huge satisfaction" exhibits the lowest weighted mean of (3.30) with a verbal interpretation of (Agree). The overall weighted mean for the parameter "Functionality" is (3.44) with a verbal interpretation of (Strongly Agree).

Table 3.20. The Acceptability of RCESt to Stakeholders in Terms of Performance.

Item	Frequency				Mean	Verbal Interpretatio
	SA	A	D	SD		
C. Performance						
The RCEst performs reliably without frequent crashes or errors.	2	6	2	0	3.00	Agree
The RCEst provides accurate cost estimates based on the input data provided.	1	9	0	0	3.10	Agree
The RCEst allows for quick and efficient uploading and processing of project data.	1	7	1	1	2.90	Agree
The RCEst's speed and responsiveness meet my expectations.	4	5	1	0	3.30	Strongly Agree
The RCEst allows easy collaboration and sharing of project information with team members.	3	7	0	0	3.30	Strongly Agree
			Overall		**3.12**	**Agree**

Table 3.20 shows the acceptability of RCEst to stakeholders, in terms of Performance. Based on the result, the statements "The RCEst's speed and responsiveness meet my expectations" and "The RCEst allows easy collaboration and sharing of project information with team members" exhibit the highest weighted mean of (3.30) with a verbal interpretation of (Strongly Agree). However, the statement "The RCEst allows for quick and efficient uploading and processing of project data" exhibits the lowest weighted mean of (2.90) with a verbal interpretation of (Agree). The overall weighted mean for the parameter "Performance" is (3.12) with a verbal interpretation of (Strongly Agree).

Internal Testing

The proponents conducted internal testing on the web based RCEst software to ensure its accuracy and credibility. The researchers firsthand experienced the software after the programmers encoded the provided formulas based on the book entitled, *"Simplified Construction Estimate"* by Max B. Fajardo Jr. and "Estimating Bill of Materials" by Vicente A. Tagayun.

For the 1st Trial, the researchers explored all the features of the software to confirm functionality. Moreover, for the main "estimation" features, the researchers input the values of their provided sample data into the software and compared the results with manual calculations. On the initial check, various technical difficulties were discovered, including the software's accuracy in estimating, typographical errors, and additional features. These issues were noted and discussed with the programmers to correct the coding in real-time.During the 2nd trial, only minimal errors were revealed compared to the initial issues. Like the first trial, observed issues were noted and reported to the programmers for correction.

In the 3rd trial, the researchers thoroughly checked the estimated parts and found no issues with the computations. Along with the manual computation, discrepancies were resolved through continuous checking of formulas from those two estimating books and guided the programmers for the precise encoding of data. This process is indeed

involved trial and error until the desired accuracy was achieved.

Certainly, behind this proudly called perfection had a long process of changes, redo and ups and down moments. The researchers faced different hard times especially in programming due to their lack of experience. Guaranteed that the quality of the software is remarkable. Its mission on improving the accuracy, saves time and increases profit are surely delivered. Empower construction industry towards successful projects.

Table 3.21 Descriptive Statistics of RCEst Among Stakeholders Who Used Methvin (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. Accuracy of Cost Estimates						
I find the software closely aligns with the actual costs for vertical structure projects.	6	4	0	0	3.60	Strongly Agree
I observe that the cost estimates generated by the software are consistent with actual project costs.	3	6	1	0	3.20	Agree
I would rate the accuracy of cost estimates obtained from the software as accurate.	5	3	1	1	3.20	Agree
I rarely encounter any discrepancies between the software's estimates and actual cost.	2	7	1	0	3.10	Agree
I am satisfied with the accuracy of the cost estimation software.	6	3	1	0	3.50	Strongly Agree
B. Ease of Navigation						
I easily understand the features and tools of the cost estimation software.	5	5	0	0	3.50	Strongly Agree
I have no difficulty comprehending the features and tools of the software.	2	7	1	0	3.10	Agree
I rate the ease of navigation of the software options as easy.	5	5	0	0	3.50	Strongly Agree
I find that the software is applicable to my understanding.	4	6	0	0	3.40	Strongly Agree
I completed the work quickly using the software.	1	6	2	1	2.70	Agree
C. Level of Unique Functionalities						
I find the software is innovative and distinctive in offering features and tools.	6	3	1	0	3.50	Strongly Agree
I am impressed by how many unique features this construction software has.	3	7	0	0	3.30	Strongly Agree
I find the software has a several unique features that are useful for estimating.	4	5	1	0	3.30	Strongly Agree
I am satisfied with the unique features and tools available in the software.	2	7	1	0	3.10	Agree
I observed that the software's innovative functions bring huge satisfaction to users and can estimate much better.	4	5	1	0	3.30	Strongly Agree
D. Learning Curve						
I find it rewarding to learn software's functionalities when I first started using it.	1	7	1	1	2.80	Agree
I find it easy to get started with the software without much prior experience.	4	5	1	0	3.30	Strongly Agree
I find that the software provides intuitive guidance for new users.	7	3	0	0	3.70	Strongly Agree
I find that using the software will allow me to continue developing skills and expertise in cost estimating.	3	6	1	0	3.00	Agree
I observed that the learning curve becomes less steep as I continue to explore what the software can offer.	1	6	2	1	2.70	Agree
			Overall		**3.24**	**Agree**

Table 3.21 shows the descriptive statistics on the assessment of the accuracy of RCEst among Stakeholders who used Methvin. Under the accuracy of cost estimates of RCEst, the data gathered shows that the software is closely align with the actual cost for vertical structure projects with an average of 3.60. Out 0f 10 respondents, six people are strongly agreed while remaining are agreed. It also shows that respondents agreed about software consistency in actual project cost with an average index of 3.20. Also, respondents are in favor in the accuracy of the software in cost estimate. In addition, respondents are agreed that they encountered rare discrepancies between the software estimates and the actual cost with an average mean of 3.10. Furthermore, the software's accuracy in cost estimation strongly satisfied its user with a total mean of 3.50. Overall, RCEst's accuracy in cost estimates got positive feedback with a mean index of 3.32.

Under the ease of navigation of RCEst, the data gathered shows that the respondents easily understand the software's feature and tools. It got a total index of 3.50 where its verbal interpretation is strongly agreed. It also shows that the respondents did not experience any difficulty in comprehending the feature and tools of the software. Also, respondents rated the software's options as easy for having a mean of 3.50. In addition, respondents are agreed that the software is applicable to their understanding and can be learn along the way. In addition, respondents still completed their work quickly for having an index of 2.70. In conclusion, Methvin's claimed a 3.24 mean index for its navigations and tools are exceptional to use and understand.

Moreover, the data gathered under the level of unique functionalities of RCEst shows that the respondents find the software innovative and distinctive in offering features and tools. It got a total index of 3.50, with a strongly agreed verbal interpretation. Respondents are also strongly amazed by its unique features and for having several special functions that can be used in estimation for having a mean of 3.30. In addition, respondents are satisfied with the software's availability of unique features, with a mean of 3.10. Moreover, the software's innovative functions bring massive satisfaction to the respondents. It got a total mean of 3.40, with a strongly agree verbal interpretation. As a result, Methvin's 3.30 mean index shows exceptionality in its unique functionalities.

Furthermore, the data gathered in learning curve of RCEst shows that the respondents found the software fulfilling to learn when they started using it. The seven respondents among the 10 agreed with

a total index of 2.80. However, they strongly agreed about its ease of use without prior knowledge for having a mean of 3.30. Thus, it is advantageous to have an early understanding of the software. Also, it got a total index of 3.70, where its verbal interpretation strongly amazed with its aid in providing intuitive guidance for new users. On the contrary, for having a mean of 3, respondents agreed that the software allows for continuous development of its users' skills and expertise in cost estimating. Additionally, they agreed that the learning curve could not achieve gradual progress for constantly exploring the software, with a mean of 2.70. Consequently, Methvin's rate of its user's progress in gaining experience or new skills got a 3.1 total index.

Table 3.22 Descriptive Statistics of RCEst Among Stakeholders Who Used Stack (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. Accuracy of Cost Estimates						
I find the software closely aligns with the actual costs for vertical structure projects.	6	4	0	0	3.60	Strongly Agree
I observe that the cost estimates generated by the software are consistent with actual project costs.	4	5	1	0	3.30	Strongly Agree
I would rate the accuracy of cost estimates obtained from the software as accurate.	3	6	1	0	3.20	Agree
I rarely encounter any discrepancies between the software's estimates and actual cost.	2	7	1	1	3.20	Agree
I am satisfied with the accuracy of the cost estimation software.	2	8	0	0	3.20	Agree
B. Ease of Navigation						
I easily understand the features and tools of the cost estimation software.	5	5	0	0	3.50	Strongly Agree
I have no difficulty comprehending the features and tools of the software.	2	7	1	0	3.10	Agree
I rate the ease of navigation of the software options as easy.	5	5	0	0	3.50	Strongly Agree
I find that the software is applicable to my understanding.	6	3	1	0	3.50	Strongly Agree
I completed the work quickly using the software.	2	5	2	1	2.80	Agree
C. Level of Unique Functionalities						
I find the software is innovative and distinctive in offering features and tools.	4	5	1	0	3.30	Strongly Agree
I am impressed by how many unique features this construction software has.	3	7	0	0	3.30	Strongly Agree
I find the software has a several unique features that are useful for estimating.	6	3	1	0	3.50	Strongly Agree
I am satisfied with the unique features and tools available in the software.	2	8	0	0	3.10	Agree
I observed that the software's innovative functions bring huge satisfaction to users and can estimate much better.	3	6	1	0	3.20	Agree
D. Learning Curve						
I find it rewarding to learn software's functionalities when I first started using it.	3	4	3	0	3.00	Agree
I find it easy to get started with the software without much prior experience.	5	3	1	1	3.20	Agree
I find that the software provides intuitive guidance for new users.	8	2	0	0	3.80	Strongly Agree
I find that using the software will allow me to continue developing skills and expertise in cost estimating.	5	4	0	1	3.20	Agree
I observed that the learning curve becomes less steep as I continue to explore what the software can offer.	2	5	2	1	2.80	Agree
			Overall		**3.27**	**Strongly Agree**

Table 3.22 shows the descriptive statistics on the assessment of the accuracy of RCEst among Stakeholders who used Stacks. Considering how RCEST is an accurate estimate of costs, the data gathered presents that the software is generally well-aligned with actual costs for vertical structure projects, with a mean of 3.60, indicating strong agreement among respondents. Additionally, respondents observed consistency between the software's estimates and actual project costs, reflected in a mean rating of 3.30, which indicates strong agreement. Moreover, respondents rate the accuracy of the software's cost estimates as generally accurate, with a mean of 3.20, indicating that most respondents agreed. They also observe rare discrepancies between the software's estimates and actual costs, indicating an agreed category of accuracy with a mean of 3.20, falling into the agreed category. Furthermore, a mean rating of 3.20 indicates agreement among respondents regarding their satisfaction with the accuracy of the cost estimation software. In summary, the data indicates that respondents had overall positive feedback regarding the accuracy of RCEst.

In addition, it displays the descriptive statistics on the assessment about the user-friendliness of RCEst among Stakeholders who used Stack. Respondents strongly agree that they easily understand the features and tools of the cost estimation software, with a mean rating of 3.50. In addition, respondents agreed that they have no difficulty comprehending the features and tools of the software, reflected in a mean rating of 3.10. However, users rate the ease of navigation of the software options as easy, with a mean rating of 3.50, indicating strong agreement and a positive user experience. They strongly agreed that the software applies to their understanding, with a mean of 3.50. Respondents agreed that they completed their work quickly using the software, with a mean rating of 2.80.

Moreover, it presents the data analysis that provides insights about the level of unique functionalities of the RCEst among Stakeholders who used Stack. Stakeholders strongly agreed that the RCEst is innovative and distinctive in offering features and tools, with a mean of 3.30. Also, users strongly agreed that they are impressed by the number of unique features the software offers, reflected in a mean of 3.30. Respondents strongly agreed that the software has several unique features that are useful for estimating, with a mean of 3.50. They also agreed that they are satisfied with the

unique features and tools available in the software, with a mean of 3.10. This suggests general satisfaction with the software's distinctive features. Respondents agreed that the software's innovative functions bring significant satisfaction and improve estimation accuracy, with a mean of 3.20. This indicates that users find the innovative functionalities beneficial for their estimation tasks. As a result, the data indicates that RCEst is outstanding, given its unique features, highlighting its usefulness of its distinctive features.

Lastly, it shows the data analysis provides insights about the learning curve of the RCEST among Stakeholders who used Stack. Considering how users perceive the ease of learning and starting with the software, the data gathered presents that users generally find the software rewarding and manageable to learn, especially for new users. Respondents agreed that they find it rewarding to learn the software's functionalities when first starting, with a mean of 3.00. Additionally, respondents agreed that it is easy to get started with the software without much prior experience, reflected in a mean of 3.20. This suggests that the software is accessible to beginners. Moreover, users strongly agreed that the software provides intuitive guidance for new users, with a mean of 3.80. They also agreed that using the software would allow them to continue developing skills and expertise in cost estimating, with a mean rating of 3.20. Respondents agreed that the learning curve becomes less steep as they continue to explore what the software can offer, with a mean rating of 2.80. As an outcome, the data indicates that respondents had overall positive feedback regarding the learning curve of RCEST.

Table 3.23 Descriptive Statistics of RCEst Among Stakeholders Who Used Planswift (N = 10)

Item	Frequency				Mean	Verbal Interpretation
	SA	A	D	SD		
A. Accuracy of Cost Estimates						
I find the software closely aligns with the actual costs for vertical structure projects.	4	5	0	1	3.20	Agree
I observe that the cost estimates generated by the software are consistent with actual project costs.	2	6	1	1	2.90	Agree
I would rate the accuracy of cost estimates obtained from the software as accurate.	5	5	0	0	3.50	Strongly Agree
I rarely encounter any discrepancies between the software's estimates and actual cost.	2	7	1	0	3.10	Agree
I am satisfied with the accuracy of the cost estimation software.	4	6	0	0	3.40	Strongly Agree
B. Ease of Navigation						
I easily understand the features and tools of the cost estimation software.	6	4	0	0	3.60	Strongly Agree
I have no difficulty comprehending the features and tools of the software.	6	3	1	0	3.50	Strongly Agree
I rate the ease of navigation of the software options as easy.	4	5	1	0	3.30	Strongly Agree
I find that the software is applicable to my understanding.	7	3	0	0	3.70	Strongly Agree
I completed the work quickly using the software.	1	6	2	1	2.70	Agree
C. Level of Unique Functionalities						
I find the software is innovative and distinctive in offering features and tools.	1	9	0	0	3.10	Agree
I am impressed by how many unique features this construction software has.	2	7	1	0	3.10	Agree
I find the software has a several unique features that are useful for estimating.	4	5	0	1	3.20	Agree
I am satisfied with the unique features and tools available in the software.	3	6	1	0	3.20	Agree
I observed that the software's innovative functions bring huge satisfaction to users and can estimate much better.	2	8	0	0	3.20	Agree
D. Learning Curve						
I find it rewarding to learn software's functionalities when I first started using it.	1	7	2	0	2.90	Agree
I find it easy to get started with the software without much prior experience.	4	5	1	0	3.30	Strongly Agree
I find that the software provides intuitive guidance for new users.	5	5	0	0	3.50	Strongly Agre
I find that using the software will allow me to continue developing skills and expertise in cost estimating.	3	5	1	1	3.00	Agree
I observed that the learning curve becomes less steep as I continue to explore what the software can offer.	2	7	1	1	3.20	Agree
			Overall		**3.23**	**Agree**

Table 3.23 shows the descriptive statistics on the assessment of the accuracy of RCEst among Stakeholders who used Planswift. Considering how accurate the cost estimate of RCEst, the data gathered shows that the software closely aligned with actual costs for vertical structure projects, with a mean rating of 3.20, indicating that majority of respondents agreed. Additionally, respondents observed a consistency between the software's estimates and actual project costs with a mean rating of 2.90 which indicates that the respondents agreed. Moreover, the respondents rated the accuracy of software's cost estimate as precise, with its mean rating of 3.50, indicating a strong agreement within the respondents. They also observe how rare discrepancies between the software's estimates and actual costs occur, with the mean rating of 3.10, indicating that most respondents agreed. In terms of the respondent's satisfaction with the accuracy of the cost estimate they were generally satisfied, with a mean rating of 3.40 which indicates the respondents strongly

agreed. In summary, the data indicates that respondents had overall positive feedback regarding the accuracy of RCEST.

Moreover, it presents the descriptive statistics on the assessment about the user-friendliness of RCEst among Stakeholders who used Planswift. This considers how easily users understand and navigate the software. The data gathered presents that users generally find the software's user-friendly and easy to navigate. With a mean rating of 3.60 respondents strongly agreed that they understand features and tools of the cost estimating software. Additionally, with a mean rating of 3.50 the respondents strongly agreed that they had no difficulty in comprehending the features. In rating the ease of navigation of the software as easy the respondents strongly agreed with a presented mean rating of 3.30. The respondents also strongly agreed that the software applies to their understanding, with a mean rating of 3.70. The respondents agreed that they completed the work quickly using the software with a presented mean rating value of 2.70. In conclusion, the data indicates the respondents had an overall positive experience with regards to the user-friendliness of the cost estimating software.

It also presents a descriptive statistic which provides insights about the level of unique functionalities of the RCEST among Stakeholders who used Planswift. The data gathered shows that respondent found that the software is innovative and distinctive in offering features and tools as presented in their mean value of 3.10 and verbal interpretation as agree. The respondents agreed that the with the impressive number of unique functionalities in the software which is presented in their mean value of 3.10. The respondents also agreed that they found the unique features useful for estimating with a presented mean rating of 3.20. Additionally, the respondents agreed that they are satisfied with the unique features and tools available in the software as presented in their mean value of 3.20. The respondents agreed that the software's innovative functions bring significant satisfaction and improve estimation accuracy, with a mean rating of 3.20. It indicates that the respondents are generally satisfied with the unique functionality of the RCEst.

Furthermore, it shows the data analysis provides insights about the learning curve of the RCEST among Stakeholders who used Planswift. This considers how users perceive the ease of learning the software system. The data gathered shows users generally find the software rewarding and manageable to learn, especially for new users as presented in their mean value of 2.90 and verbal interpretation as agree. The respondents strongly agreed that they found it easy in the beginning without any prior experience with the software which has a mean value of 3.30. The respondents also strongly agreed that the software provides a intuitive guidance for new user which is indicated by their mean rating of 3.50. Furthermore, the respondents found that the software will continue to develop their skills and expertise in estimating as presented in their mean value of 3.00. The respondents agreed that the learning curve becomes less steep as they continue to explore what the software can offer, with a mean rating of 3.2. The outcome of the data gathered indicates that the user had a positive experience with the learning curve of the RCEst that highlighted its intuitive guidance and accessibility.

Table 3.24 Assessing the Differences in Estimates Obtained from the Methvin and RCEst for Cost Estimation in Construction Projects.

Paired Samples Test (Methvin-RCEst)

		95% Confidence Interval of the Difference			
	Mean	Lower	Upper	t	Sig. (2-tailed)
Accuracy	.02000	-.08389	.12389	.535	.621
Ease of Navigation	-.72000	-1.30503	-.13497	-3.417	.027
Level of Unique Functionalities	.04000	-.10157	.18157	.784	.477
Learning Curve	-.60000	-1.41893	.21893	-2.034	.112

Table 3.24 shows the differences in estimates obtained from the web-based cost estimation software namely Methvin and RCEst in construction projects in terms of accuracy, ease of navigation, unique functionalities, and learning curve.If the Sig. (2-tailed) value is greater than .05; it can conclude that there is no significant difference between the two conditions. If the Sig. (2-tailed) value is less than or equal to .05; it can conclude that there is a statistically significant difference between the two conditions.

Based on the result, using T-Test, the obtained p-value for the parameter “Accuracy, p = 0.621”,

"Unique Functionalities, p = 0.477", and "Learning Curve, p = 0.112". Since the obtained p-values are greater than 0.05, then we failed to reject the null hypothesis. Therefore, there are no significant differences in estimates obtained from the two software options for cost estimation in construction projects in terms of accuracy, unique functionalities, and learning curve.

This means that each software provides equally accurate cost estimates. It also suggests that both offer similar unique features, ensuring that users have access to a comparable range of functionalities regardless of their choice. Additionally, it implies that users will experience a similar learning curve with either software.

Meanwhile, "Ease of Navigation, p = 0.027", which is less than to significant at 95% level of confidence (α = 0.05).According to the literature, α dictates the acceptable risk of incorrectly rejecting Ho. In this case if considering α = 0.05, the result obtained would give enough evidence to reject Ho and conclude Ha. Therefore, the researchers can conclude that there is a significant difference in ease of navigation between Methvin and RCEst. This significant difference suggests that the RCEst is easier to navigate than the Methvin, implying more user-friendly interface, which can enhance user efficiency.

Table 3.25 Assessing the Differences in Estimates Obtained from the Stack and RCEst for Cost Estimation in Construction Projects.

Paired Samples Test (Stack-RCEst)

		95% Confidence Interval of the Difference			
	Mean	Lower	Upper	t	Sig. (2-tailed)
Accuracy	-.08000	-.18389	.02389	-2.138	.099
Ease of Navigation	-.80000	-1.28884	-.31116	-4.544	.010
Level of Unique Functionalities	.18000	.01811	.34189	3.087	.037
Learning Curve	-.94000	-1.58876	-.29124	-4.023	.016

Table 3.25 shows the differences in estimates obtained from the Stack and RCEst in construction projects in terms of accuracy, ease of navigation, unique functionalities, and learning curve.Based on the result, the obtained p-value for the parameter "Accuracy, p = .099" is greater than 0.05, then we failed to reject the null hypothesis. Therefore, there are no significant differences in estimates obtained from the two software options for cost estimation in construction projects in terms of accuracy. It implies that both software options provide equally accurate cost estimates.

However, the p-value for the parameter "Ease of Navigation, p = .010", "Unique Functionalities, p = .037", and "Learning Curve, p = .016" is less than to significant at 95% level of confidence (α = 0.05). Therefore, the researchers can conclude that there is a significant difference between the obtained from the two software options for cost estimation in construction projects in terms of ease of navigation, unique functionalities, and learning curve. Furthermore, it indicate that RCEst is easier to navigate, offers better unique functionalities, and has a steeper learning curve than Stack.

Table 3.26 Assessing the Differences in Estimates Obtained from the Planswift and RCEst for Cost Estimation in Construction Projects.

Paired Samples Test (Stack-RCEst)

		95% Confidence Interval of the Difference			
	Mean	Lower	Upper	t	Sig. (2-tailed)
Accuracy	-.14000	-.25106	-.02894	-3.500	.025
Ease of Navigation	-1.00000	-1.35120	-.64880	-7.906	.001
Level of Unique Functionalities	-.02000	-.18189	.14189	-.343	.749
Learning Curve	-.52000	-.94471	-.09529	-3.399	.027

Table 3.26 shows the differences in estimates obtained from the Planswift and RCEst in construction projects in terms of accuracy, ease of navigation, unique functionalities, and learning curve.Based on the result, the obtained p-value for the parameter "Level of Unique Functionalities, p = .749" is greater than 0.05, then we failed to reject the null hypothesis. Therefore, there are no significant differences in estimates obtained from the two software options for cost estimation in construction projects in terms of level of unique functionalities. This means that both software options offer similar unique functionalities, ensuring that users have access to the same range of tools and features.

Meanwhile, the p-value for the parameter "Accuracy, p = .010", "Ease of Navigation, p = .010", and "Learning Curve, p = .016" are less than significant at 95% level of confidence (α = 0.05). Therefore, the researchers can conclude that there is a significant difference between the obtained from the two software options for cost estimation in construction projects in terms of accuracy, ease of navigation, and learning curve. This implies that RCEst provides more accurate

cost estimates, is easier to navigate, and has a steeper learning curve than Planswift.

IV. CONCLUSION

Cost estimation software (CES) plays a crucial part in construction projects. It helps estimators, including quantity surveyors, project managers, site engineers, office engineers, and contractors, ensure faster calculations, effective cost monitoring, minimize human error, and enhance project profitability.However, amidst its significance, the adaptation of cost estimation software remains limited among local construction firms, especially smaller ones, due to its expensiveness since most available options are often foreign-made software. This lack of access to appropriate tools can lead to continuous problems, including increased costs, project hold-ups, lower productivity, loss of earnings, or even damage to business relationships that can influence project succession. The research emphasizes the necessity of the residential construction industry, especially in embracing new technology and adapting to the fast pace of the 21st century. The construction sector is crucial in global economic infrastructure developmentand productivity enhancement.

There is compelling proof supporting the need to keep up with technological advancements. The construction company should maximize its resources and adopt advanced estimating software that effectively meets the needs of the digitalindustry.

The research presented a comparative analysis of cost-estimating software used in construction projects that provides valuable insights for developing a customized residential cost estimator (RCEst). Stakeholders acknowledged the significant advantages of cost-estimating software over traditional methods due to its efficiency, accuracy, time-saving features, and ease of collaboration. Users generally perceive the user interface of the RCEst software positively, with high marks related to ease of navigation and visual consistency. Moreover, users express high satisfaction with the functionality of the software, mainly features that guide them through unfamiliar tasks. The study also agrees on the satisfactory performance of the software in relation to speed, responsiveness, and ease of collaboration. However, there is room for improvement in certain areas, such as uploading and processing project data, which received a lower satisfaction rating.

Furthermore, the research findings are helpful in residential construction firms as they address and overcome the problems identified in the study. The outcomes of this study reveal that the most effective solution is the development and adoption of customized cost-estimating software like the RCEst. Construction firm representatives may utilize these findings to guide their modernization efforts appropriately for their organizations. This will support the development of the new customized cost estimating software that addresses the user's specific needs and preferences. Researchers can further analyze the data to determine challenges and areas and propose solutions for the industry's initiatives.

In a nutshell, while commercially available software might perform similarly, the RCEst offers a cost estimation that is a user-friendly alternative with room for growth in data handling. The findings shows that the RCEst software generally satisfy the expectation and preferences of the user. However, it also reveals it’s still need for improvement for some areas in functionality and performance. In addition, including feedback of the user and knowing user preferences can enhance their contentment and usability. By incorporating that it will be helpful on better project outcomes and for the advancement of the construction industry.

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