Investigation on the Factors Influencing Time and Cost Overrun in Vertical Construction in Pampanga

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Abstract*—The construction industry in the Philippines has been experiencing significant challenges in recent years due to various events and happenings that have resulted in cost overruns and time overruns or delays. The aim of this study is to identify the factors behind the occurrence of time and cost overruns in construction projects in the province of Pampanga. Furthermore, to determine the level of significance of each factor causing time and cost overruns in a construction project. From this study, the contractors' perception on the risk factors would help in the improvement of the management system of any construction site which helps reduce loss and damages acquired from overruns. A total of 63 factors applicable to the study were identified from the literature review and were grouped into 8. Survey questionnaires were distributed to 116 different contractor companies within the province of Pampanga. 69 responses remained after removing those that are not inclined toward vertical construction and respondents that failed to respond. The perception of the risk factors was divided into two parameters: (1) the severity of the risk factor; (2) the frequency of the risk factor. These variables were subjected to statistical analysis. The Statistical Package for Social Sciences (SPSS) was used to calculate Cronbach's Alpha. The survey had an excellent level of internal consistency based on the Cronbach's Alpha. Spreadsheet was utilized to compute for the severity index, frequency index, and relative importance index. The results of the survey revealed that the most significant risks factors contributing to the overruns of vertical construction are inflation, high-cost fluctuation, delay in manufacturing of materials, material damage, client's lack of construction project experience, decision-making that is slowly approved, delays caused by sub-contractors or suppliers, delay in transportation of materials, lack and shortage of construction supplies, and construction change/variation orders. The common risk factors were then analyzed further by identifying possible causes and some of the ways to mitigate such risks. The possible solutions highlighted the importance of collaboration among stakeholders, proactive risk management, and flexible planning to ensure successful project delivery in the face of unexpected events.

***Indexed Terms*—Contractors, General Building, Inflation, Philippines, Relative Importance Index**

I. THE PROBLEM AND A REVIEW OF RELATED LITERATURE AND STUDIES

1.1 Introduction

Construction industry exerts significant impact on economic growth and progress of many countries [1] and it accounts for 6-9 percent of the Gross Domestic Product (GDP) [2]. It also offers job opportunities and contributes to employment rate [3]. However, it is fundamentally crucial to make construction projects completed successfully within the expected time and allotted budget. Delays and cost overruns are frequently and continuously faced in construction projects regardless of their size, nature, and complexity [4].

Cost overrun is a global phenomenon in the construction industry, it refers to an unforeseen change in the project budget that raises the overall project cost. Delays and cost overruns are usual problems in the construction industries of many developed and developing countries. Cost overrun is the difference

between a higher actual cost from a lower estimated cost, which is evaluated in local currency at constant prices relative to a consistent base [5]. It occurs recurrently in significant numbers of infrastructure projects. This is because a project's cost is likely one of the most important factors in determining a building construction's success [6].

Projects going beyond the estimated budget and completion date have a significant impact on the owner and the company, especially on a contractor's reputation. Assessments on construction projects in various emerging regions show that the final cost of a project typically exceeds the original cost by approximately 30% [7], and this could be a major issue for many building contractors. It also heralds the beginning of uncertainty in the building construction process for the owner, contractor, and all parties involved. 9 out of 10 projects had cost overruns [8].

The extent of the cost overruns differs depending on the size, location, and the type of the project. Furthermore, various research states that construction cost overruns vary from place to place and from time to time, in decades [9]. Additionally, geography matters for cost overruns [10].

Time is another crucial determinant of a project's success. Completing a project on time is an indicator of efficiency, but the construction industry is subject to many variables and unpredictable factors; hence, delays cannot be avoided. Delay can be defined as the act of performing work that is either slower than anticipated or performing a task that was originally intended to be accomplished earlier [11].

In the Philippines, the construction industry continues to expand and loom over the years. Therefore, it is significant to investigate the factors influencing time and cost overrun in construction projects to reduce expenses and time wasted.

Statistical methods were used to understand the perceptions of construction professionals in a project toward the factors influencing time delays and construction costs. A data set was provided, and researchers presented summary statistics of the data set, with or without analytical form, in an easily digestible format for the respondents.

The aim of this study is to provide an analysis of the time and cost overruns of construction projects. The findings of this study are hoped to help the company managers improve the performance of the construction industry in the future. The province of Pampanga is the area where researchers conducted their study.

1.2. Review of Related Literature

1.2. 1 Overview of Construction Industry

Constructing buildings of any kind is a very detail-oriented process. It basically comprises three phases: pre-construction, construction, and post-construction phase. Pre-construction is the stage where the client conveys the intention and purpose to the architect, who transforms it into a design or draft. The construction phase involves transforming the design from drawings into physical structures, with a contractor appointed based on approved architect's drawings. Finally, the post-construction phase marks the completion of the building, which is then handed over to the client [12]. The construction process is classified into six stages [13]: i) Project conception, design, and planning: This stage involves considering initial ideas, locating the project's site, and specifying relevant building codes. Involving an architect is crucial at this point to ensure feasibility. ii) Building permits: Obtaining the necessary building licenses before starting the project is essential. This process can be complex and time-consuming as multiple agencies must approve the project. iii) Pre-construction: In this phase, the project team is assembled to prepare the construction site. Cost estimation and contract signing between parties occur during this stage. iv) Procurement: The project team acquires the required tools, manpower, and materials based on the project's scope and available resources. General contractors may subcontract certain tasks. v) Construction: This is when the actual construction work begins. The principal contractor oversees resource management and shares project updates, while the design team ensures adherence to approved plans and handles quality control. vi) Post-construction: This phase is critical and often involves a formalized procedure called commissioning for larger projects. Systems are tested to ensure they meet the required standards.

In the Philippines, the construction process involves three primary groups: owners, contractors, and consultants. Owners can be either public or private

entities, with the public sector representing government agencies implementing public construction projects, while the private sector includes entities undertaking residential, commercial, and industrial construction [14].

Construction project delays are common and often accompanied by cost and time overruns. Various factors contribute to delays, such as project types, locations, sizes, and scopes [15]. Unforeseen circumstances can arise even when plans are well prepared, leading to delays in the early stages of construction projects. Therefore, careful preparation and detailed documentation before the project starts are crucial [16].

Previous studies investigated the primary reasons for delays in building projects [17]. It was found that changes in design, fluctuating material prices, delays in material delivery, slow issuance of permissions by local authorities, and incompetent subcontractors were the main causes of delays. Granting of building permits, modification orders, design revisions, incomplete documentation, inspections, and specification changes as major reasons for delays in construction projects [18].

Furthermore, cost inflation affected a majority of building projects, with most expense escalation occurring before construction starts [8]. Accurate cost estimation at an early stage is crucial to prevent cost overruns. Poor site supervision, slow decision-making, client-initiated variations, and other factors contribute to cost overruns during the construction phase [19].

Identifying the causes of time and cost overruns is essential in minimizing them. Early detection of project concerns allows for preventive measures, particularly during the earlier stages of the project.

1.2. 2 Philippine Construction Industry

In 2021, the size of the Philippine construction market was estimated to be $54.5 billion. The Build, Build, Build (BBB) initiative, an improvement in the state of the world economy, and a rise in demand for construction are all expected to help the market grow at an AAGR of more than 7% between 2023 and 2026. The Philippines construction market research report offers in-depth market analysis, data, and insights into the country's construction industry, as well as industry growth prospects by market, project type, and construction activity. Along with providing important insight into the effects of market trends and concerns, the research also analyzes the main dangers and possibilities facing the Philippines' construction sector. The research also analyzes the pipeline of large-scale projects with a development-focused approach.

Rail infrastructure, road infrastructure, and other infrastructure projects are among the project types in this industry. The government's initiatives to improve the nation's transportation system will aid the sector's growth in 2022. Energy and utilities construction include sewage infrastructure, water infrastructure, telecommunications, oil & gas infrastructure, and electricity & power.

The government's goal, as part of the National Renewable Energy Program, is to increase the share of renewable energy in the whole power mix to 35% by 2030 and 50% by 2040, which will boost the sector's growth (2020–40). The Philippine government has given high priority to infrastructure development nationwide since it sees the sector as a vital support for the country's economic growth. After 2020, double-digit growth is anticipated as the nation recovers from the pandemic. After seeing an annual decline of 30.3% in 2020, the Philippine construction industry had annual growth of 10.6% in real terms the previous year.

A strong foundation, an improvement in global economic conditions, and investments in infrastructure projects made as part of the government's flagship Build Build Build (BBB) initiative all contributed to the industry's rise in 2021. A total of PHP807.5 billion ($16.4 billion) of the PHP1 trillion ($20.7 billion) that the government has allotted for the BBB program in 2021 was spent in the first nine months of that year.

The construction sector is anticipated to rise by 21.8% annually this year before averaging 7.5% annually from 2023 to 2026; nevertheless, until then, its output is anticipated to be below pre-pandemic levels. The National Economic and Development Authority

revealed data showing that in 2018, the government's cost overruns more than tripled due to HIGH inflation and project revisions (NEDA). According to the Neda's Official Development Assistance (ODA) Portfolio Review 2018 report, total cost overrun, which refers to extra expenses above the project cost that the Investment Coordination Committee (ICC) has approved, increased to P24.79 billion in 2018 from P6.81 billion in 2017, a 264.02 percent increase.

1.2. 3 Cost Overrun

This study collects data from several construction projects to conduct an in-depth investigation into the major causes of construction project time and cost overruns, as well as to test the strength of association between the rankings of the respondent groups. Cost overruns are unforeseen costs that exceed an estimated amount due to an underestimation of the actual cost [20]. These are simply occurrences in which the final or actual cost of a project exceeds the original or initial estimate [21]. Quantitatively, it is also the percentage of actual or final costs that exceed the estimated or tender cost of a project. Cost overruns are regarded as one of the most serious issues impeding project progress in construction because they reduce the contractor's profit, resulting in massive losses and putting the project in jeopardy. Construction cost is one of the most important success criteria for a project throughout its lifecycle and is of great concern to those in the construction industry.

Cost overrun is considered as one of the most serious issues affecting the progress of construction projects, as it reduces profit, resulting in massive losses and putting the project at risk. Construction cost is one of the most important success criteria for a project throughout its lifecycle and is of great concern to those in the construction industry. Cost overruns are common in infrastructure, construction, and technology projects around the world. Cost overrun should be distinguished from cost escalation, which refers to the anticipated increase in the budgeted cost as a result of factors such as inflation. Construction industries are critical to the development of a country's economic growth. It has recently been observed that the construction industry has become one of the world's leading industries. The increasing complexity of construction projects places an increased burden on construction managers to complete projects on time, within budget, and with high quality [22].

When a project is completed at a cost that exceeds the budgeted cost, this is referred to as budget or cost overrun. It occurs when a project exceeds its planned timeline and is regarded as a common problem encountered by construction industries, both macro and micro. One of the critical success factors is completing projects within the timeframe specified in the contract. Therefore, a cost overrun is treated as the margin between the initial project cost expected and the real final costs. Cost overruns are consistent regardless of project type, procurement method, or contract value.

The managerial effectiveness and sophistication of the client and their representatives in terms of creating and maintaining positive project team dynamics have the greatest influence on project teams relationships between contractor and design teams. A lack of skilled project managers emerges as the root cause of project time and cost overruns. Cost overruns are caused by frequent changes in design and poor procurement planning, which can be mitigated by adequate project manager training and coaching. As a result, cost uncertainty analysis is an important component of cost estimation, assisting decision makers in understanding not only the potential funding exposure but also the nature of risks for a specific project or program. Usually, obtained uncertainty is due to uniqueness (no similar experience), variability (trade-off between performance measure like time, cost, and quality), and ambiguity (lack of clarity, data, structure and bias estimates).

Studies were done which investigated the impact of various factors on budget overruns in Malaysian construction projects [23]. In this case, a quantitative method is used to collect data from contractors, consultants, and clients via a structured questionnaire survey. The analysis revealed that all the model's constructs contribute significantly to budget overrun.

1.2. 4 Time Overrun or Delay

Time overruns are defined as the extra time required to complete a given project beyond its original planned duration, whether compensated for or not. Time overruns are the difference in time between the actual

and originally planned completion dates [20]. Time overrun is an act or event that extends the time required to complete or perform an act under the contract. It is a problem that occurs frequently in construction projects around the world.

Delays occur in most construction projects; they can be defined as time overruns either beyond the completion date specified in the contract or beyond the date that the parties agreed upon for project delivery [24]. It occurs when the contract work is not completed within the time frame specified. Time overruns are a common occurrence in almost all construction projects. Time delay is critical in developing countries where construction projects take longer than expected. In general, a time overrun (delay) occurs when actual work does not finish within the estimated time. Most construction projects were delayed. Delay is the process of slowing down but not completely stopping a construction project, whereas suppression is the stoppage of the project directed from the clients to the contractor.

Time overrun (delay) can be classified into two types which are inexcusable (non-excusable) and excusable. Inexcusable delays (non-excusable delays) in the event of an inexcusable delay, the contractor or its suppliers have the right to accelerate their work and pay compensation to the owner [25]. If the contract does not include a section on liquidated damages, the contractor will compensate based on actual damages. Liquated damages are based on the daily rate of estimated costs that the owner is likely to incur because of the contractor's delay in completing construction projects. Excusable delays have two kinds these are the non-compensable delays and compensable delays. Non-compensable delays are delays that are caused by a third party rather than the owner or contractor. Natural disasters, bad weather, and mass wrongdoing are examples (strikes, fires, acts of government in its sovereign capacity, etc.). As a result, the contractor receives a tie extension and does not pay any compensation to the owner or contractor for delay damages. Compensable delays are compensable are ones that the owner or the owner's agents are responsible for, rather than a third party. An illustration of the architect of the owner failing to complete the plans within the allotted time, which causes the schedule to be extended and forces the contractor to charge the owner more money. The contractor will be responsible for additional indirect costs for both the extended field office and the home office in this scenario.

Delay is regarded as one of the most common issues in the construction industry, and it frequently has a negative impact on project success in terms of time, cost, and quality. It is shown from previous studies that most project failures are caused by the influence of contactors, consultants, and owners on project performance. Delays are costly to all parties involved, and they frequently lead to disagreement, cost overruns, arbitration, litigation, total abandonment, and project infeasibility. Construction is a risky industry with numerous external and internal factors influencing the construction process.

Throughout the project life cycle, constant and effective planning, controlling, and monitoring are required to keep the project on track. The project manager must determine and incorporate the project scope, milestones, key activities, delivery time, stakeholders, and other important aspects into the project planning. Delays can be avoided if the causes are identified early on. Aside from having professional and competent consultants and contractors, the Project Manager must establish a control procedure to monitor the identified issues that are causing the delay. However, the success of a project is heavily dependent on the project team; thus, the goals and scope must be clearly defined early on, so that the project team has a clear understanding of its objective; only then can a good project team be built with the project's success in mind.

1.2. 5 Local Research

Few studies in the Philippines have been conducted to address the issue and factors that contribute to project time and cost overruns. In the province of Pampanga, there are 13 common factors that causes the said overruns given below [26]. It is to bear in mind that their study is focused on program design of solutions, and these factors were only obtained and selected through comprehensive literature review only and not from survey. The risk factors mentioned in the study are: shortage or lack of tools and equipment, unreliable supplier of construction materials in the local market, labor strikes, shortage of manpower and skilled

manpower, client's payment delays, necessary rework because of improper or subpar work or wrong supplies, alterations in the nature and complexity of the task, poor communication between laborers and contractors, inadequate monitoring, control, and supervision, discrepancies between project documents, disagreement between the client, consultant and contractor, inaccurately estimated quantities, and sudden increase of material cost.

Furthermore, a study has been done on the transportation cost overrun. The said research focused on road and bridge projects and was able to conclude that half of the projects suffered from cost overruns [27]. Another study was conducted in Cebu City. They were able to identify several factors that are significant contributors to project delays through related studies [28]. Hence, these factors were evaluated according to their impact on construction project delays by their selected respondents, who are construction professionals. Based on their findings, lack of financial liquidity, ineffective project planning and scheduling, poor management decision-making, and material and equipment shortages are identified as significant causes of project delays, among others. In addition, the various risk factors were ranked based on their contribution to the project's delay by solving their weighted mean and classified into categories: Quality (3.53), Management (3.49), Financials (3.47), External factors (3.45) and materials and equipment (3.37).

As a summary, most of the said studies were focused on single variables or sub-factors such as material price, labor, and machinery that are influencing cost overrun [29]. Correspondingly, the factors causing cost and time overruns may differ depending on the type of construction project. As an outcome, there is a need to focus the research on specific building projects in the context of Pampanga. Furthermore, most studies in literature investigated the causes of either cost or time overruns in the construction industry, but very few considered both. Given these gaps, it is critical that risk factors and risk management techniques in Pampanga be studied on a regular basis to prevent damage/losses and avoid cost and duration overruns in construction projects.

1.2. 6 Foreign Research

In the recent years, different countries have been a subject of construction cost and time delay research. In Saudi Arabia, a study considering both delay and cost overruns. 83 identified factors are used and then grouped into 9 (client-related, designer-related, consultant-related, contractor-related, labor-related, material-related, equipment-related, external risks, and force majeure) to be analyzed through spearman rank's correlation coefficient [30]. In Vietnam, there were 11 variables of delays and 7 variables of cost overruns and grouped into 6. The statistical method used was spearman rank's correlation as well [15]. Meanwhile, a different study has identified 69 risk factors with 6 groups using relative importance index (RII) [31]. With the same statistical tool, countries Palestine, UK, Egypt, and Uganda had research with differences in common risk factors and with grouping similarities. Although only focusing on cost overrun, there are other notable statistical tools used in other studies such as the weighted score method in United Arab Emirates, regression analysis in Nigeria, and bounds testing approach by Malaysia. Another study identified 173 risk factors from various studies and from multiple countries that are significant for cost overruns [32]. The researchers classified these factors into two categories: internal and external factors. They stated that each category had its own sub-classifications: project financer, project owner, project designer, and consultant are internal cause sub-classifications, whereas system, country-related, economic related, weather-related, and unclassified are external cause sub-classifications. The researchers identified and analyzed the number of risk factors in various countries' national studies. According to their findings, the factors found in numerous studies that have a significant contribution to cost overruns were frequent design changes, contractors' financing, payment delay for completed work, lack of contractor experience, poor cost estimation, poor tendering documentation, and poor material management. According to the researchers, building project management should take cost overruns seriously because they have a large impact on more than one country. The studies support the idea that there are several primary causes of cost overruns from one nation to another.

A study in India determined the factors that influence time and cost overruns in Indian construction projects [33]. The research method that was used was a questionnaire-based survey. The factors behind these overruns were determined through related studies and consultations with professionals in the construction industry. Upon finalizing the questionnaire, a field study was conducted through consultation with professionals in the field to ensure the relevance of the factors that were identified. Wherein, these factors were divided into 12 primary categories for time overruns and 8 categories for cost overruns.

The researchers conducted a survey among individuals in the Indian construction sector, including owners, consultants, and contractors, to uncover the elements that contribute to time and cost overruns. The questionnaires were collected and analyzed using the statistical software package SPSS v. 21. SPSS (Statistical Package for the Social Sciences) is a software package used for statistical analysis in social sciences. It provides tools for data analysis, data management, and data documentation, making it a powerful tool for researchers and data analysts (IBM Corp., 2020). A statistical method called the Relative Importance Index (RII) was utilized to determine the level of significance of each factor causing time and cost overruns in a construction project. In this study, a thorough examination of the consistency and stability of the data was carried out through a reliability analysis. The Cronbach Alpha method was utilized to determine the reliability of the data. Results indicated that when the Cronbach Alpha score was less than 0.3, the data was deemed unreliable and thus inadmissible for the study. Conversely, a score above 0.7 indicates a high level of reliability. The computation of Cronbach's alpha was conducted utilizing SPSS Version 21 software. The study found that the top five factors contributing to time and cost overruns, as ranked by overall respondents, were material market rate, contract modification, a high level of quality requirement, project location, and freshmen bearing the entire responsibility.

Another study utilized survey questionnaires as an integral part of acquiring the necessary data for the study, wherein the respondents also included contractors, owners, and consultants [34]. The factors were then ranked based on their occurrence, impact, and importance as indicated by the various stakeholder groups. The researchers used methods to determine the mean scores for occurrence, impact, and relevance. Furthermore, the researchers utilized Spearman's rank correlation to assess the level of agreement among various stakeholders. The study provides significant insight into the causes of cost overruns in the Indian construction industry to reduce the occurrence of cost overruns.

There were investigations that determines whether there is a correlation between cost and time overruns [35]. The researchers utilized statistical analysis to examine the factors influencing time delay and cost overrun in highway construction projects in connection to one another. Three-stage least-squares regression analysis was applied as a statistical tool. This method is used to represent the relationship between one or more independent variables (factors such as project size, project duration, weather conditions, and the results of the contract bidding process) and a dependent variable (in this case, cost overrun and time delay). The research showed a relationship between cost overruns and time delays and outlined various factors that can cause cost overruns and time delays. In simpler terms, the study found that when a construction project takes longer or costs further than anticipated, they are often related.

1.3 Background of the Study

Time overrun is defined as the extension of time beyond planned completion date specified in contract or beyond the date that parties agreed upon for delivery of project and the extension of time beyond planned completion dates traceable to the contractors [34].

The duration of construction projects from inception to completion is becoming a great concern, especially among clients and beneficiaries, because of the rising interest rates, inflation, and development plan targets, among other factors. Hence the need to understand the causes of delays and cost overrun in the construction sector has become more important than ever.

This study therefore aims to identify the major factors affecting time and cost overruns in construction projects, and how it will affect a certain project. This paper also reviews the findings of similar studies conducted in several countries.

Figure 1: Map of Pampanga (Source: http://bitly.ws/yGR2)

Pampanga is a province in the Philippines situated in the Central Luzon region occupying the central section of Luzon. Its capital is the City of San Fernando and is bounded by the provinces of Bataan and Zambales to the west, Tarlac, and Nueva Ecija to the north, and Bulacan to the southeast. Furthermore, Pampanga is located on Manila Bay's northern shore.

It covers a total land area of 2,001.22 square kilometers. It comprises 19 municipalities and three cities. Its population as determined by the 2020 Census was 2,437,709. This denoted 19.62% of the total population of the Central Luzon region, 3.92% of the overall population of the Luzon Island group, and 2.24% of the entire population of the Philippines. Based on these figures, the population density is computed at 1,218 inhabitants per square kilometer or 3,155 inhabitants per square mile.

The province of Pampanga, especially San Fernando City has miraculously transformed from a lahar-stricken region following the destructive eruption of Mt. Pinatubo in 1991 into one of the country's fastest-growing economies outside of Metro Manila, supporting progressive business and commercial districts, top-notch educational institutions, and several transportation stations. It is not unexpected that the province of Pampanga, along with Bulacan, Iloilo, and Bacolod, has been named one of the most promising emerging cities in the Philippines.

Pampanga's current and upcoming infrastructure developments are likely the province's greatest asset for investors. With the "Build, Build, Build" infrastructure system critically affecting the province of Pampanga, it is expected to transform into one of the country's main settings for various real estate developments. That is why it is important to analyze the causes of delays and cost overruns in a construction venture in the province, even more so now that property investors have been eyeing the province as a prime location for several developments. The study is focused within the region of Pampanga, and it will be a huge help in improving the construction industry in the province.

1.4 Objectives of the Study

1.4. 1 General Objective

The intent of this study is to analyze the individual and collective risk factors that adversely affect the duration and cost overrun in building construction within the province of Pampanga, Philippines.

1.4. 2 Specific Objective

1. To study and analyze identified risk factors to survey questionnaires obtained from comprehensive literature review.
2. To measure the strength of the internal consistency of the identified risk factor using Cronbach's alpha analysis in Statistical Package for the Social Sciences (SPSS).
3. To rank the risk factors using Frequency Index, Severity Index, and Relative Importance Index.

1.5 Statement of the Problem

Construction time and cost overruns have been a significant concern in the construction industry. In this regard, it is necessary to identify and address the factors behind these overruns. Specifically, the study sought to answer the following questions:

1. What are the identified risk factors that have been shown to be significant contributors to construction overruns?
2. What are the ratings of the respondents for the indicated risk factors?

3. How are the risk factors ranked using Frequency Index, Severity Index, and Relative Importance Index, and what are the implications of these rankings?

1.6 Significance of the Study

With the data gathered from this study, information on the risk factors mostly affecting the cost and time overruns would help in the improvement of the management in building construction within the locale of Pampanga.

This research will benefit the following sectors:

Clients. This study will guide the owners in considering the flexibility of the whole building construction with regards to their financial capability and the external factors that may suddenly affect the process. Room for errors could be considered to prevent further delays, and still arrive at the expected quality.

Consultants. In awarding the building construction to a contractor, the consultant cooperates with the client in assessing the project bids. This study will prevent the party from choosing poorly and not taking consideration the factors that may negatively affect the process. In the project design, the engineers and architects could prevent losses by choosing materials not subjected to price fluctuations.

Contractors. The contractors could create programs to monitor the risk factors that they can control and keep track of their progress accurately. In the project bidding process, more accurate reports could be made by considering the risk factors provided by the research. This study helps in the documentation, and the management of the building construction.

Researchers. This study contains a handful of knowledge that can be used by future researchers in developing a solution to cost and duration overruns in Pampanga. Likewise, the research could be done to other places and act as a guide. In the aspect of time, this is a starting point that could be reevaluated in the future years and be subjected to comparative studies.

1.7 Scope and Limitations

Size Range	License Category	Single Largest Project (₱)	Allowable Ranges of Contract Costs (₱)
Large B	AAAA and AAA	Above 225 Million	< or above 450 Million
Large A	AA	Above 150 Million up to 225 Million	Up to 450 Million
Medium B	A	Above 75 Million up to 150 Million	Up to 300 Million
Medium A	B	Above 15 Million up to 75 Million	Up to 150 Million
Small B	C & D	≤ 15 Million	Up to 30 Million
Small A	Trade/E	Up to 1 Million	Up to 1 Million
Note: Par. 3 of Sec. 23.11.2 of the IRR of RA 9184 allows Small A and Small B contractors without similar experience to bid only for contracts not more than fifty percent (50%) of the allowable range of contract cost of their respective size range(s).			

Table 1: PCAB Categorization – Classification

The study aims to identify the factors behind the occurrence of time and cost overruns in construction projects in the province of Pampanga. Furthermore, to determine the level of significance of each factor causing time and cost overruns in a construction project.

The limitations of the study include the following: The risk factors are identified through literature reviews. The risk factors irrelevant within the context of Pampanga were removed. The researchers administered a survey questionnaire to respondents which rated the identified risk factors on a 4-point Likert scale instead of a 5-point Likert scale. A 4-point Likert scale is a type of asymmetrical scale. Asymmetric Likert scales have fewer options on one side of neutrality (on average) than on the other. When there is no perception of the researcher's neutrality or indifference, an asymmetrical scale may also reflect coerced choices [36]. The respondents are the representatives of engineering firms specifically the contractors. A contractor may only work on general building projects not including industrial plants. They can be licensed on any of the categories provided in Table 1.

The researchers focused on only one kind of respondent, the contractors, instead of having two or three kinds of respondents such as owners, and consultants as to prioritize the engineers directly involved with the construction process. One study investigated the causes of construction delays in Jordan and found that contractors had the highest level of knowledge regarding causes of delays compared to clients and consultants [37]. Additionally, a recent study suggests that contractors are likely to be more knowledgeable in construction cost overrun and delay than consultants and clients [38].

1.8 Conceptual Framework

Figure 2: Conceptual Framework

The paradigm consists of three sections and is in the Input-Process-Output (IPO) format. Shown in the first section are the factors connected with the dependent and independent variables of educational research. The second section includes the processes involved such as the sampling technique, data collection through online and face-to-face survey approach, and the statistical treatment of data. Lastly, the output includes the conclusion and recommendations that provide benefit to various sectors in the construction industry.

II. METHODOLOGY

2.1 Phase 1 – Methodological Framework

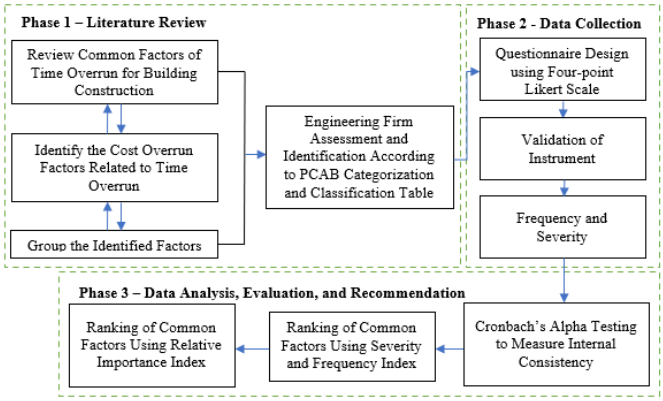

Figure 3: Research Methodology Process

The paradigm consists of three phases with eight stages in total. The researchers used this as a tool to achieve the main objective of the study in this way. The procedures are organized so that the data and results are unaffected. After the comprehensive literature review, the questionnaire was created, then validated by professionals such as statistician, psychometrician and a construction field expert. Data was then gathered using survey questionnaires. The data provided the severity and frequency of the cost and time overruns and were subjected to statistical treatment. Reliability analysis was conducted, then proceeded three indices frequency, severity, and relative importance index to arrive at a conclusion.

This methodological framework is intended to provide guidance to researchers conducting research. This can be used to determine what data to collect and how to analyze it. It can also be used to assess the strengths and weaknesses of research methodologies. This research theme focuses on the investigation of factors influencing time and cost overruns in building construction in Pampanga. The researchers aim to conduct a comprehensive literature review to identify individual risk factors that influence duration and cost overruns. Survey, measure of internal consistency using Cronbach's Alpha Analysis, ranking, and analysis of the common risk factors were identified using the raw data from the survey questionnaires.

In this study, researchers used best practices to collect all the data necessary to answer all topic-related questions. Clients, contractors, and consultants across Pampanga will benefit most from this study as it helps them improve their management of building construction. With the help of researchers, factors influencing time and cost overruns in building construction were discovered in previous studies and articles related literature. The methodological framework describes the use of designs, locale, and respondent sampling, and finally the instruments used in research, which are survey questionnaires.

This section consists of three major parts: Research Design, Research Locale and Respondent Sampling, and Research Instruments.

2.1.1 Research Design

For this study, the researchers adopted a cross-sectional survey-based approach to determine the common factors affecting time and cost overrun in the province of Pampanga. This is a deductive research based on theories of previous studies and used the collected data by the researchers to confirm whether the identified risk factors are common and if there is existing relationship in between their respective groups. Qualitative approach was used to interpret the data gathered from related literature and arrive with the common factors to be used in the formulation of

questions. Quantitative approach was employed to interpret numerical or statistical data gathered from the survey. Discrete data such as the frequency index, and severity index are analyzed. Ranking of the common factors are established after using a statistical tool. The said step was preceded by the testing of internal consistency using Cronbach's Alpha Analysis.

Surveys were either self-administered, or person-administered. Person-administered surveys are done through face-to-face or electronic interviews to aid the respondents in answering the questionnaire, and to get faster responses. Self-administered surveys were conducted through mail or other social media platforms; therefore, softcopies were distributed online.

2.1.2 Research Locale and Respondent Sampling

The study was conducted in the province of Pampanga as it has shown development in its infrastructures in recent years.

The respondents were determined through stratified random sampling. Researchers split a population into homogeneous subpopulations called strata (plural of stratum) depending on specific traits or characteristics in a stratified sample (e.g., race, gender identity, location, etc.). Each person in the population under study should belong to one specific stratum determined by the researchers. Contractors and subcontractors within the locale of Pampanga were the respondents of this study. Based on the Department of Labor and Employment's (DOLE) list of registered contractors and sub-contractors in Pampanga as of December 01, 2022, the total population amounts to 164 respondents (n = 164). A sample size of 116 was calculated using Raosoft sample size calculator providing a confidence level of 95% with a margin of error of 5%. The required contractors can be licensed in any of the license categories shown in Table 1 but should work on general building projects only, not including industrial plants.

2.1.3 Research Instrument

In gathering the data relevant to the study, the researcher has adopted field survey methodology to uncover factor influencing delay and cost overruns arising during construction stage.

The questionnaire is the most important instrument used in the study. It is the major tool used by the researcher in gathering data from the respondents. The instrument was designed in a simple and clear manner. The survey questionnaire consists of 63 common factors in delays and cost overruns that are grouped to eight. The eight group factors are client-related risks, contractor-related risks, consultant-related risks, labour-related risks, materials-related risks, equipment-related risks, external risks, and force majeure risks.

The client-related risks consist of: client's lack of construction project experience; excessive administration and layers of management of the owner; client's financial capability; owner's delay in making progress payments for finished works; tight schedule for project completion set by clients; political pressure to complete the project and speed up construction operations; delay in project development and pre-construction documents (permits, drawings, and others); construction change/variation orders; delay in documents approval for project execution; owner has put the project on hold; terms and payment conditions by client.

The contractor-related risks consist of: inexperience, and lack of managerial skills of the project manager or project information coordinator; financial constraint of the contractor (ineffective cash flow handling); weak and ineffective site management and supervision; poor project planning and scheduling; ineffective supervision and improper monitoring of project progress; delays caused by sub-contractors or suppliers; delay in submission of approval documents prior to execution (e.g., shop drawings, material samples, and RFA/RFI); delay in site mobilization; rework due to poor workmanship execution/quality; changes in quantities of scope of work based on actual site condition; contractors abstain to make site visits during the bidding process; new existing underground utilities not specified on the design documents (e.g., live cables and sewer lines); health and safety requirements (in light of COVID-19); accidents/injury on site.

The consultant-related risks consist of: incompetence and lack of expertise among the consultant's personnel; decision-making that is slowly approved

(shop drawings, submittals, sample materials, change orders, etc.); submissions rejected by the consultant (shop drawings, equipment, and material samples); delay in inspection, testing, and guidance from the consultant; coordination and communication issues between the consultant and other stakeholders; inadequate quality assurance and control; corruption on the part of a consultant; consultant's rigidity (inflexibility); being overly concerned with safety; internal business issues (at the headquarters of the consulting firm).

The labor-related risks consist of: shortage of manpower; unqualified/inexperienced workers; low levels of labor force or worker productivity; low wage for laborers; accidents/injuries to workers on site; late salary payments to staff; high rate of personnel replacement; labor strikes.

The materials-related risks consist of: delay in manufacturing of materials; delay in transportation of materials; lack and shortage of construction supplies, particularly special building materials; delay in material procurement; material damage; rejecting items planned for use or installation.

The equipment-related risks consist of: inadequate or ineffective machinery, tools, and plants; equipment breakdown.

The external risks consist of: economic instability; high-cost fluctuation (e.g., money exchange rate, taxes and burdens, and interest rates charged by bankers on loans); inflation (e.g., material, equipment, and labor prices); changes in government regulations and laws (e.g., economy, tax, safety, environment, industrial, recruitment and workers' visas, and localization); delay in connecting services to outside sources such as electricity, water, sewage, etc.; delay in recruitment; corruption (deceptive business tactics, kickbacks, and violating the law); import/export restrictions.

Lastly, the force majeure risks consist of pandemic, epidemic, or disease spreading (e.g., COVID-19); severe weather conditions; political instability; earthquakes, fires, and floods.

2.2 Phase 2 – Data Collection

The research was conducted in the province of Pampanga through face to face with compliance to the COVID-19 health protocols of the local government and via online. Face-to-face approach of gathering information from respondents are significantly more effective than other methods because respondents are more likely to trust the surveyors and give open and frank feedback about the subject at hand. However, online survey questionnaire was also administered.

The data were collected from the contractors and subcontractors within the locale of Pampanga. The questionnaire was created through four-point Likert Scale and was validated by professionals and experts in the field. As the 4-point Likert Scale is easy to comprehend, both survey administrators and respondents had less trouble with its usage and compared to higher-point scales, it requires less time to complete, and respondents have choices without becoming overwhelmed. After the collection of data, Cronbach's alpha testing was used to measure the strength of internal consistency. Furthermore, Relative Importance Index (RII) was used to determine the relative importance of the various causes of time and cost overruns using four-point Likert Scale.

2.3 Phase 3 – Data Analysis and Evaluation

In this study, the researchers used both descriptive statistics and different statistical tools. Descriptive statistics involves tabulating, depicting, and describing the collected data. The data are summarized to reveal overall data patterns and make them manageable [39]. This is done based on the research questions. On the other hand, statistical treatment was done to the data that has been analyzed in the survey questionnaire.

The statistical tools including the three indices used are written as follows:

Cronbach's Alpha Testing. In this study, the reliability and degree of the internal consistency of the risk factors discovered were assessed using Cronbach's alpha (Cα). The Cα range is between 0 and 1, and the acceptable reliability number is typically 0.7 or higher [40]. The Cα formula for Likert scale is shown in the equation below.

$$C\alpha = \frac{K}{K-1}\left[1 - \frac{\sum_{i=0}^{k} \sigma_b^2}{\sigma_t^2}\right]$$

where:
Cα = Cronbach's alpha;
K = is many items;
σ_b^2 = variance of test score;
σ_t^2 = variance of item scores after weighing.

Frequency Index. This index expresses the occurrence frequency of the common factor responsible for delay and cost overruns. The frequency index is a crucial measure in assessing risk factors related to cost overruns and delays. It helps identify the likelihood of occurrence for each risk, allowing project stakeholders to prioritize and allocate resources, accordingly, mitigating the potential impact on project timelines and budgets. It is computed as per following formula:

$$F.I. = \sum_{1}^{4} \frac{a_1 n_1}{4N}$$

where:
a = constant expressing the weight assigned to each response from 1, 2, 3, and 4 for very low, low, high, and very high, respectively;
n = frequency of each response;
N = total number of responses.

Severity index. This index expresses the severity of common factors that caused delays and cost overruns. The severity index plays a vital role in evaluating the potential consequences of risk factors on cost overruns and delays. By assigning a severity rating to each risk, project teams can focus on addressing high-severity risks that pose significant threats to project success, enabling proactive risk management strategies and contingency planning. It is computed as per following formula:

$$S.I. = \sum_{1}^{4} \frac{a_1 n_1}{4N}$$

where:
a = constant expressing the weight assigned to each response from 1, 2, 3, and 4 for very low, low, high, and very high, respectively;
n = frequency of each response;
N = total number of responses.

Relative Importance Index. This index expresses the overview of factors based on both their frequency and severity. It is an essential tool for prioritizing risk factors based on their overall significance in contributing to cost overruns and delays. By assigning a relative importance rating to each risk, project stakeholders can allocate appropriate attention, resources, and risk management efforts to the most critical factors, improving project outcomes and minimizing potential financial and schedule impacts. This index is used for the ranking of the risk factors. It is computed as per following formula:

$$R.I.I. = F.I. \times S.I.$$

III. RESULTS AND DISCUSSIONS

3.1 Cronbach Alpha Analysis

Risk Factor Group	No. of Risk Factors	Severity		Frequency	
		Cα	Result	Cα	Result
Client-related Risks	11	0.861	Good	0.922	Excellent
Consultant-related Risks	14	0.961	Excellent	0.965	Excellent
Contractor-related Risks	10	0.908	Excellent	0.912	Excellent
Labour-related Risks	8	0.917	Excellent	0.888	Good
Materials-related Risks	6	0.891	Good	0.904	Excellent
Equipment-related Risks	2	0.757	Acceptable	0.792	Acceptable
External-related Risks	8	0.836	Good	0.844	Good
Force Majeure Risks	4	0.744	Acceptable	0.827	Good
Overall		**0.987**	**Excellent**		

Table 2: Cronbach Alpha Values

Reliability was measured using Cronbach Alpha for the eight groups and the overall factors, as shown in Table 2. The results of Cronbach's alpha were all more than 0.7, thus indicating an acceptable level of reliability achieved. The survey questionnaire has an overall rating of 0.987 indicating an excellent internal consistency among the items.

3.2 Severity Index and Frequency Index

No.	Risk Factors	S.I.	Rank	Group
54	Inflation (e.g., material, equipment, and labour prices)	0.845	1	External
1	Client's lack of construction project experience.	0.817	2	Client
44	Delay in manufacturing of materials.	0.798	3	Materials
48	Material damage.	0.786	4	Materials
53	High-cost fluctuation (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan).	0.778	5	External
8	Construction change/variation orders.	0.774	6	Client
27	Decision-making that is slowly approved (shop drawings, submittals, sample materials, change orders etc.)	0.754	7	Consultant
45	Delay in transportation of materials.	0.754	7	Materials
17	Delays caused by sub-contractors or suppliers.	0.750	9	Contractor
5	Tight schedule for project completion set by clients.	0.742	10	Client

Table 3: Top 10 Ranked Severity Index

No.	Risk Factors	F.I.	Rank	Group
54	Inflation (e.g., material, equipment, and labour prices)	0.877	1	External
46	Lack and shortage of construction supplies, particularly special building materials.	0.758	2	Materials
53	High-cost fluctuation (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan)	0.758	2	External
44	Delay in manufacturing of materials.	0.734	4	Materials
48	Material damage.	0.734	4	Materials
56	Delay connecting services to outside sources such as electricity, water, sewage etc.	0.726	6	External
1	Client's lack of construction project experience.	0.702	7	Client
9	Delay in documents approval for project execution.	0.698	8	Client
47	Delay in material procurement.	0.698	8	Materials
17	Delays caused by sub-contractors or suppliers.	0.694	10	Contractor
27	Decision-making that is slowly approved (shop drawings, submittals, sample materials, change orders, etc.)	0.694	10	Consultant

Table 4: Top 10 Ranked Frequency Index

The frequency indices and severity indices are presented in Tables 3 and 4, along with their rankings. Sixty-nine respondents from different construction companies in the province of Pampanga ranked these causes. These two tables show that the overall rankings of frequency and severity index vary slightly. Inflation of materials, equipment, and labor prices was ranked first as the main factor that influences overruns in construction. Inflation is one of the factors that influence a country's economy. The role of inflation in economic growth cannot be omitted, yet it is often neglected in most construction projects' economics and budgeting, which results in project cost overruns because the costs of building materials, labor, and machines are changing annually. The data from tables 3 and 4 shows that these factors occur frequently in the construction sector, not only in the province of Pampanga but also globally.

Clients' lack of construction project experience was classified as the 2nd in S.I. and the 7th in F.I., along with a lack and shortage of construction supplies, particularly special building materials. As it caused unrealistic expectations, inadequate planning, and inefficient project management, which resulted in cost overruns and time delays.

Delay in the manufacturing of materials and material damage are included in the top five, which are both in the material cluster and are one of the most significant issues that delay construction projects globally. For instance, it occurs when materials are not available when needed. On the other hand, material damage can also influence additional costs and delays, as it certainly requires the damaged materials to be replaced or repaired.

High-cost fluctuation (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loans) was ranked 5th in S.I. and 2nd in R.I. in the sense that these factors can influence the cost of construction projects through increasing the material cost, financing, and labor. Specifically, fluctuations in exchange rates allow the cost of materials to increase, while changes in taxes and interest rates can affect the cost of the project's financing.

Decision-making that is slowly approved (shop drawings, submittals, sample materials, change orders, etc.) was ranked 7th in severity index and 10th in frequency index, as the work cannot continue or proceed without these approvals.

Delaying connecting services to outside sources such as electricity, water, sewage, etc. was ranked 6th in the frequency index as it can cause delays in the construction as the project cannot proceed and progress without these essential services. These services contribute a great deal to the costs, such as idle labor and equipment, and they also influence delays in the schedule of the construction project.

Delays in document approval for project execution were ranked 8th in the frequency index. Delayed approval of construction documents leads to additional costs and delays. In the same manner, when delays occur, they also increase overhead costs.

Delay in material procurement was ranked 8th in the frequency index. It refers to the time it takes to order and receive the specific materials for a construction project. These delays occur because of several factors, such as quality issues, supply chain interference, logistical challenges, etc.

Delays caused by subcontractors or suppliers were ranked 9th in severity index while being placed 10th in frequency index. This factor can greatly increase the cost and duration of a building project. Whenever a subcontractor or supplier creates a delay, it may result in a chain reaction, delaying future jobs and generating delays in the entire project timeline. Delays such as

these might result in additional expenditures such as wages for overtime, contractual fines, or lower efficiency. As an outcome, it is necessary to establish a contingency plan in place to deal with such delays and to hold subcontractors and suppliers liable for their performance.

3.3 Relative Importance Index

No.	Risk Factors	R.I.I.	Rank	Group
54	Inflation (e.g., material, equipment, and labour prices)	0.741	1	External
53	High-cost fluctuation (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan)	0.59	2	External
44	Delay in manufacturing of materials.	0.586	3	Materials
48	Material damage.	0.577	4	Materials
1	Client's lack of construction project experience.	0.574	5	Client
27	Decision-making that is slowly approved (shop drawings, submittals, sample materials, change orders, etc.)	0.524	6	Consultant
17	Delays caused by sub-contractors or suppliers.	0.521	7	Contractor
45	Delay in transportation of materials.	0.521	8	Materials
46	Lack and shortage of construction supplies, particularly special building materials.	0.511	9	Materials
8	Construction change/variation orders.	0.510	10	Client

Table 5: Top 10 Ranked Relative Importance Index

As a result of Relative Importance Index classification (high, moderate, and low), revealed five groups as the most important groups with score more than 0.45, which include external-related risks, material-related risks, client-related risks, consultant-related and contractor-related risks considering the remaining categories, labour-related, equipment-related and force-majeure, all of which were found to have a greater impact on both cost and time overruns. (1) Inflation (e.g., material, equipment, and labour prices) (RII = 0.741), (2) High-cost fluctuation (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan) (RII = 0.590), (3) delay in manufacturing of materials (RII = 0.586), (4) material damage (RII = 0.577), (5) client's lack of construction project experience (RII = 0.574), (6) decision-making that is slowly approved (shop drawings, submittals, sample materials, change orders, etc.) (RII = 0.524), and (7) delays caused by sub-contractors or suppliers. (RII = 0.521), (8) delay in transportation of materials (RII = 0.521), (9) lack and shortage of construction supplies, particularly special building materials (RII = 0.511), (10) construction change/variation orders (RII = 0.510).

External-related risks were ranked being one of the most significant risks factors identified in the study. However, this finding contrasts with some other studies where contractor-related risks were given the highest importance, while in client- related risks were identified as being in this place. Contractor-related risks have been elicited as being the fifth most important risk in this study, which contrasts with its rankings in other studies because of inflation that typically increases coming out of downturns as demand outpaces supply early in the recovery, but this tendency has been worsen by COVID-19 impacts. Demand for many goods dropped in 2020 and remained lower into 2021 as further waves of COVID cases led to government restrictions on consumer behavior.

Furthermore, from the perspective of the respondents (contractor) they didn't just indicate the risks related to them but to what they experienced the most compared to the other groups. For instance, RII for the external-related risks was less than 0.6, as rated by the participants who were in this category, whereas some of these risks were rated more than 0.6 by the contractors. However, no major differences among the groups were identified in rating the risks pertaining to material-related, consultant-related, contractor-related, and client-risk factors.

3.4 Analysis and Interpretation of the Overall Ranking Inflation.

In Pampanga, inflation ranks first as a risk factor influencing time and cost overruns in vertical construction. It is a significant challenge for the construction industry because it raises the prices of building materials, machinery hiring rates, consultation fees, and other construction project inputs. As a result, project completion may be delayed, construction costs may rise, and profit margins may fall. Construction projects face more than just inflation. Unlike others, it has an impact on the construction industry, clients, and employees. According to Business World (2022), building materials in the National Capital Region (NCR) continued to rise in price, reaching their highest level in more than 13 years. Higher import costs drove this growth after the country reopened its economy. As a result, the prices of new houses and lots for sale may be affected. According to the Philippine Statistics Authority (PSA), the NCR construction materials retail price index increased by 6.2 percent

year on year in May. Only a year ago, the growth rate was 1.2 percent. That's how dramatic the increase was. Other price increases in construction materials reported by the PSA relative to the previous month's annual increase (June vs May 2022):

- Carpentry materials prices increased by 2.5 percent, including timber, plywood, molding, sealers, nails, screws, chalks, and other wood materials.
- Wires and cables, electrical conduits, connectors, circuit breakers, enclosures, and other electrical materials saw a 4.5 percent increase in just one month.
- Masonry materials increased by 4.3 percent, including bricks, marble, granite, concrete blocks, glass blocks, cast stone, limestone, and other construction rocks.
- Painting materials and other related compounds increased by 4.6 percent, including cement paint, aluminum paint, and other anti-corrosive paint.
- Miscellaneous construction materials saw the greatest increase, rising 10.6 percent in a month. This included glass (which is more than one compound), bitumen, plastics, varnishes, asbestos, distemper, and other materials used in interior fixtures.

To mitigate the effects of construction inflation and long lead times, consider the following tool-based strategies: seek out partners who understand local and global market impacts, eliminate procurement roadblocks, integrate trades early and pay them quickly, communicate with the construction manager, embrace target value delivery, implement commodity tracking logs, and consider leveraging warehouse storage.

- *High-cost fluctuation.*

As presented in table 4 high-cost fluctuation ranked second. Undoubtedly, the COVID-19 pandemic caused disruptions in nearly every aspect of people's lives, including businesses, jobs, and even the money exchange rate. Due to decreased output and consumer demand, the COVID-19 pandemic caused a substantial impact on the entire global GDP. As reported by the Department of Economic Research Exchange Rate 2020 the average value of the peso dropped from February 2020 average by 0.31 percent to $50.90/US in March. The coronavirus epidemic has since moved outside of China, raising fears about its worldwide effects. Additionally, there have been rumors that the US Federal Reserve may decrease interest rates to lessen the impact of the outbreak on the US economy. These concerns are reflected in the peso's depreciation. The National Capital Region (NCR) being placed under a community quarantine, followed by the entire island of Luzon being placed under an expanded community quarantine due to fears that COVID-19 may be spreading throughout the nation has also put pressure on the peso. AL Camba and AC Camba Jr. also stated that the Philippine stock exchange index, the exchange rate of the Philippine peso to the US dollar, and the retail pump price of diesel have all experienced short-term effects from a positive shock due to COVID-19 daily infections, but the effects decrease gradually. In June 28,2022 Philippine Inquirer reported that the peso crossed the 55:$1 threshold versus the dollar at its intraday low of 55.15, fueling worries that the local currency is depreciating too quickly despite government claims that it is stable. According to Michael Ricafort, chief economist at Rizal Commercial Banking Corp., the peso hasn't traded at an intraday low that surpassed 55:$1 since October 25, 2005, or more than 16 and a half years ago. Trading ended that day at a ratio of 55.26:$1. "Currencies in Asia have been pummeled in recent months, due in large part to the strong and persistent downward pressure that the post-Ukraine invasion spike in commodity prices has had on trade balances," said Miguel Chanco, Pantheon Macroeconomics' chief economist on Emerging Asia.

- *Delay in manufacturing of materials.*

Delay in material supply was ranked 3rd in the Relative Importance Index. As it was considered one of the main drivers or factors of cost overruns and delays in the construction industry. A recent study was able to identify the underlying reason for its occurrence and effect. In a study conducted by Rahman et al. (2017), they were able to determine the causes behind it, such as labor productivity, inclement weather conditions, government restrictions, slow decision-making, shortage of raw materials, logistics, poor planning and scheduling, unrealistic construction duration, and variations and changes in construction. However, the most infuriating among them was

inefficient material procurement and inventory management.

- *Material damage.*

Material damage ranks fourth among the top ten risk factors. This is due to faulty materials or workmanship. This can cause construction delays because the time they need to work will be diverted to the time they need to order or purchase again. Incorrect use of equipment or building materials for purposes other than those intended. Other workers are unfamiliar with the proper handling and application of materials. This can lead to a variety of challenges, including material waste, poor work quality, project delays, and poor material flow. Natural disasters can also cause material damage and cause delays, especially if the majority of the materials were damaged. It is the contractor's responsibility to cover all damages because it is his obligation to perform the works using materials, goods, equipment, and construction methods of the quality and standards required by the contract, as well as to provide and pay for all labor, materials, equipment, tools, construction equipment, and all machinery, transportation, and other facilities and services required for the proper execution and completion of the works. To reduce material damage during construction, it is best to hire a professional laborer, find high-quality materials, and find a trusted supplier who offers a better quality and price.

- *Client's lack of construction project experience*.

The client's lack of construction project experience was rated 5th in the Relative Importance Index table. This is due to the fact that inexperienced clients tend to have unrealistic expectations of project timelines and budgets. Furthermore, a lack of knowledge and experience in managing the project may lead to inefficient decision-making and poor communication and coordination within the team. Additionally, they are also vulnerable to struggling to mitigate risks in construction.

- *Decision-making that is slowly approved.*

Delays in decision-making for approval ranked 6th overall in the most common risk factors. This is because the approval process is critical to ensuring that the materials and designs being used in the project meet the required standards and specifications.

In the Philippines, specifically in Pampanga, the construction industry has been impacted by the COVID-19 pandemic, which has led to delays in the approval process due to restrictions on movement and the need for remote collaboration. According to a report by the Philippine Contractors Accreditation Board (PCAB), delays in the processing of construction permits have been a major challenge for the industry, leading to increased costs and delays in project completion (PCAB, 2020).

Additionally, a study suggested that the delays in the approval process for construction materials can result in increased costs due to the need to reorder materials or make changes to designs [41]. The study also highlighted the importance of effective communication and collaboration between stakeholders to ensure timely approval of materials and designs.

- *Delays caused by sub-contractors or suppliers.*

Unqualified and unskilled personnel, delivery of low-efficiency equipment, late delivery of materials and equipment, and low-quality material supply are all examples of delays brought on by suppliers and subcontractors in construction projects which are ranked seven in table 4 [42]. The COVID-19 epidemic also had varied degrees of effects on the members of the construction sector, including owners, developers, contractors, subcontractors, and supply chain vendors. The location of the individual enterprises and underlying initiatives have a significant impact on the type of effects and scope of ramifications. Direct effects have included everything from a slowdown in the supply of products and labor to the suspension and, in rare cases, the cancellation of parties or entire projects. Philippine News Agency also reported that cement shortage is seen to delay new construction projects. Pronove Tai International Consultants said that an increase in the supply of cement is important in order to create more office spaces that can be utilized by business enterprises. The firm estimated that the shortage of cement has caused a 30 percent delay in the first quarter of 2019 building completions in Metro Manila.

- *Delay in transportation of materials.*

Overall, it is ranked 8th. Material is one of the important resources in construction project. The delay will occur caused by shortage of materials, late delivery of materials, damages of materials on site, and other. It all started when nations enacted lockdown measures in an effort to stop the spread of COVID-19, which caused a temporary halt in production and the closure of numerous factories. As a result, many containers were stopped at ports, causing a disruption in the flow of traffic. In order to stabilize prices and the erosion of ocean rates, carriers decreased the number of ships at sea, which slowed import and export. Additionally, empty containers weren't picked up as a result. Due to the inability of Asian traders to reclaim empty containers from North America, this was particularly crucial for China, which controls the majority of the world's containers. At present, ports throughout the globe are backed up or jammed with idle vessels waiting to berth. To ensure a smooth flow of materials until the associated construction works are finished at the project site, it is important to identify the material required, estimate quantities, define specifications, forecast requirements, locate sources for procurement, obtain approval for material samples, and design a materials inventory. This is done through effective planning of delivery of materials and equipment. The requirement to lessen cost overruns by the contractor and owner has been underlined in this study along with related factors. The factors contributing to suppliers' default were identified as monopoly control of the market by some suppliers, work stop pages in factories manufacturing materials, fluctuating demands forcing suppliers to wait for accumulation of orders and difficulties in importing required raw materials from other countries.

- *Lack and shortage of construction supplies, particularly special building materials.*

According to all respondents, as shown in Table 4, material shortage is ranked ninth. Construction projects are thought of as having their foundation in materials, that's why any issue with the construction materials would have a big impact on the project. The origin or accessibility of construction materials is the primary factor in material shortages. On the other hand, a weak materials procurement and inventory management system, which has additional underlying causes including a slow identification of the type of materials required, was discovered to be the most significant contributor to material delivery delays. The approximate total quantity of all necessary materials, such as aggregates, cement, reinforcing steel, sand, etc., that must be produced should be listed on a schedule of material requirements in order to manage material shortages. It could be said that the source of construction materials shortages can be traced back to February 2020, when the first factories in China and Italy were closed due to the onset of the COVID-19 pandemic, causing them to stop the production of items such as kitchen appliances, floor tiles, and elevator parts. As the pandemic spread, factories around the world were forced to shut down operations, suffering financial losses and creating a massive backlog of orders for specific materials and components, such as computer chips. When construction materials are in short supply and the demand for them is growing, their prices go up. Based on the U.S. Bureau of Labor Statistics (BLS) data, the Associated General Contractors of America (AGC) calculated that the prices of construction inputs grew nearly 20% in 2021 compared to 2020.

- *Construction change/variation orders.*

Construction changes or variation orders is ranked 10th overall in the most common risk factors encountered in Pampanga, Philippines. This can have a significant impact on cost overruns and delays, as they can lead to additional work, materials, and time. Change orders can occur due to a variety of factors, such as design changes, unforeseen site conditions, and project suspension or cancellation due to the pandemic.

Previous researchers investigated the impact of COVID-19 on the construction industry in the Philippines [43]. The study found that construction projects were significantly impacted by the pandemic, with a significant increase in the number of change orders due to project suspension or cancellation, supply chain disruptions, and changes in client requirements. These change orders led to significant cost overruns and delays, which negatively impacted project performance.

Another study analyzed the impact of COVID-19 on construction projects in the Philippines [44]. The study found that COVID-19 had a significant impact on

project delivery, with a majority of construction projects experiencing delays and cost overruns due to various factors, including supply chain disruptions, labor shortages, and changes in client requirements. The study also identified that effective management, communication, and collaboration between project stakeholders can help mitigate the negative effects of change orders on project performance.

IV. SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 Summary

This research is considered one of the first to study the risks factors that causes cost overruns and time overrun in vertical construction projects in the province of Pampanga, moreover, the results of the study help to enhance the chances of success of projects by ranking the causes of risk and its impact, which helps companies and people involved in this matter to take precautions and develop strategies to reduce the impact of risk, which supports national economic growth. Feedback from the survey was analyzed via spreadsheet and SPSS.

The study shows the reliability and validity of the research instrument, and the results were assessed using the Cronbach's alpha test. Results of the tests supported the research instrument and the findings. Reliability of the data is considered as at low level when Cronbach alpha is less than 0.3 which means the data is not suitable for further analysis whereas reliability of the data is considered as high level when Cronbach alpha is greater than 0.7 The alpha values presented in study are in the range of 0.744 to 0.965 for each category of the questionnaire and an overall value of 0.987 for the questionnaire. Thus, the reliability of the questionnaire is assured. This certainly indicates the accuracy and credibility of the survey data.

The findings showed that various factors significantly affect construction projects in Pampanga. These factors were evaluated based on their severity, frequency, and importance. The severity and frequency of these factors were computed by multiplying the weight of the response by their frequency and dividing them by the number of responses, wherein the number of responses is multiplied by 4. According to the data acquired based on the severity index, the ten most significant factors that drive cost and time overruns were identified: inflation, clients' lack of construction project experience, delay in manufacturing of materials, material damage, high-cost fluctuation, construction change or variation orders, decision-making that is slowly approved, delay in transportation of materials, delays caused by sub-contractors or suppliers, and a tight schedule for project completion set by clients.

The frequency index revealed that the ten most influential factors that frequently occur in a construction project are as follows: inflation, high-cost fluctuation, delay in manufacturing materials, material damage, delay connecting services to outside sources, client’s lack of interest in the project, delay in document approval for project execution, delay in material procurement, delay caused by sub-contractors or suppliers, and decision-making that is slowly approved.

To evaluate the factors according to their level of significance, a hierarchical assessment of the factors was conducted. Relative Importance Index (RII) value was used to evaluate it and was computed for all respondents. Eight main groups have been identified out of the 63 various delay factors that were gathered for the purpose of this study. From the total, the top 10 most significant factors out of all have been determined which are: I. Inflation (e.g., material, equipment, and labour prices) II. High-cost fluctuation (e.g., money exchange rate; taxes and burdens; and interest rates charged by bankers on loan) III. Delay in manufacturing of materials. IV. Material damage. V. Client's lack of construction project experience. VI. Decision-making that is slowly approved (shop drawings, submittals, sample materials, change orders, etc.) VII. Delays caused by sub-contractors or suppliers. VIII. Delays caused by sub-contractors or suppliers. IV. Lack and shortage of construction supplies, particularly special building materials. X. Construction change/variation orders. Lastly, the possible root causes of the common risk factors were determined with the possible solutions and suggestions to mitigate the risks involved in the construction.

4.2 Conclusion

Delays are the most common and expensive issue on construction projects. Construction delay analysis has become an important part of the project's life cycle. This study identified and ranked problems related to delays and cost overruns during the construction phase by administering and analyzing a questionnaire survey. The current study identified and analyzed the causes of cost and time overruns in the construction industry in Pampanga. The statistical analyses revealed that the identified risk factors from the contractors had an acceptable level of reliability. External-related risks, material-related risks, client-related risks, consultant-related risks, and contractor-related risks were identified as the most significant by the survey results. Each group was discovered to have a significant impact on cost and time overruns.

The findings of this study are novel because of the situations created by external factors such as inflation, which has greatly affected resource management and continuity in construction, and they may help industry experts and government agencies in future plans to mitigate the risks identified in this study. Furthermore, with market uncertainty continuing, future studies could focus on investigating force majeure risks and the impact these have on the relationships between stakeholders and supply chain systems in the Pampanga construction industry, which must be effectively managed.

The findings might help professionals in gaining a better understanding of the issues affecting the budget and timeline of large projects during the construction stage. Construction participants can reduce and control the extent of delays and cost overruns by taking care of these potential factors in their current and future projects. This will aid in strengthening strategic planning and the implementation of new policies in response to unforeseen events. Researchers could use the data to identify additional aspects of the problem and recommend appropriate solutions to improve community constructions. Other potential solutions to these factors can be included, and these solutions can be found in related literature or studies, as well as recommended explanations. The experience of the construction staff or the common familiarity of other construction engineers also has an impact on the construction project problems.

4.3 Recommendations

The following recommendations are for future researchers:

1. Include factor analysis to filter the underlying risk factors and create a more reliable survey instrument that is more efficient and effective in measuring the frequency and severity of the identified risk factors.
2. It is highly recommended that the respondents primarily consist of quantity surveyors, estimators, project engineers, and project managers, as they possess extensive knowledge and expertise in the field of construction.
3. To enhance the measurement of cost overruns and delays, future researchers should analyze relevant records and existing documents from construction firms, utilizing methodologies such as time impact analysis, Gantt charts, and the critical path method.
4. Further research on this subject in the other province of the Philippines is recommended to have a comparative study.
5. A replication of this study with different respondents and factors is advised to validate the findings of the study.

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