

# DISCOVERING PROJECT MANAGEMENT TOOLS AND TECHNIQUES TO MITIGATE FACTORS CAUSING CONSTRUCTION DELAYS

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## Abstract

According to the Philippine Statistics Authority, in the second quarter of 2021, one of the main drivers of the increase in the Philippine gross domestic product was the completion of project construction. [1] The "Build, Build, Build" initiative, which aims to solve unemployment and poverty by developing infrastructure projects that better the lives of Filipinos, is the primary project of the previous president Duterte's administration, and it posted the greatest growth rate at 25.7 percent. However, some variables make it impossible to prevent project delays; this is just one of the barriers to project completion that have a detrimental impact on many kinds of construction projects. This study's main goal is to identify the causes and effects of delays in construction projects in Ilocos Norte. Data from surveys will be arranged according to the seriousness of effects using statistics. Principles and theories in construction project management will be discovered to address these factors, and a mitigation plan will be advised to reduce delays in these projects. The investigation was conducted in Laoag City, Ilocos Norte, during the pandemic year of 2021. The researcher ran an online survey for a month with a total of 106 respondents having a 95% confidence level and 5% margin of error. The research method used by the researcher was in the form of triangulation which included an online survey, identification of three (3) different project occupancies, inspection with interview, and swot analysis. Aside from those, the purpose of this research methodology is to develop a mathematical formula to check the slippage of a project's status. By calculating the project's schedule variance, we can determine if scheduling efforts are effective or not. The survey produced 25 potential causes of delay, which were ranked by 9 major categories: material, manpower, equipment, financing and budgeting, site issue/environmental, changes (in design, specifications, and materials), government action, contractual relations, scheduling, and techniques. The three main elements having a very large impact on their weighted mean were financing and budgeting, site problems, and modifications. Innovation in knowledge management systems for construction projects is crucial for maintaining and guaranteeing on-time project completion. Data management revision and other cutting-edge technologies, like BIM, must be used to improve construction delay mitigation. One of the suggested mitigation plans is to have a mobile application or project management software to address the risk factors of project delays. It is where you can easily plot your scheduling, update your project accomplishment, and designate who will do a certain project item or task. The "Buildertec" mobile application was introduced in this study.

**Keywords:** Construction Project Delay Factors, Causes and Consequences of Delay Factors, the Severity of Effects on Projects, Project Management Concepts and Theories, and Mitigation Measures

## INTRODUCTION

According to the Philippine Statistics Authority, the construction industry experienced an 11.8 percent increase in the country's gross domestic product (GDP) during the COVID-19 era. [1] This report demonstrates that the delivery of project construction is one of the major factors in the growth of the Philippine GDP, particularly given that construction experienced the highest growth rate, at 25.7 percent, as the "Build, Build, Build" program, the government's top priority project, aims to combat unemployment and poverty by constructing infrastructure projects that

enhance Filipinos' quality of life. Contractors and A/E builders play a crucial role in ensuring that projects are completed on schedule because both the national and local governments as well as private clients heavily rely on them.

According to Ronilo Balberian, Vice President for Operations at REID Foundation, their organization conducted interviews with industry players and their study revealed that construction companies spend 35% of their costs on costs incurred from delays as well as corruption from some government employees. Their organization of economic solutions experts empowers our partners with comprehensive reform packages that facilitate inclusive economic growth and development. Small and large construction firms were forced to deal with this harsh and shady loop. [2] Because of this, contractors have occasionally been forced to reduce the quality of the materials to keep the project moving forward and avoid project failure that could even result in abandonment. This is only one example of the detrimental effects of building delays, which is why it must be extensively investigated.

The region of the study is Ilocos Norte, in particular Laoag City, because it is a rapidly developing city with functional amenities, a center of economic growth in the north, and a city that promotes its identity as a melting pot, a place where people from various places converge. It has the potential to quickly become the metropolitan center of the north. The city is intended to be developed as a worldwide economic and tourism hub akin to Hong Kong, Taiwan, Singapore, Jakarta, and Japan, according to the [3]. This is part of the North Luzon Growth Quadrangle Plan.

The major development program of the place when it comes to infrastructure is the **Ilocos Norte Master Plan** initiated by Senator Imee Marcos, Governor Matthew Marcos Manotoc continues the effort of his mother to boost sustainable development in the province and the evidence is the "**Big Three Infra Projects**" comprising of the Provincial Capitol Expansion, Rehabilitation of Marcos Stadium and Eight (8) Storey Dap-ayan Project. The Provincial Government of Ilocos Norte has allocated Php 2 Billion pesos for the said projects. The first two projects were stated and hoped to be constructed within 425 days and the latter will be constructed within 730 days since it started last June 2019. [4]. If to consider the project duration mentioned and compare the progress of work of the three projects until now, these three major government projects are just a good example of delayed government projects in North Luzon. So with this, the researcher was encouraged and determined to discover project management tools and techniques to mitigate factors causing construction delays here in Ilocos Norte.

## Objectives

The major goal of this proposed study is to investigate the causes and consequences of the elements that cause building projects in Ilocos Norte to be delayed. It will be done through online and field surveys, data gathered from surveys will be arranged according to the degree of serious effects through Statistics, and principles and theories in construction project management will be discovered to address these factors, and a mitigation plan will be recommended to minimize delays in the project completion.

*Specifically, this study aims to address the following:*

1. Identify different risk factors that cause construction delays through literature review and perception of the respondents.
2. Determine the root causes and effects of these factors on the delay of project completion using field data collection through online a questionnaire with open and close-ended questions from project owners, consultants, project contractors, site engineers, and architects -in -charge of construction.
3. Rank and arrange the factors according to serious effects that lead to construction delays using IBM SPSS software, particularly the Likert -Scale, and interpret scores using weighted mean.
4. Discover principles and theories in construction project management that could avoid these factors.
5. Propose a mitigation plan or guidelines that could recommended in minimizing the construction delays.

## **METHODS**

This kind of research employs a quantitative methodology, specifically the descriptive approach. The study's main objective was to identify project construction delay issues from the views of a few chosen project stakeholders. Since it's the best tool for getting the essential data or information from the respondents, online survey questionnaires with closed and open-ended questions were issued as part of the data collection procedure. They were to give each component a rating on a Likert Type Scale that ranged from 1-4. (1 representing No Impact, and 4 representing Very High Impact).

The top risk factors discovered from the literature study will be the ones indicated or identified in the questionnaire. The weighted mean used to interpret the results allowed for the impact of the delaying variables was formulated as: Weighted mean is equal to  $wx/w$ , where  $w$  is the weights and  $w$  is the total of all the variables. The value is  $x$ .

The main statistical tool used was the IBM-SPSS tool wherein it will help the researcher input the gathered data and analyze results. Aside from the survey method, the researcher also conducted fieldwork interviewing the stakeholders involved in three project occupancies namely residential, commercial, and institutional that experienced project delays.

## **RESULTS**

Based on the survey result, most of the respondents were male comprising 73.5% of the total number of participants. The majority of the respondents belong to young adults aged 20-29 years old 45.1% followed by 30-39 years old which has 31.4% out of 102 respondents. Civil engineers dominated in the survey which has 51% followed by the group of architects which has 23.5%. Other people who participated in the survey were businessmen, government employees, police officers, sales engineers, project owners, foremen, apprentices, project

financers and contractors, and ordinary residents of Ilocos Norte. In the working sector classification, 73.5% were under private company, and 22.5% were under government sector. Almost 83% of the civil engineers and architects handled or completed a construction project in the last two years and the top two project classifications that experienced the most type of project failure and delay were commercial which has 30.4%, and residential which has 27.5%. Considering the perception of the residents of Ilocos Norte particularly Laoag City in general, roads and bridges experience the most type of project delays which have 87.3%, and followed by institutional projects which have 44.1%. Based on the open-ended question, asking for the main reasons why those projects experienced delays or failure were bad weather conditions, lack of resources like budget, equipment, manpower, and poor project management. They also suggested strategies or actions to avoid construction delays and the top answer is proper construction management and strategic planning and scheduling of projects. Most of the technical respondents which is 86.3% of them already experienced project failure and delays and this is the result of the problems they encountered during the actual construction. The enlisted factors were already pre-determined or given which was based on the related literature of the study. Among the twenty-five factors, bad weather conditions ranked as the top reason for construction delay.

**Table 1: Percentage and Rank of Survey Result on Individual Factors of Delay**

Factors Of Construction Delay	Percentage	Rank
1. SHORTAGES OF MATERIALS ON-PREMISES OR IN SUPPLY CENTER	48	4
2. LATE MATERIAL DELIVERY	54.9	3
3. SHORTAGE OF SKILLED AND UNSKILLED LABOR	45.1	5
4. EQUIPMENT DEFICIENCY OR BREAKDOWN	29.4	7
5. UNSKILLED EQUIPMENT OPERATORS	8.8	22
6. DELAY IN HONORING PAYMENT	37.3	6
7. FLUCTUATION OF CONSTRUCTION MATERIAL COST	28.4	8
8. BAD WEATHER CONDITIONS /UNFAVORABLE SITE CONDITIONS	76.5	1
9. CLIENT CHANGE OF ORDER OR VARIATIONS	62.7	2
10. MISTAKES IN SOIL INVESTIGATION	8.8	22
11. POOR DESIGN	10.8	17
12. DELAYS IN OBTAINING PERMIT	19.6	10
13. DISCREPANCY BETWEEN DESIGN SPECIFICATION AND BUILDING REGULATIONS LIKE NBC AND FIRE CODE	10.8	17
14. LEGAL DISPUTES	22.5	9
15. INSUFFICIENT COMMUNICATION BETWEEN PARTIES	15.7	13
16. POOR PROFESSIONAL MANAGEMENT	6.9	24
17. DELAY FROM CONSULTANTS	6.9	24
18. DELAY BY SUBCONTRACTORS	16.7	11
19. POOR SITE MANAGEMENT	10.8	17
20. POOR SUPERVISION	15.7	13
21. LACK OF PROGRAM OF WORKS	11.8	16
22. ACCIDENTS DURING CONSTRUCTION	9.8	20
23. UNDERESTIMATION OF COSTS	13.7	15
24. UNDERESTIMATION OF PROJECT COMPLEXITY	9.8	20
25. UNDERESTIMATION OF TIME COMPLETION	16.7	11

Among the 25 risk factors, these were grouped into 9 major problem areas and were ranked according to their frequency of encounters.

**Table 2: Weighted Mean and Degree Equivalent Result of Group Factors Based On Survey Results**

RISKS FACTORS MAJOR GROUP	RATING SCALE					OVERALL	
	5	4	3	2	1	WM	DE
1. MATERIAL	11	14	29	23	22	2.44	HI
2. MANPOWER	10	15	20	19	21	2.08	HI
3. EQUIPMENT	18	15	14	10	3	2.12	HI
4. FINANCING/ BUDGETING	9	10	9	13	20	1.38	VHI
5. SITE PROBLEM /ENVIRONMENTAL	13	11	4	8	10	1.37	VHI
6. CHANGES (DESIGN, SPECIFICATION,MATERIALS)	7	15	6	15	16	1.43	VHI
7. GOVERNMENT ACTION	8	12	9	5	5	3.78	LI
8. CONTRACTUAL RELATIONS	16	7	5	6	1	2.14	HI
9. SCHEDULING AND CONTROLLING TECHNIQUES	14	7	10	7	8	2.10	HI

LEGEND:

RATING SCALE	DEGREE EQUIVALENT	WEIGHTED MEAN
1-ALWAYS	VHI (VERY HIGH IMPACT)	1.00-1.75
2-OFTEN	HI (HIGH IMPACT)	1.76-2.51
3-SOMETIMES	MI (MEDIUM IMPACT)	2.52-3.27
4-RARELY	LI (LOW IMPACT)	3.28-4.0
5-NEVER	N (NEVER)	4.1-5.0
WM-WEIGHTED MEAN	DE-DEGREE EQUIVALENT	

Another research methodology or data gathering method conducted was a fieldwork observation and an interview with the concerned stakeholders on the identified top project occupancies that experience project delays. These were residential, commercial, and institutional. Two project sites were identified for residential commercial and institutional.

The purpose of this research methodology is to determine if our scheduling efforts are effective or not. In project terminologies, based on the task management guide, project slippage is defined as a time length for which a given project postpones the accomplishment of its goal or objective. It is a delay that identifies the project's inability to follow the schedule baseline because of some reason(s) (e.g. poor scheduling, lack of control). We can determine the project slippage by using the formula for Schedule Variance =  $(Actual Project Duration - Planned Project Duration / Planned Project Duration) * 100$  [5]

## DISCUSSION

In the table above (Table 2), the weighted mean was computed based on the formula:

**Weighted mean =  $\Sigma wx / \Sigma w$  Where:  $\Sigma$  = the sum of all variables w = the weights. x = the value**

The nine risk factors major group are: site problem ranked first, financing /budgeting ranked second, and changes ranked third. The research findings revealed that these three groups of risk factors degree equivalent have a very high impact on the cause of construction delays while material, manpower, equipment, contractual relations, scheduling, and controlling techniques have a high impact equivalent and the government action got the lowest impact equivalent.

SWOT analysis is a useful technique to determine the causes of these findings that could influence the performance of a project and this is one of the dominant tools for searching mitigations on the risks that have been recognized. These are based on the survey's findings and readings from relevant literature, and they are as follows:

### **Strengths**

*Materials and equipment* contribute to fifty percent (50%) of the total composition of the entire project, the other half is the labor. Ilocos Norte construction industry has abundant raw construction materials as well as equipment that are ready to be rented for faster work results. Raw materials include sand, gravel, wood, steel, and bamboo. If these materials are abundantly available in local areas and equipment to be rented, these make it as a key contributor to the success of a project.

*Ubiquitous Labor* in addition has a large impact on the construction industry of Ilocos Norte, they may be skilled and unskilled. The availability of manpower at any time is another key contributor to a project's success because you are confident enough to start and finish a project on time.

*Government Action* is the only factor that has the lowest impact based on the survey results. This could be a strength as well because this factor can be addressed easily. Actions such as delays in obtaining permits, public holidays, and discrepancies between design, specification, and building code can be mitigated by concluding adjustments on securing building permits, and reviewing the different building regulations so that they can be applied to the submitted design.

### **Weaknesses**

*Site problem/weather condition.* This environmental factor ranked first on the survey result which resulted in a very high impact degree equivalent. Since we are now experiencing an environmental crisis due to climate change, we cannot predict the weather conditions which would result in project delay sometimes. Another factor is *financing*, ranked as second to have a very high impact. These include issues including payment delays, trouble obtaining bank credit or loans, restrictions on remittances, and fluctuating pricing of building materials. *Changes* are another weakness in which there is no consistency when it comes to decision-making. These aspects can lead to delays in project construction as well as issues like client-initiated design changes, changes in materials or specifications, errors in the soil investigation, and foundation conditions observed on site.

## Opportunities

Housing demand, Ilocos Norte's rapid population growth, and urbanization all present promising prospects for the building sector. The construction of infrastructure projects like bridges, boulevards, and by-pass highways would necessitate the potential to raise the land value for residential and commercial development. These possibilities will draw in investors and lead to the creation of new construction jobs.

## Threats

Where there is a high demand for housing projects, comes with a threat of sacrificing *contractual relationship factors*. Contractual relationship factors include legal issues, inadequate party communication, poor professional management, delays in receiving instructions from consultants, and delays from subcontractors. These things may happen if the main contractor handles multiple projects at one time. If the demand for construction projects is high, the supply of materials, manpower, and equipment will be a threat due to the possible scarcity of those. Scheduling and regulating would be an additional component that might pose a concern. This includes inadequate supervision, construction-related accidents, a lack of a work schedule, an underestimation of project expenditures, and an underestimation of project complexity. All these factors may be of big threat and their degree of equivalent based on the survey result has a high impact on project delays.

Another section of the survey was focused on the management tools and techniques that the respondents used. 84.9% of them use construction management tools or techniques to address site problems and 15.1% don't. The top three techniques identified were Program Evaluation and Review Techniques (PERT) ranked first which is equivalent to 66%, critical path method ranked second which has 49.1% and performance report ranked third which has 46.2%. Other techniques specified were the S-Curve method which has 39.6%, Gantt Bar chart which has 36.8%, and Work Breakdown Structure which has 32.1%. Aside from the mentioned techniques others specified Autodesk Builder, Lean and Six Sigma, Primavera, Survey 123, Toolbox Every day, and Trello. Based on another survey result, the most effective project management tool which has 32.4% is the Program Evaluation and Review Techniques (PERT), followed by the Critical Path Method which has 16.7% and the third rank is the Performance Report which has 15.7%. When it comes to familiarity with any project management tool mobile application, the majority of the respondents were not familiar with any mobile application which has 82.4% and 90.2% of them have not yet tried using any mobile application to mitigate delays. With this result, 95.1% of them were interested in using an advanced mobile application if it will be available shortly. The respondents also gave their insights on the advantages of having a project management tool in a construction site most of them answered: that to avoid delays, for faster monitoring of projects, proper planning, and scheduling, to check project alignment on a schedule based on progress of work and for construction team communication and collaboration. The goal of this study is to categorize and rank the twenty-five criteria based on their impact on building delays. Based on the survey result, site problems ranked first, followed by financing /budgeting and the third rank is change. All three of these aspects have a very high impact on the reasons for construction delay, while material, people, equipment, contractual

relations, scheduling, and controlling techniques have a high impact and government action has the lowest impact. Ranking these factors and analyzing their strength, weaknesses, opportunities, and threats will reflect their serious effects that lead to construction delays. Based on the related studies, survey results, and interviews with the construction stakeholders, each factor depends on the other, one delay factor could trigger another factor which may cause a domino effect. In conclusion, there must be careful planning and proper project management at very firsthand to avoid the different risk factors mentioned in the study. Below is the recommendation table of the researcher on how to mitigate the top 9 risk factors of project delays.

**Table 3: Mitigation Plan of Project Delays**

Risk Factors Major Group	Overall		Mitigation Plan
	WM	DE	
1. Material	2.44	HI	Should Be Locally Available for Cheaper Cost; Advance Order to Avoid Delays; Proper Coordination of Contractor And Client In Material Selection; Immediate Approval Of Change Order
2. Manpower	2.08	HI	Availability Of Enough Manpower and Deployment Anytime; Well-Experienced / Skilled Are Preferred to Render Good Workmanship and Avoid Back jobs/Rework; Preparation of Gantt Chart Detailing Using software or Mobile Application
3. Equipment	2.12	HI	Availability of Equipment Before the Start of Project; Well-Conditioned or Fully Functional to Avoid Repairs
4. Financing/ Budgeting	1.38	VHI	Need A Written Contract to Indicate Terms of Payment and Advance Upon Contract Signing; Penalty Clauses Should Be Indicated to avoid delays in payment
5. Site Problem /Environmental	1.37	VHI	Check Weather Updates and There Must Be Plan “B” Of Site Activities If Unpredicted Weather Is Unavoided. Conduct Ocular Inspection and Investigation First to Avoid Errors in the Plan and Actual Construction.
6. Changes (Design, Specification, Materials)	1.43	VHI	Strictly Follow What Is in the Approved Plan and Specification to avoid changes in materials Or Design; Update Your Client on the Selection of Materials to Avoid Miscommunication. If the Owner Causes the Change of Design or Specification, He /She Must Approve It Immediately to Avoid Delays. KMS-DFD
7. Government Action	3.78	L I	Check Engineering Office Requirements Properly To Avoid Delays In Permit Plan Processing; Provide Complete Details Of Plans And Strictly Follow Building Regulations To Secure Fast Approval of Plan Signatories.
8. Contractual Relations	2.14	HI	Check the Project Awarding Procedure for Consultant by Adding Qualification Criteria. Enhance And Revise the Written Contract to Include Clauses on Time Duration and Delays Of Payment.
9. Scheduling and Controlling Techniques	2.10	HI	Use Project Management Software, and Knowledge Management System applications to Have Proper Checking of Scheduling and Designation of Manpower. Mobile Application Will Be More Convenient If Introduced.

Innovation in knowledge management systems for construction projects is crucial for maintaining and guaranteeing on-time project completion. A knowledge management technique for projects that is more robust, adaptive, and risk-focused is data management revision. To better mitigate construction delays, Data Flow Diagram (DFD) and other cutting-edge technologies like BIM must be implemented. Project supervision time will be kept to a minimum, and it will be made sure that they are finished on time and budget. [5] Using mathematical models is another mitigating solution that seeks to offer a new method for cost estimation in construction project management to avoid issues with cost overruns during



project execution. According to a mathematical model created through multiple linear regression analysis, project scale, equipment management, site condition, and client collaboration were significant predictors of residential project cost. The model's validity was determined through graphical and mathematical validation, demonstrating the mathematical model's high degree of prediction accuracy. [6] To reduce personnel risk, the Silva's Management Competency Framework Assessment Instrument (SMCF-AI) and the Silva's Management Competency Theory (IaMSilvA) are recommended tools. These are aimed at developing a framework for human resource development in the construction sector to identify the behaviors that contribute to effective construction management performance.[7] Another mitigation plan is to have a mobile application where you can easily plot your scheduling, update your project accomplishment, and designate who will do a certain project item or task. There are already several mobile applications available worldwide and most of them come with a certain price if not a subscription. The researcher with the help of IT experts developed a free mobile application named "**Buildertec**". It is a simple Gantt chart or project scheduling application wherein we can create the title of the work item, its description or manner of installation, indicate priority level, the start date, end date, and image attachment. Through this application, we can easily monitor the timeframe and progress of our work and manage deadlines. It is still a developing mobile application wherein it only limits scheduling for the meantime, but features can be added if needed. The application "Buildertec" can be downloaded on the Google Play Store and it only runs on Android phones.

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