



Article

# A Study on Causes of Delay in Road Construction Projects across 25 Developing Countries

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**Abstract:** Delays in road construction projects due to various reasons are a major problem facing construction professionals. The incapability of finishing projects punctually and within a given budget is a persistent issue worldwide. This study aims to determine the ten principal causes of delay in road construction projects in 25 developing countries across the globe. The study involves two steps. First, the authors compiled information regarding the most frequent delays in a road construction project. Second, they analyzed the intensity of each cause of delay in these projects. Being more accurate in the methodology, given the nature of the information, the researchers used a quasi-meta-analysis for processing the data. Half (50%) of the countries have similar causes of delay, and likewise, 50% of the countries identified the top ten primary causes of delay in road construction projects based on the intensity results. This study uses the results of the intensity. According to the results of the homologation, the lack of experience of the construction manager, inadequate planning/scheduling, and influence on people's land alongside the road construction project (expropriation for the construction of the project) have more significant impacts than frequent changes in the design (which was listed as the most frequent cause of delay).

**Keywords:** developing countries; untimed completion; construction delay; road project

## 1. Introduction

The primary function of roads is to provide accessibility and mobility. Presently, developing countries around the world are prioritizing the improvement and linking of their road networks. Road projects are being listed as the primary focus in their national budget, given that a good road network contributes to the development of the economy and national growth. The authors cannot deliver goods and services without adequate transportation infrastructure.

Therefore, road projects should be completed in accordance with the schedule to serve the immediate needs of stakeholders. Unfortunately, delays in road construction projects due to various reasons are a major problem facing construction professionals. It has been proven that the incapability to finish projects punctually and within a given budget continues to be a persistent issue worldwide [1]. Although the causes of delays are quite comparable across developing countries, several factors unambiguously pertain to local industries, socio-economic backgrounds, cultural matters, and project features, such as land disputes and problems of the right of way for roads. With road construction projects already producing a multitude of issues to the community, such as heavy traffic and increased possibilities of road accidents, among others, project personnel is also facing the consequences of project failure, profit decrease, and loss of faith to the public in government-funded projects. Therefore, on-time completion of a road project is exceptionally crucial.

Card [2] stated that “... the advancement of scientific knowledge is based on the systematic building of one study on top of a foundation of prior studies, the accumulation of which takes our

understanding to ever-increasing heights." Hence, in order to develop a better framework to address the current problems faced by the construction sector in the process of developing a road, the authors will compile the leading causes of delays from 25 countries around the world. The approach to conduct this study is through a universal comparison of various research studies in these countries on the reasons for a delay in a road project. The researchers will identify the primary reasons that directly influence the untimely completion of a road project and recommend proven techniques based on a literature review to address the problem. Meanwhile, the research findings could be considered a reference to road project implementers, both the government and the contractor, as to the precautionary actions to be taken to avoid delays in road project implementation.

Battaineh [3] determined that road delays are widespread. The typical proportion of the real completion time to the scheduled length is around 160% for new road projects. Delays have undesirable results on every participant in the project. They affect the growth in confrontational relations, mistrust, lawsuit, arbitration, cash-flow issues, and an overall sense of anxiety [4]. This problem is not limited to developed countries. Developing countries also experience the same issues [5].

Duran's [6] study concluded that most of the delays in construction projects had not been managed appropriately or stringently. Even no analysis was also easily observed. As an upfront tactic, contingency is a common method to back up delays. Accordingly, it is not easy to assure project completion dates. The study emphasized the significance of delays in the implementation of construction projects.

The study's primary objective is to recommend precautionary measures that will guide road project implementers to reduce delays in road construction projects from the results of the analysis in identifying the ten (10) principal reasons for a delay in road construction projects in 25 developing countries. In addition, this study also identifies the likelihood of delay situations in the delivery of road construction projects in these countries.

This study aims to develop a broad knowledge of the primary causes of delays in road construction projects. Therefore, it is necessary to understand what a project is and how the authors can materialize an idea of a project. According to Loftus [7], a project is a temporary effort with a start and an end. It creates a unique output, service, or result. Concerning its construction, three principal stages must be completed: the Planning and Definition Stage, the Design Stage, and the Procurement and Construction Stage. In the first stage, the owner determines the main requirements and sets the initial budgetary constraints. The definition of the main requirements refers to the establishment of the broad project components such as the scope, the equipment that will be required, and the primary outcomes expected. The information assembled for the main features of the future project will help the owner draw an idea of the amount of money required for the building. This information will form the basis for the second stage.

Along with this theory of project management, Sears and Clough [8] define the second stage, such as the engineering and architectural stage. The primary purpose of this phase is the preparation of the final working designs and specifications for the technical requirements. In this phase, the engineers and technical staff will schedule the main activities for the development of the project. The scheduling defines what will be performed, how it will be performed, and the plan for its accomplishment. The purpose of scheduling is to divide the project into many subcomponents, which are called activities. Once the schedule for the construction is completed, the contractors will establish a calendar-date agenda for the timing of specific activities.

Sears and Clough [8] propose that a project schedule is a timetable for its construction and operation. According to the authors, there are eight steps for appropriate scheduling:

- Estimation of the time required to perform each network activity
- Computation of the overall project time required using the previous estimates
- Establishment of time intervals within which each activity must commence and conclude to satisfy the completion date requirements
- Identification of those activities that are crucial to timely project completion

- Decrease of the project length at the lowest cost if the project completion date is not likely to meet the contract or other requirements
- Adjustment of the start and completion time of selected activities to minimize resource conflicts and set suitable demands for workforce and equipment using surplus or float time that most activities possess
- Preparing a working project schedule that focuses on anticipated calendar dates for the commencement and conclusion of each network activity
- Recording the assumptions made and the plan's necessary boundary conditions for an integral aspect of the completed baseline project schedule.

Sears and Clough [8] define the third phase as the delivery phase in which the key project equipment and materials will be collected. According to the authors, the phase of construction must be regarded as a procedure of the physical progress of the project. This activity involves the setting up of materials, manpower, and construction equipment, and addressing workforce complaints to accomplish the project successfully.

Burke [9] indicates that a delay is "the event in which something happens later than the expected", and according to him, there are four primary methods to classify delays: "Critical or Non-Critical, Excusable or Non-Excusable, Compensable or Non-Compensable, and Concurrent or Non-Concurrent". Critical delays are the ones that affect project completion. The category of critical factors depends on the type of project; nevertheless, some factors can determine the activities that can be identified as critical. Some of those factors are the requirements of the construction equipment, the physical constraints of the project, etc. The second category, Excusable–Non-Excusable Delays, refers to the delays that occur due to unforeseeable events such as general labor strikes, fire, floods, weather changes, and force majeure events.

The third category of delay, Compensable Delay, introduces the delays in which the contractor can be compensated for the occurrence of one determined event, to summarize some delays in which the contractor can be compensated. Returning briefly to the second category of delay, the third category of delay in many cases is related to unforeseen events. To prevent disputes between the contractor and the owner, it is necessary to specify which items in the contract of construction can be considered as non-compensable or compensable.

Finally, the fourth category of delay or the Concurrent Delay is when the concurrency dispute is not from the position of defining the project's severe delays but from the viewpoint of conveying accountability for damages related to critical path delays. In their investigation for the main causes of construction delays, Trauner, Manginelli, and Nagata [10] presented a relationship between the delays.

The analysis of the main cause of the delay in project construction is a key issue in the appropriate management of the project on account of two things. The good management of delays allows accomplishing the objectives of the project and the allocation for the reliabilities. Sears and Clough [8] mentioned that when the contractor is accountable for the delay, the loss caused by the delay must be covered by the contractor. When the owner is in charge of the delay, the contractor must request additional contract time. Faridi and El-Sayegh [11] said that construction delays are the most recurring problems in the building industry, which hurt the success of the projects in terms of safety, cost, time, and quality. Therefore, it must be a priority for the owner and the contractor to define and identify the most significant causes for project delay to reduce the scope of its impact on the construction project.

## 2. Literature Review

A study on the factors affecting delays in road construction projects determined that the most severe aspects are human-related. They can be managed and reduced by refining the skills of the construction sides [12]. Santoso and Soeng [13] emphasized that delays affect not only the last time of the project but also the cost and quality. Recommendations to decrease delays in road projects must include authorities of services in the early stage of the project. Consistent conferences with the authorities are imperative to recognize their needs and accommodate them during the first phase of

the project. This approach offers the authorities of services a chance to design their work packages and control the procurement of the materials required in the project. Thus, it is expected to have a nominal adverse influence on the road project [14].

A study by Mahamid [12] indicates that the administrative skills of construction parties should be enhanced, the labor motivation system developed, and communication among construction parties enhanced at the early project stages to minimize late changes during the construction phase. In addition, the procedure of contract awarding could be improved. The resources and capabilities of bidders should be verified carefully for minimizing schedule delays in public construction projects. For a successful Social Overhead Capital (SOC) project, it is critical for a government to control cost overruns and estimate a realistic budget. There are many reasons for the cost overruns, such as changes in the project scope, delays in construction, inappropriate estimation, alteration of the cost of the project, and the absence of the earned value management system [15].

For developing the present paper, data were collected from 25 studies from different countries, as presented in Table 1.

**Table 1.** Literature used for a data collection.

Country	Paper	Project Type	Author	Year
India	Delay in Construction of Highway and Construction Projects [16]	Highway and Expressway	Kumar, V.	2020
Ethiopia	Determinants of Infrastructure Project Delays and Cost Escalations: The Cases of Federal Road and Railway Construction Projects in Ethiopia [17]	Federal Road and Railway Construction	Kassa, Y.F.	2020
Oman	A Conceptual Paper: Factors Causing Delays in Roads Construction in Sultanate of Oman [18]	Road	Al Hinai, S.S., Widyarto, S., and Bhuiyan, A.B.	2020
Malaysia	Causes of delay in construction of highway projects: A review [19]	Highway	Karunakaran, S., Malek, M.A., and Ramli, M. Z.	2019
Colombia	Identificación de factores que generan diferencias de tiempo y costos en proyectos de construcción en Colombia. Ingeniería y ciencia [20]	Road	Lozano Serna, S., Patiño Galindo, I., Gómez-Cabrera, A., and Torres, A.	2018
Philippines	Factors Influencing the Delay of Road Construction Projects in Northern Mindanao, Philippines [21]	Road	Ruel R. Cabahug, Mariell B. Arquita, Sheena Marie E. De La Torre, Michelle S. Valledor and Shiela Mae D. Olivares	2018
Ecuador	Causas de Retrasos en Proyectos de Construcción: Un análisis cualitativo [22]	Road	N. Rudeli, E. Viles, J. Gonzalez, and A. Santili	2018
Thailand	Causes of delay on highway construction projects in Thailand [23]	Highway	Thapanont, P., Santi, C., and Pruethipong, X.	2018
Sudan	A Management Framework to Reduce Delays in Road Construction Projects in Sudan [24]	Road	Khalid Khair, Zainai Mohamed, R. Mohammad, Hazir Farouk, and Mohammed Elhadi Ahmed	2017
Saudi Arabia	Schedule Delay in Saudi Arabia Road Construction Projects: Size, Estimate, Determinants and Effects [25]	Road	Ibrahim Mahamid	2017
Cambodia	Analyzing Delays of Road Construction Projects in Cambodia: Causes and Effect [13]	Road	Djoen San Santoso, Ph.D. and Sothy Soeng	2016
Qatar	Causes of Construction Delays in Qatar Construction Projects [26]	Road	Murat Gunduz, Mohanad H. A. AbuHassan	2016
Kenya	An Investigation into Factors Causing Delays in Road Construction Projects in Kenya [27]	Road	MsafiriAtibuSeboru	2015

Table 1. Cont.

Country	Paper	Project Type	Author	Year
Bangladesh	Causes of delay in construction projects in Bangladesh [28]	Road	M. S. Islam, B. Trigunaryyah, M. Hassanain, and S. Assaf	2015
Iraq	Causes of Delay in Public Construction Projects in Iraq [29]	Road	Ghanim A. Bekr	2015
Bahrain	An Investigation into the Delays in Road Projects in Bahrain [14]	Road	Rehab Hasan, Saad M. A. Suliman, Yusuf Al Malki (2014)	2014
Malawi	Causes of delay in road construction projects in Malawi [30]	Road	M J Kamanga, W J v d M Steyn	2013
Egypt	Causes of Construction Delays for Engineering Projects in the middle-east: An Egyptian Perspective [31]	Road	Samer Ezeldin and Mohamed Abdel-Ghany	2013
Uganda	Investigation into the Causes of Delays and Cost Overruns in Uganda’s Public Sector Construction Projects [32]	Road	Henry Alinaitwe, Ruth Apolot, and Dan Tindiwensi	2013
Palestine	Causes of Delay in Road Construction Projects [33]	Highway and Road	Ibrahim Mahamid, AmundBruland, and Nabil Dmaidi	2012
Peru	Transportation concessions and unclear status of land: when an obligation loses its nature [34]	Road	C. Fierro	2011
Ghana	Causes of project cost overruns within the Ghanaian road construction sector [35]	Road	Nicholas Chileshe and Paul DansoBerko	2010
China	Evaluating schedule delay causes for private participating public construction works under the Build–Operate–Transfer model [36]	Road	Yang, J., Yang, C, and Kao, C.	2010
Zambia	Cost escalation and schedule delays in road construction projects in Zambia [5]	Road	Chabota Kaliba, MundiaMuya and Kanyuka Mumba	2009
Vietnam	Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries [37]	Road	Long Le-Hoai, Young Dai Lee, and Jun Yong Lee	2008

### 3. Research Design

According to Attia, Hamdy, O’Brien, and Carlucci [38], the construction sector relies considerably on the review of previous cases, with the best practices for the construction management of a facility, the materials that previous construction projects used, the issues that other companies faced, etc. being information that will help in future construction projects. In this backdrop, the researchers decided to utilize one of the meta-analysis tools for studying the delays in road construction projects because, as stated by Borenstein, Hedges, Higgins, and Rothstein [39], this tool can combine previous studies on a single specific subject.

Being more accurate in the methodology, given the nature of the information that was found by the authors about delay causes in road construction projects, the researchers will use a quasi-meta-analysis for processing the data. Several authors that have used the meta-analysis have noted that one of the main advantages of these types of tools is the information that can be collected from the variable and fixed effects. Nevertheless, these effects can be calculated only with numerical data. In the case of the present investigation, the sources of data contain only qualitative data of the delay causes, making it impossible to identify those effects. Furthermore, in several cases, the application of pure statistical research for peer-reviewed data has proven the existence of bias against statistically irrelevant results [40].

The general characteristics of the design methodology are non-experimental, non-cross-sectional, and explanatory study.

According to Price, Jhangiani, and Chiang [41], non-experimental research lacks the management of an independent variable, arbitrary assignment of participants to situations, or orders of conditions.

Price, Jhangiani, and Chiang [41] suggested three main features to employ this non-experimental research, as mentioned below.

- The research question or hypothesis can concern a single variable rather than a statistical association between two variables. For the present research, the authors will analyze the causes of the delay in road construction.
- The research question can concern a non-causal statistical relationship between variables. In addition, the research aims to decide the relationship between certain specific delay causes and construction problems.

The research question can be broad and include exploratory information. This research will explore the leading causes of delays in road construction projects in 25 developing countries.

This research is also a non-cross-sectional study because the information gathered to analyze the delay from 25 countries was extracted in different temporalities. As mentioned in the literature review, the data were collected from 2003 to 2020. In addition, a variant of the meta-analysis will be used. The research methodology process can be divided into two main steps. The first one will be the analysis of the common causes of delay in the 25 developing countries. After the analysis of the common causes of delay, an analysis of the intensity of each cause will be held. For the analysis of the basic statistics of the data, the present investigators used RStudio.

Price, Jhangiani, and Chiang [41] defined an exploratory study as research used to investigate a problem that is not clearly defined. As stated earlier, there are no clear studies of the major causes of the delay in road construction projects in developing countries. Therefore, this research will be conducted to offer a better understanding of the delay, but it will not provide conclusive results because of the lack of data. Furthermore, this research explores secondary data, since the present authors will collect data from other studies regarding the delay in a road construction project. It is also descriptive research, because this study will describe the characteristics of the causes of delay. This methodology pays more attention to the “what” rather than the “why”. In this case, the study proposes answering the query: “What are the most frequent causes for the delay of a road construction project?” It also elucidates: “What are the most significant causes for the delay in a road construction project?”

#### 4. Analysis and Results

The data gathered for this study came from 25 developing countries. The data analysis will be performed in two steps. The first step will collect information on the most frequent causes of delay in road project construction. The second step will analyze the intensity of each cause of delay in road projects. It is necessary to mention that this intensity comes from evaluating each author of the data gathered.

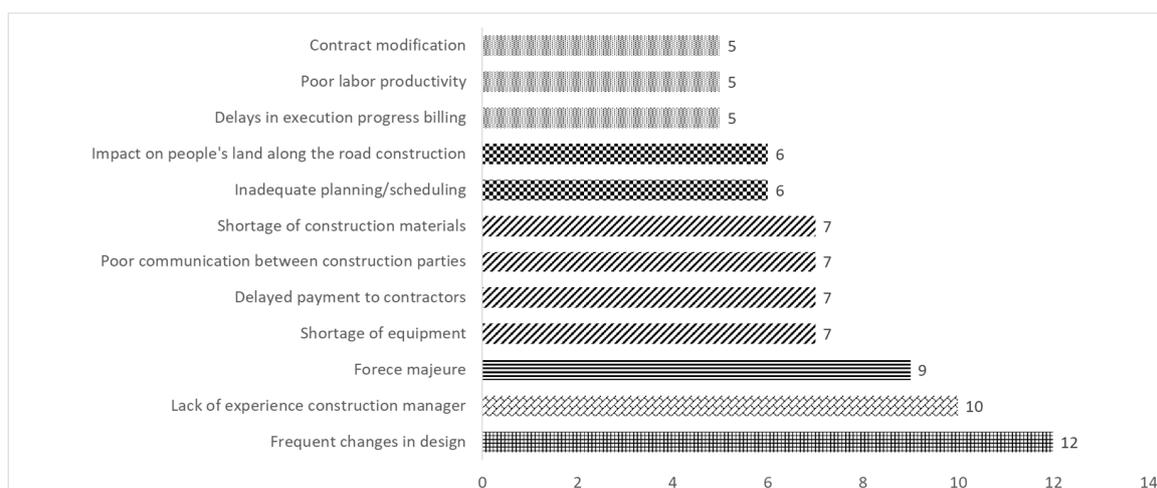
##### 4.1. Frequent Causes of Delay

After gathering the data, 84 different causes of delay were identified, which are presented in Table 2.

In view of the specific characteristics of each country, the nations faced diverse challenges with regard to the delays in a road construction project. Accordingly, to obtain additional information about the causes of delay in each country, the Appendix A highlights the causes of delay by country. From the analysis and count of all the major causes of delay, the next 12 causes of delay were identified as the most frequent delays, as demonstrated in Figure 1. In this case, the most important causes have a sum of 5 (1 + 1 + 1 + 1 + 1).

**Table 2.** Causes of delay.

By Origin	Delays
Owner	Delays in accomplishment progress billing; technical complexity/size of the project; insufficient inspectors; financial issues with the bank; delayed payment to contractors; delay in paying compensations (landowners); delays in decision making by the owner; slow decision making and administration in client organization; protracted financial procedures in client organizations; contract modification; financial difficulties of the owner; lowest bidder selection; low performance of the bidder; delay in progress payments; owners lack experience and involvement; delay in approving whole designs, shop drawing, the sample tested materials, and significant changes in the work
Constructor	Lack of experience of the construction acquisition equipment manager; low tender price; poor labor productivity; rework from poor material quality; impact on people’s land alongside the road construction project; shortage of equipment; insufficient qualification of the contractor; health problems of technical workforce and project crews; lack of modern communication equipment; cost overruns; delay of other projects associated to the main one; rework; changes in material types; lack of adequate manpower; shortage of construction materials; shortage of technical personnel; delay in site mobilization; need for labor; delays in payment by the contractor; labor disputes; unpredictable sources of materials on the local market; inadequate assignment of manpower; less project engineer experience; lack of traffic safety during construction; fluctuation of resources; financial difficulties of contractor; summer restriction on time of work; less structural engineer experience; low educational level of manpower; delays in sub-contractor work and their ineffectualness, which leads to recurrent changes in sub-contractors; lack of expertise for construction managers
Consultant	Change in quantities; schedule slippage; underestimating; frequent changes in design; inadequate planning/scheduling; incomplete drawing; delay in relieving environmental impact; inaccurate cost estimation; unclear and ineffective details in drawings and also slow reply on query arising from the drawings
Shared	Poor communication between construction parties; disputes; discredit the ministry of works amongst the people and in the media; arbitration; break of a contract; litigation; total neglect; changes in the duration of the contract period; delay in relocating utilities; official and non-official holidays; underestimation of the labor force
Outside	Inflation; political situation; force majeure; lack of proper IT management; disruption of traffic movement; obstruction of economic and urban development; shortage of fuel; shortage of overseas currency (import of materials and equipment); effects of unexpected subsurface and changing ground condition; environmental claims; economic hardships; slow decision making and administration in the non-client organization; road right of way; peace and order; government change of regulations and bureaucracy; economic conditions; accident during the construction



**Figure 1.** Frequent delay causes.

#### 4.2. Intensity of Each Cause of Delay

The second part of the study ranked the intensity of each of the ten most frequent causes of delay. The evaluation was made for each author of the data collected. In this part of the study, a variation of the Likert scale was used, where 1 represents the most important cause of delay in a road project, with the significance waning for figures higher than 1. The main reason for using this kind of measure was to prevent a loss of information. The causes of delays in some countries are completely different from other nations from other continents. In some cases, one cause can be ranked number 1, but in another study, it could be ranked 6. Therefore, the intensity will be measured as the sum of the first three lowest countries that witnessed that particular cause of delay. The results are presented in Figure 2.

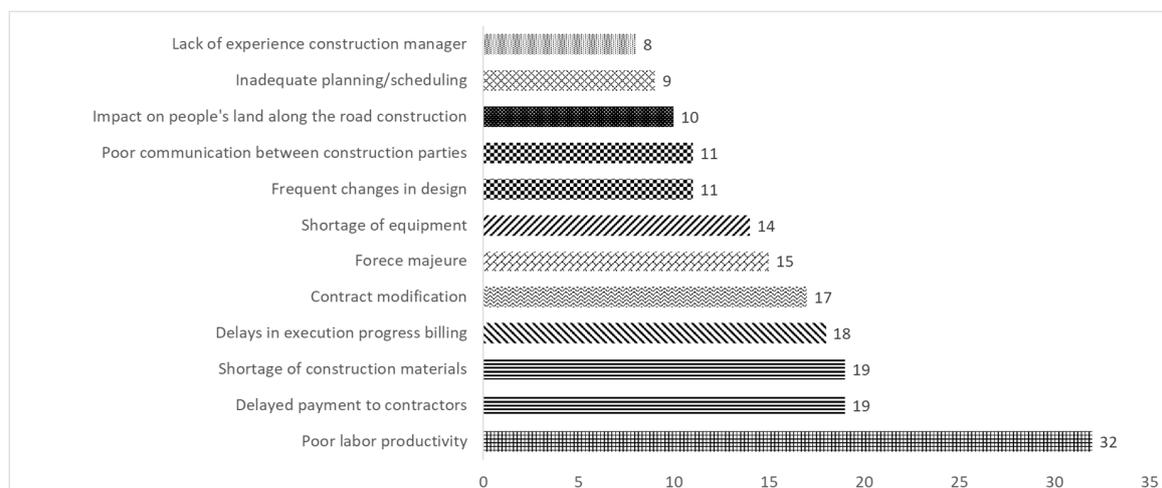


Figure 2. Intensity for the delay causes.

#### 5. Discussion and Conclusions

This study generated two results, while the frequency and intensity of each cause of delay were identified. Repetition ranks the cause of delay in the number of countries in which the delay was mentioned in the comprehensive data gathered. One of the main findings is that the frequency of a delay does not always imply importance. According to the results of the homologation in the assessment of the impact of the causes of delay, the lack of experience of the construction manager and the inadequate planning/scheduling and influence on people's land alongside the road construction project (expropriation for the construction of the project) have a more significant impact than the frequent changes to the design (which was listed as the most frequent cause of delay). Below is the list of the most important causes of delay:

- Lack of an experienced construction manager
- Inadequate planning/scheduling
- Influence on people's land along with the road construction project
- (a) Poor communication between construction parties and (b) Frequent changes in design
- Shortage of equipment
- Force majeure
- Contract modification
- Delays in execution of progress billing
- (a) Shortage of construction materials and (b) Delayed payment to contractors
- Poor labor productivity

In general, 50% of the countries have similar causes of delay, as shown in the repetition data. Likewise, 50% of the countries identified the top ten primary causes of delay in road construction projects, as shown in the intensity results. This study used the results of the intensity as the main output on the ten principal causes of delay in road construction projects, since this result showed the overall ranking of the cause of delay in the consideration as to how it was ranked in the countries.

This study reaffirms the saying, *“There is more wisdom to be found in an old person than in a clever one,”* highlighting the necessity to employ construction experts, which is a factor that the construction sector should focus on to avoid the most significant causes of delay in terms of road construction projects. Their expertise and knowledge with regard to the construction sector will help achieve the goals faster due to their previous experiences. After analyzing the results of this study, the researchers drew the following conclusions and recommendations to address the top ten factors for delay in road construction projects:

- Construction manager’s primary duties include planning construction projects and overseeing their progress in a well-timed and cost-effective manner. They are responsible for the budget, organization, implementation, and schedule of the projects. These skills are honed through immense exposure that requires technical experiences in managing construction projects.
- Poor planning and administration of the construction projects might lead to several adverse effects on the project duration. Construction delays and duration issues are frequently responsible for transforming productive ventures into failures. These delays can be reduced or prevented by appropriate pre-project planning and effective project management, since they are critical success aspects for completing the construction project.
- The implementing agency must address the disputes in land acquisition for road construction projects prior to implementation. The land must already be acquired so as not to cause any delay at the construction stage.
- Effective communication is critical for the success of any construction project since it can improve collaboration and lead to better project partnerships. Deprived communication may result in misunderstanding, delays, and other problems during the project work. It is important to determine a chain of command for communication in a construction project. These are usually spelled out in the contract documents and typically require the owner and general contractor to communicate with each other. Effective communication promotes the successful implementation of a construction project. Problems and delays may occur when construction parties stop communicating or replying to queries. When everyone is cooperating and communicating well, projects should run smoothly and be completed on schedule and within the budget. Planning is very important in project implementation because improper planning could lead to a delay. The authors often find that planning personnel are rushing to complete their tasks, so the plan they produce is prone to contain errors. Although changes in some aspects of the plan are quite common in road construction projects, alterations made to almost the entire plan poses a major problem. This is either because the designer was not able to develop the blueprint properly or there is something wrong with the survey data that they gather during the planning stage.
- The shortage of equipment is certainly a major problem in implementing road projects in all developing countries. The reason is that during the procurement process, the adequacy of equipment from the contractor was not properly reviewed. They were not able to check that the equipment pledged in the project was already committed to some other projects of the contractor. Therefore, it is recommended that proper checking of the pledged equipment is conducted by the evaluators during the qualification stage of the procurement phase.
- It is almost impossible to predict the occurrence of natural disasters, which could, among other things, impact road projects. Delays associated with such events can be avoided by incorporating certain precautionary measures in the preparation stage. It is necessary to create a proper plan and schedule to conduct construction activities in extreme field conditions. Since most road projects

are scheduled during the rainy season, it is recommended that the government and contractors must consider what project activities are appropriate during such conditions [42].

- A significant number of contract modifications (even some unforeseen work) can be avoided during the pre-construction phase (planning and design stage) of a project's life cycle. In the public sector, it may not be possible to have a contractor do a constructibility review prior to award due to restrictions on bid work. Procedures to reduce design error and omissions are being conducted, such as a formal review process of plans and specifications, pre-bid conferences, and quality management programs during design [43].
- In reference to the execution of the progress billing of the contractor, it is crucial that those who are in charge of the finances of a specific project must evaluate and monitor the cash flows properly and foresee the financial requirements of the project. Progress billing requirements for governments are arduous, and it takes a considerable time for the finances to be released. To avoid a shortage of construction materials, the contractor must always have a contingency fund.
- Shortage and delay in materials supply are argued to be one of the most important factors that lead to delay in construction project delivery globally. The most important cause of the shortage of materials relates to the origin or availability of construction materials. On the other hand, the most influential cause of delay in material supply was found to be poor materials procurement and the inventory management system, which has other underlying reasons such as late identification of the type of materials needed [44]; however, this is deemed avoidable. The impact of late payment translates to a delay in the progress of the project. It will affect the schedule and budget of the work. Thus, clients should search for co-investors for support on financial assurance. Working closely with the stakeholders as a team in the project is recommended to respond to problems easily expected in contract payment procedures [45].
- Productivity remains a fascinating and dominant matter in the construction area. It assures cost savings and the practical use of resources. Without adequate and efficient human resources, it is not feasible to proceed with a construction project. Hence, there is a need to ensure that labor offers the best input for achieving the project goals [46].

The outcome of the construction of a road is the improvement of the connectivity of a country; therefore, it improves productivity. The results found in the present investigation showed that there is a clear pattern between developing countries, the existence of changes in the design, and the lack of human capital for the proper management of the construction. It represents an opportunity to improve the quality of the studies. Several actions can be done to overcome this issue. One of those can be the adoption of new technologies such as Business Intelligence Modeling. In reference to the lack of experts in construction management, the private sector and the public sector must improve the training to the human resources in the field of construction management.

## 6. Recommendation and Limitation

Overall, the present investigation has three main limitations. First, the data gathered from previous studies about delay causes in road construction projects are made by qualitative perceptions collected from surveys. As a result of that, the present researchers were unable to find the fixed and variable effects (pure meta-analysis process). The second limitation of the research that is related to the data is its accuracy. The foundations of the present investigation are supported by the assumption that previous studies in each country have been elaborated following the proper process. Finally, the last limitation of this investigation is related to the scope of the investigation. There are several types of roads; however, due to the lack of data, the present researchers could not find the exact typology of the roads (rural road, urban roads).

As a recommendation for future studies, the authors strongly recommend to future researchers to make one step further and investigate the exact contribution of each cause to the delay in one road project. The recognition of this will help both private and public sectors in the provision of

better services. In the case of the public sector, it will help to recognize bottlenecks in the process for road construction and take actions to overcome those, providing the service of transport in the programmed time. In the private sector, the identification of these causes may contribute to improving the construction process and taking action to overcome cost overrun.

In summary, as a limitation, this study has not discussed the methodologies that were used in the reference journal studies conducted on road construction delay in developing countries. Therefore, it is suggested to review various methodologies used in delay studies to determine the most appropriate methods of identifying the causes of delay in the implementation of road projects.

**Author Contributions:** L.R. and H.B. contributed conceptualization; L.R. and H.B.J. contributed data curation; L.R. and H.B.J. contributed formal analysis; L.R. and H.B. contributed original draft writing; L.R. and H.B.J. contributed investigation; L.R. and H.B.J. contributed methodology; C.Y. contributed project administration; C.Y. contributed supervision; C.Y. contributed visualization; C.Y. contributed writing, reviewing, and editing. All authors have read and agreed to the published version of the manuscript.

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## Appendix A

### Causes of Delays by Typology

Delay cause	Typology					
	By Its Level of Importance		By Predictability		By Compensation	
	Critical	Non-critical	Excusable	Non-excusable	Compensable	Non-Compensable
Inflation	X		X		X	
Political situation	X		X		X	
Force majeure	X		X		X	
Lack of proper IT management		X	X			X
Disruption of traffic movement		X	X		X	
Obstruction of economic and urban development	X		X		X	
Shortage of fuel	X			X		X
Shortage of foreign currency (importation of materials and equipment)		X	X		X	
Effects of unforeseen subsurface and changing ground condition (e.g., soil, high water table) factors	X		X		X	
Environmental claims	X		X		X	
Economic hardships		X	X		X	
Slow decision-making and bureaucracy in non-client organization			X		X	
Road right of way	X		X		X	
Peace and order	X		X			X
Government change of regulations and bureaucracy	X		X		X	
Economic conditions; local or global	X		X		X	
Accident during construction	X			X	X	
Poor communication between construction parties	X			X		X
Disputes		X	X		X	
Discredit the Ministry of Works among the people and in the press	X		X			X
Arbitration	X			X		X
Breach of contract	X			X	X	
Litigation	X			X		X
Total abandonment	X			X		X
Changes in the duration of contract period		X		X		X

	Typology		
	By Its Level of Importance	By Predictability	By Compensation
Delay in relocating utilities		X	X
Official and non-official holidays		X	X
Delays in accomplishment progress billing		X	X
Technical complexity/size of project	X		X
Insufficient inspectors;	X		X
Financial issues with the bank		X	X
Delayed payment to contractors		X	X
Delay in paying compensations (landowners)	X		X
Delays in decision making by owner	X		X
Slow decision making and bureaucracy in client organization	X		X
Protracted financial processes in client organizations	X		X
Contract modification	X		X
Financial difficulties of owner	X		X
Lowest bidder selection	X		X
Low performance of the bidder	X		X
Delay in progress payments	X		X
Owners lack of experience and involvement	X		X
Delay in approving overall designs, shop drawing, sample tested materials, and major changes in the work	X		X
Underestimation of labor force	X		X
Change in quantities	X		X
Schedule slippage	X		X
Underestimating on-time completion	X		X
Frequent changes in design	X		X
Inadequate planning/scheduling	X		X
Incomplete drawing	X		X
Delay in relieving environmental impact	X		X
Inaccurate cost estimation	X		X
Unclear and inadequate details in drawings and also slow response to doubts arising from the drawings	X		X
Lack of experience construction acquisition equipment manager	X		X
Low tender price		X	X

	Typology				
	By Its Level of Importance		By Predictability		By Compensation
Poor labor productivity	X		X		X
Rework from poor material quality	X			X	X
Impact on people's land along with the road construction project	X		X		X
Shortage of equipment	X			X	X
Poor qualification of the contractor	X			X	X
Health problems of technical staff and project teams		X	X		X
Lack of modern communication equipment		X	X		X
Cost overruns	X			X	X
Delay of other projects related to the main one	X			X	X
Rework	X			X	X
Changes in material types	X			X	X
Lack of adequate manpower	X			X	X
Shortage of construction materials	X			X	X
Shortage of technical personnel	X			X	X
Delay in site mobilization	X			X	X
Shortage on labors	X			X	X
Delays in payment by the contractor	X			X	X
Labor disputes	X			X	X
Unreliable sources of materials on the local market	X			X	X
Inadequate assignation of manpower	X			X	X
Less of project engineer experiences	X			X	X
Lack of traffic safety during construction	X			X	X
Fluctuation on resource	X			X	X
Financial difficulties of contractor	X			X	X
Summer restriction on time of work		X		X	X
Less of structural engineer experiences	X			X	X
Low educational level of manpower		X		X	X
Delays in sub-contractors work and their incompetence, which leads to frequent changes in sub-contractors	X			X	X
Lack of experience of the construction manager	X			X	X

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