



CAUSES OF DELAY IN CONSTRUCTION OF HIGHWAY PROJECTS: A REVIEW

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ABSTRACT

Construction is an essential process for all of the developing countries. Moreover, highway and infrastructure construction projects are rigid development in a country. Delay is a common phenomenon in the construction industry which directly impacts the cost and quality of the project. Delays can only be reduced when the causes and its influences are identified and analyzed. In the past, most researchers have been working on finding the causes of delay in the construction project through several method and analysis. Nevertheless, the study on the delay causes and its influences towards the infrastructure and highway construction project is still limited and require more precise attention on it. The main objective of the study is to find the significant factors causes delay in the construction project especially in highway and road construction projects. Thus, the review methodology based on the frequency of occurrences of the factors causes delay in the highway and road construction project were significantly analyzed. This paper contributes a deep review on the factors that cause delay in the construction industry especially in the construction of highway and road projects. The top most significant factor causes delay in construction project was poor project planning and scheduling with the highest frequency of occurrences and percentage value which is 25 and 2.5% respectively. Therefore, this findings will be useful for future planning and time management in order to minimize the delay occurrences on the highway and road construction projects.

Key words: Delay, Cost, Quality, Construction, Highway

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1. INTRODUCTION

Construction is one of the vibrant engineering industrial activities in Malaysia. According to [1],[2] six to nine percentage of the developed countries' gross domestic comprised of construction industries. Thus, in Malaysia, construction industry plays a vital role in positive growth of the economic as well as in improvising the nation's standards of living. Nevertheless, construction delay is a common issue that occurs locally as well as globally. It has become the major problem faced by construction projects worldwide. However, delay factors differ from a country to another, from a construction project to another and from a construction type to another due to the project's conditions and circumstances [3]. Moreover, [4] stated that the construction projects in India were averagely 55% of schedule overrun compared to actual planned duration. Thus, the main objective of this paper is to investigate on the factors that cause delay in the construction industries especially in highway and road projects.

2. DELAY

The output of construction projects mainly depend on the performance during the project duration. According to [5], 70% of the construction projects in United Kingdom were delivered late from the planned schedule. This occurred due to several factors such as external factors, project complexity, incompetent project management, and unrealistic estimates. In addition, as stated by [6], 97% of the projects in Saudi Arabia encountered delay in the construction project scheduled especially for road and bridge construction projects. Furthermore, a study conducted in Sri Lanka summaries that road construction projects faced delay of about 60% from the estimated duration at the planning stages [7].

Generally, there are three types of delays namely non-excusable delays, excusable delays and concurrent delays as illustrated in Figure 1. [8][9]. Apparently, non-excusable delays are caused by contractors or supplier where the owner is not at fault. Excusable delays are divided into two categories which are compensable and non-compensable delays. Compensable delays are caused by owner or the owner's agents. Meanwhile, non-compensable delays are caused by third parties or incidents beyond the control of the owner and contractor. This delay is also declared as "acts of God" since such delay are not the direct responsibility of fault by any specific party [8],[9],[10]. Concurrent delays are common delays in construction projects. It occurs when more than one factor is identified to delay the project at the same time or in overlapping periods.

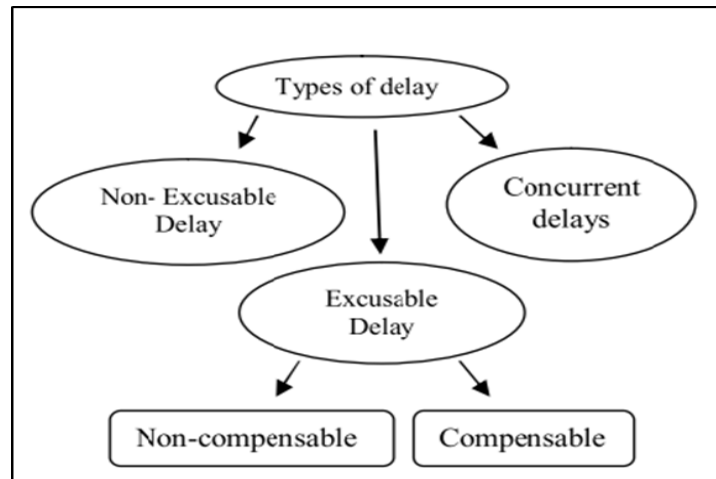


Figure 1 Types of delay [8]

2.1. Causes of Delay

This study reviews on causes of delay in construction projects as summarized in Table 1. In addition, the delay cause factors have been classified accordingly into several construction phases in accordance to Project Management Book of Knowledge (PMBOK) which was established widely.

Table 1 Summary of studies on causes of delay in construction projects

Phases	Factors cause delay	Source of references
Initiation	<ul style="list-style-type: none"> -Financial problems -Improper of project feasibility study -Underestimation of project cost -Land acquisition -Political interferences -Site location -Time spent to hire appropriate contractors for each task -Fluctuation of costs(economic issues) 	[3],[4],[6],[7],[8],[11],[12],[13],[14],[15],[16],[17],[18],[19],[20],[21],[22],[23],[24],[25],[26],[27],[28],[29],[30],[31],[32],[33],[34],[35]
Planning	<ul style="list-style-type: none"> -Delay in handing over site to contractor -Delay in project documents/drawings approval -Misunderstanding of the project requirements -Poor project planning and scheduling -Poor site investigation -Delay in conducting the field survey -Shortage in labour due to remoteness of site location -Shortage in skilled and experienced labour -Contract modification & renewing -Delay in awarding contract -Tendering system that obligates the choice of lowest bidding -Mistakes, errors & discrepancies in contract document -Late machinery & equipment procurement 	[3],[4],[6],[7],[8],[11],[14],[15],[16],[17],[18],[19],[21],[22],[23],[24],[25],[26],[27],[28],[29],[30],[31],[32],[33],[34],[36],[37],[38],[39],[40],[41],[42],[43],[44],[45],[46]

<p>Execution</p>	<ul style="list-style-type: none"> -Lack of proper machinery & equipment -Slow mobilisation of equipment to site at early stage of construction -Delay in material procurement -Shortage of local materials -Delay in special manufactured materials (imported materials) -Late approval/permission/permits by authority -Cultural and heritage issues -Unclear project scope -Improper organizational structure -Location of site from material storage -Lack of experienced contractors -Conflicts in work schedule -Delay in site preparation -Slow decision making -Delayed payments to contractors/consultant -Scope changes during construction -Additional work during construction -Changes in material types and specifications during construction -Design changes -Unclear and inadequate details in drawings -Mistakes and discrepancies in design documents -Subcontractor's problem -Improper construction method -Delay in shop drawings and sample material approval -Delayed payments to sub-contractor/supplier -Design changes due to construction mistake -Poor/incompetent performance of contractors -Old technology/ method used -Rework/defective work due to errors -Labour disputes and strikes -labour absenteeism -Low productivity of labour -Late salary to labour -Unskilled machinery/equipment operators -Frequent changes of labour -Problems related to transportation of machinery/equipment to site -Delay in delivery of machinery/equipment by supplier -Machinery/equipment failure -Problem related to transportation of material to site -Delay in delivery of material by supplier -Changes in government regulations and law -Weather condition -Underground utilities 	<p>[3],[4],[5],[6],[7],[8],[10],[14],[15],[16],[17],[18],[19],[20],[21],[22],[23],[24],[25],[26],[27],[28],[29],[30],[31],[32],[33],[34],[35],[37],[38],[39],[40],[41],[42],[43],[44],[45],[46],[47],[48],[49],[50],[51],[52],[53],[54],[55]</p>
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<p>Monitoring & Control</p>	<ul style="list-style-type: none"> -Topographical conditions -Natural disaster -Emergency works -Disruption due to local demand -Litigation -Public interruption -Poor communication and coordination between project parties -Poor telecommunication networks -Unpredictable site conditions -Geological and geotechnical condition -Limited/inconvenient site area -Limited availability of proper testing facilities -Accident/safety & health issues -Project complexity -Lack of temporary facilities/utilities on site (buildings, electricity, etc.) -Improper technical information on site -Accessibility problem at site -Project size -Blockade of access road to site -Poor condition of access road to site -Conflicts between owners, contractors, and other stakeholders -Poor project monitoring and control -Ineffective delay penalties -Delay/ lack of site supervision/inspection -Poor site management -Low quality in material -Shortage of technical & site staff -Cooperation issues(performing inspection and testing) 	<p>[3],[4],[6],[7],[8],[14],[15],[16],[20],[21],[23],[25],[26],[27],[28],[29],[30],[31],[34],[37],[38]</p>
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As mentioned earlier, the methodology that being used for peer review on the causes of delay in the construction project is by the significant frequency of occurrences of the factors in the construction projects. Therefore, the top twelve significant factors towards the study as listed in the table 2 as below. Furthermore, the percentage calculation based on the frequency analysis has been done for each of the significant factors as shown in table below.

Table 2 Significant factors causes delay in construction projects

Significant factors causes delay in construction projects	Source of references	Frequency of occurrences	Percentage
Poor project planning and scheduling	[3],[4],[6],[7],[8],[9],[10],[13],[15],[16],[17],[20],[22],[28],[29],[30],[34],[39],[41],[46],[47],[50],[51],[52],[53]	25	2.5%
Design changes	[4],[5],[6],[8],[9],[11],[12],[14],[15],[20],[21],[22],[24],[25],[26],[29],[33],[42],[43],[48],[49],[50],[51]	23	2.21%
Underground utilities	[3],[4],[6],[10],[13],[19],[20],[21],[27],[30],[31],[38],[39],[40],[42],[46],[47],[48],[49],[52],[53],[54]	22	2.12%
Additional work	[4],[6],[14],[17],[20],[21],[22],[23],[24],[26],[27],[29],[30],[32],[33],[37],[40],[42],[44],[49],[50],[53]	22	2.12%
Shortage of materials	[4],[7],[8],[9],[11],[16],[18],[21],[22],[26],[27],[32],[33],[36],[37],[40],[41],[44],[45],[50],[53]	21	2.02%
Failure of material and equipment	[3],[4],[7],[10],[12],[17],[20],[21],[24],[27],[28],[30],[31],[33],[39],[38],[39],[45],[46],[48]	20	1.92%
Poor communication and interaction	[6],[7],[13],[16],[17],[19],[20],[23],[25],[28],[29],[31],[32],[34],[39],[40],[44],[45],[51]	19	1.83%
Labour issues	[3],[5],[8],[10],[11],[14],[15],[19],[22],[26],[27],[29],[30],[32],[33],[34],[40],[45],[46]	19	1.83%
Weather	[7],[8],[9],[12],[13],[19],[20],[22],[25],[29],[30],[32],[33],[35],[37],[38],[52],[53],[54]	19	1.83%
Improper construction method	[3],[4],[11],[14],[18],[23],[24],[25],[29],[34],[37],[38],[42],[43],[44],[47],[49],[52]	18	1.73%
Inexperienced contractors	[3],[9],[14],[15],[18],[20],[22],[23],[27],[31],[35],[36],[38],[39],[43],[46],[50]	17	1.64%
Poor site investigation	[3],[4],[7],[11],[12],[19],[23],[25],[29],[33],[37],[40],[42],[43],[44],[56]	16	1.54%

Thus, based on rigid literature review conducted, the top most significant factors with higher frequency of delay occurrences were found to be in the highway construction projects. As shown in table 2, the significant delay factor causes are identified to begin with poor project planning and scheduling, followed by frequent design changes, existence of many underground utilities, unforeseen additional work, shortage of materials, failure of material and equipment, poor communication and interaction, labour issues, weather, improper construction method,

inexperienced contractors and poor site investigation. According to [15], poor planning was one of the rigid factor that causes delay in the construction projects. Proper planning is an essential task in all construction projects regardless of its type [28]. Thus, [28],[29] emphasis that when the planning goes in a wrong direction, the project will definitely be unsuccessful in terms of completion time and budget. Moreover, [13] also declared that improper planning was the top most factor that causes major delay in construction of road projects in Palestine. In addition, [30] mentioned that inadequate planning and scheduling are typical delay risks in highway and road construction projects which frequently occurred in construction projects of Peninsular Malaysia.

Furthermore, [50],[51] stated that design changes is a critical risk that will influence the entire project schedule. In fact, design changes during the construction yields many inconveniences to the project that definitely delays the project completion time [48]. In addition, [49] analysed that design changes is one of the top most factors that delay highway construction projects in Taiwan. For instance, the design agreed by the client and consultant will be changed during the construction period or just before the construction begins due to ignorance of certain municipal rules. This would result to massive delay in the entire progress of the project. In Malaysia, [24] stated that design changes during execution of construction work was ranked as a crucial factor that affects the duration of road construction project in Perak.

Underground utilities is typically a barrier to successful completion of construction project allocated within the planned timeline [21]. In Kenya, [52] found that existence of underground utilities were critical factor that affects the project duration. The route along a highway construction project would have hidden sources that require relocation and result to consuming extra time. Hence, this frequently occurred in the construction projects in Kenya. Based on [6], factor on underground utilities was rank as fourth in severity since it occurred in nine cases at an average 48% of time extension on the effected highway projects in Saudi Arabia.

Besides that, [53] stated that one of the main cause that delay the construction of highway projects in United States is due to incurred additional work which was differed from planned work. A study has been conducted to prove that 50 % of the construction projects in Egypt exhibited delay due to rework [44]. Generally, rework caused many inconveniences at all circumstances in construction projects where time, cost and quality will be affected [33]. Thus, rework occupies extra time and causes massive delay in the progress of construction projects. On the other hand, numerous studies have found that the issues of construction materials caused tremendous impact towards completion time of construction projects [27],[44][45]. Shortage of basic construction materials such as sand, cement, stones, bricks, iron, and asphalt will lead to major delay in the work progress since the construction project has to be on hold until the arrival of the construction materials. A study conducted in Nepal stated that delay in material arrival in highway projects will lead to time and cost overrun [36]. Moreover, construction material such as asphalt used in road projects could not be stored before the construction begins, since asphalt is very sensitive to temperature. This is a challenging factor that causes delay in the entire construction of road projects [4],[11].

In addition, machinery and equipment failure produces negative effects toward the construction industry [3]. For example, poor handling of machinery and equipment will result to machinery failure, thus causing performance of the entire project to be delayed. Construction of roads involved many machinery and equipment. In cases where machinery and equipment are faulty, work progress of the project has to be temporarily stopped while waiting the arrival of another machinery. This is a major delay factor at most of road projects in India [4].

Consequently, [13], [34] mentioned that construction projects in Afghanistan and Saudi Arabia were delayed from the scheduled, mainly due to poor communication and interactions among the involved parties. This factor is ranked at the top 5th among many other factors. For example, some of the workers in the construction site may not be able to converse in the country's native language. This would result to difficulties faced by other involved parties and become a barrier to successful completion of the project within the planned duration [40].

Furthermore, [14] emphasis on labour issues which lead to many inconveniences such as delay in construction projects in Norway. [8],[15] declared that labour related factors such unskilled labour, labour absenteeism, labour strikes and disputes were crucial risks and challenging in Malaysia's construction industries. A study in Egypt has concluded that shortage of skilled labour is a severe factor that influences the construction project in terms of time and cost [3]. Indeed, a study conducted by [34] established that poor qualification and unskilled labours were the top three factor at relative importance index of 0.831 that contributes delay in the construction project. For instance, construction of road project would be different as compared to other ordinary construction projects and requires workers with certain skills in order to produce the expected quality on site. Subsequently, frequent changes in labour indirectly report negative output especially in highway and road projects [22].

Above all, weather is one of the major causes of delay in many construction projects particularly in road and highway projects [12],[13],[52],[53],[54]. In Canada, due to continuous raining, work at road construction site was stopped where even partial of the completed work at the road shoulder was washed out [53]. [35] found that in Surabaya, weather is known to be a natural risk in the construction projects especially in road and highway projects where the overall process is expose to the surroundings. In Pakistan, weather is one of the severe factors that cause delay in construction project where machinery failure occurred during sudden raining situation [32]. In addition to raining, extremely hot weather during summer that exceeds 49°C also influence the construction projects of highway and infrastructure in Bahrain[12].

Method of construction plays an important role in the construction of road and highway projects as it differs from constructions of residential or high rise projects [44]. In particular, construction of road project is very unique since the construction method is irreversible and any wrong procedures would require rework from the beginning such as milling and paving. This will definitely extend the duration of work[3]. [42] declared that deficiencies in the construction methods in Sri Lanka, was a rigid interrupter for a successful construction project in terms of its time performance.

Experience is vital in the construction industry as it comes with valuable knowledge that could not be obtained from other sources. Inexperienced contractors are one of the factors that will create havoc in overrun time of a construction project. Based on study by [9], it was found that incompetent and inexperienced contractor are the fourth top most factor in mean ranking that delay timeline of the construction project. Indeed, contractors with lack of experiences will face difficulties in understanding the complexity of construction project leading to misinterpretation and confusion and might not be able to cope with progress of the project [3], [14]. [15] found that lack of experienced contractors is very risky in the construction industries, proven by experimental surveys conducted. Furthermore, past studies in Jordan, had revealed that inexperienced contractors is a critical factor that contributes to time overrun in construction project [46]. For instance, lack of suitable technique in the construction might slow the work progress and directly affects the project schedule. In fact, [55] stated that the factor of inexperienced contractor is interrelated with the risk of unskilled labours as many inexperienced contractors may not be able to hire skilled labour due to issues such as visa, work

permits and licences which negatively impacts the construction project and indirectly affects the schedule. In a nutshell, it shows that experience plays an important role in the construction project as it reflects the performances of the entire projects.

In addition, site investigation is one of earliest process and very essential in any types of construction in order to execute a project successfully within the cost and timeline [56]. However, most studies adopted poor site investigation which became barrier in many construction projects particularly for road and highway projects. In most highway projects in India, poor quality of site investigation conducted is considered as one of the key failures where the importance of such investigations is undeniable and cannot be taken for granted [4],[12]. Besides that, delay in construction work progress attributed to cost overrun at many highway projects in Slovenia [44]. This is mainly due to poor site investigation conducted at the early phase of the project that delays the construction work [44]. Thus, it highlighted that neglecting proper site investigation will result to various hassles in the project which definitely affects the project schedule.

3. CONCLUSION

This study reviews the factors that cause delay in the construction industry particularly for road and highway projects worldwide. Thus, it involved about 92 factors consisting of various construction phases. Based on this review, the top most common and frequently occurred factor that cause delay in the construction projects particularly for road and highway projects is the poor project planning and scheduling. The frequency of occurrences of the factor in the construction projects and the percentage value was 25 times and 2.5% respectively. Therefore, this review is of utmost important in construction industry especially in highway and road construction projects.

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