Analysis of Delay Factors in Construction Project Using RII Method

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Abstract: Project delay is considered one of the most common problems causing a multitude of negative effects on the project and the parties involved in a construction project. This paper aims to identify the main causes of delay in a construction project from the perspective of procurement officials and civil engineers taking the case study of Government Funded Projects within the Dewathang area. The literature review was conducted to assemble the list of delay reasons and measure to minimize the delay. In this study, it captures the interviews of 32 respondents (8 procurement officials, 8 Project Managers, and 17 civil engineers) through a survey questionnaire using google form. The MS project software was employed to determine the time duration of the selected projects and subsequently, the data analysis was done using the RII method. From the findings, the top 10 most common factor causing the delay; 5 factors from procurement and civil engineering with the highest ranks have been listed. Also, the highest rank measure to reduce delays such as proper project planning and scheduling; awarding bids to the right contractor; proper site management & supervision; and properly use of modern construction equipment are effective measures suggested to minimize construction delay.

Keywords: Project Delay, Time Overrun, Cost Overrun, MS Project and RII Method

Introduction

The delay in construction projects could be defined as the excess of time beyond the actual time stipulated in the contract parties agreed upon for the accomplishment of the project(Shahsavand et al., 2018). When there is a delay within the dated project time frame, the total cost of the project will be increased for both contractor and the client, which might affect project sustainability. Furthermore, the time required to complete the project will be readjusted to be a longer date and hence, will lead to negative impacts on both the project duration and relationship between project parties.

Globally, a considerable amount of construction projects suffer time overrun and the effect of this time overrun may be of greater magnitude on the overall performance of the project. To minimize the effect and overrun, the reasons for the occurrence should be recognized(Bekr, 2018). In Bhutan the construction industry plays an important role in the national economy as in the 11th five-year plan, 60% of the total budget outlay was allocated for procurement, out of which 80% account for construction work(Nima, 2018). So, if there is a delay in a construction project, the Royal Government of Bhutan will induce huge national debts. Despite government investing huge budget in construction of infrastructure and providing concentrate efforts, the progress in terms of professional is very limited which lead to delay.

Therefore, this study aims to identify, rank and discuss the most prominent factors causing delay by using the MS project and Relative Importance Index method. The targeted respondents were project manager, procurement officer and civil engineer since they are the one who involved in all the construction projects. The analysis of the result was based on their observations from their experience in the past and present ongoing project in Bhutan.

Literature Review

Delay in a construction project can be defined as the late completion of work as compared to the planned timeframe or it's the time overrun or extension of period to complete the project and claims that it cannot be avoided(Hedaoo & Hatkar, 2016). Delay in the construction project is considered one of the most common problems causing many negative effects on the project and its active parties(T. Subramani, n.d.). Therefore, the delay is a state when the actual progress of a construction project is imperceptive than the planned schedule or late completion of the projects.

In the constructions industry, delays are due to poor contractor experiences, ineffective project planning and scheduling, poor site management and supervision, change in design were some of the crucial factors causing delay identified from a civil engineering point of view(Sivaprakasam et al., 2017). On the other hand, it is found that improper implementation of the legislative framework, funding, corruption, hostile operating environment, inadequate knowledge of practitioners of procurement methods and unbalanced economic environment are factors affecting construction delay from a procurement point of view(Ogunsanya et al., 2019). There are many factors causing delay and different researchers have identified the factors and the methods that could be adopted. It was also realized that the cost and time overrun were crucial intimidations of project delay. So far, no research has discussed the collaboration base on civil and procurement factors related to project delay.

The study has been made to overcome the problem in the study that encourage to collect the day-to-day data in site work i.e., starting time, finishing time and completed task are recorded in MS Project differentiating task and critical activity along with the delays produced and reasons for the delays(Kumar, 2018).

However, there has been no study made on various software with the highest rating to manage project management which includes practical analysis for the same.

Methodology

To conduct the feasibility study, firstly the factors that cause a delay in construction and methods of minimizing delay was listed down through previous literature reviews. A questionnaire survey was prepared to have twenty-one civil related causes, twenty-four procurement management causes and eight methods of minimizing delay.

Furthermore, the arithmetical method i.e., Relative Importance Index (RII) was used to analyze the data from the questionnaire survey by ranking the factor and finding crucial ones based on participant's replies. The RII is calculated for each factor and ranked accordingly with the mathematical expression given by:

$$RII = \sum_w / AN = 5n_5+4n_4+3n_3+2n_2+1n_1 / 5*N$$

Where, RII=Relative Importance Index, W=Weightage of individual factor, ∑W=Summation of all weight of each factor, A= Highest score and N=Total Respondents. In this study, the RII stages are set in between 0 to 1 ($0 \leq RII \leq 1$). The value 1 is the highest importance rating for the cause of delay.

To obtain the top five most principal factors causing construction delay a case study was conducted through an online interview in the form of a questionnaire survey. The average of the methods to minimize delay was calculated to obtain the best four effective methods. To determine project duration and prepare to schedule, a software called MS-project was used.

Data collection and Result analysis

The data collection was done from the questionnaire survey, case study and the work breakdown schedule. The quantitative approach was used to understand the perception of project managers, engineers and procurement managers towards factors influencing construction delay. Two sets of questionnaires were prepared using the Likert scale in google form i.e., civil related and materials and procurement related.

Analysis of questionnaire survey

From the targeted respondents of 30, the responses received for the civil related questionnaire were 17 within the range of two months. The responses were analyzed using the RII method and ranked to find out the most principal factors causing a delay in the construction projects in Bhutan. Similarly, from the targeted respondent of 20, the received responses for materials and procurement-related questionnaire were 16.

Causes of delay in construction projects

On analyzing the data collected from the targeted respondents using the relative importance index, the following result was achieved whereby the most principal factors with a crucial contribution to causes of delay were determined.

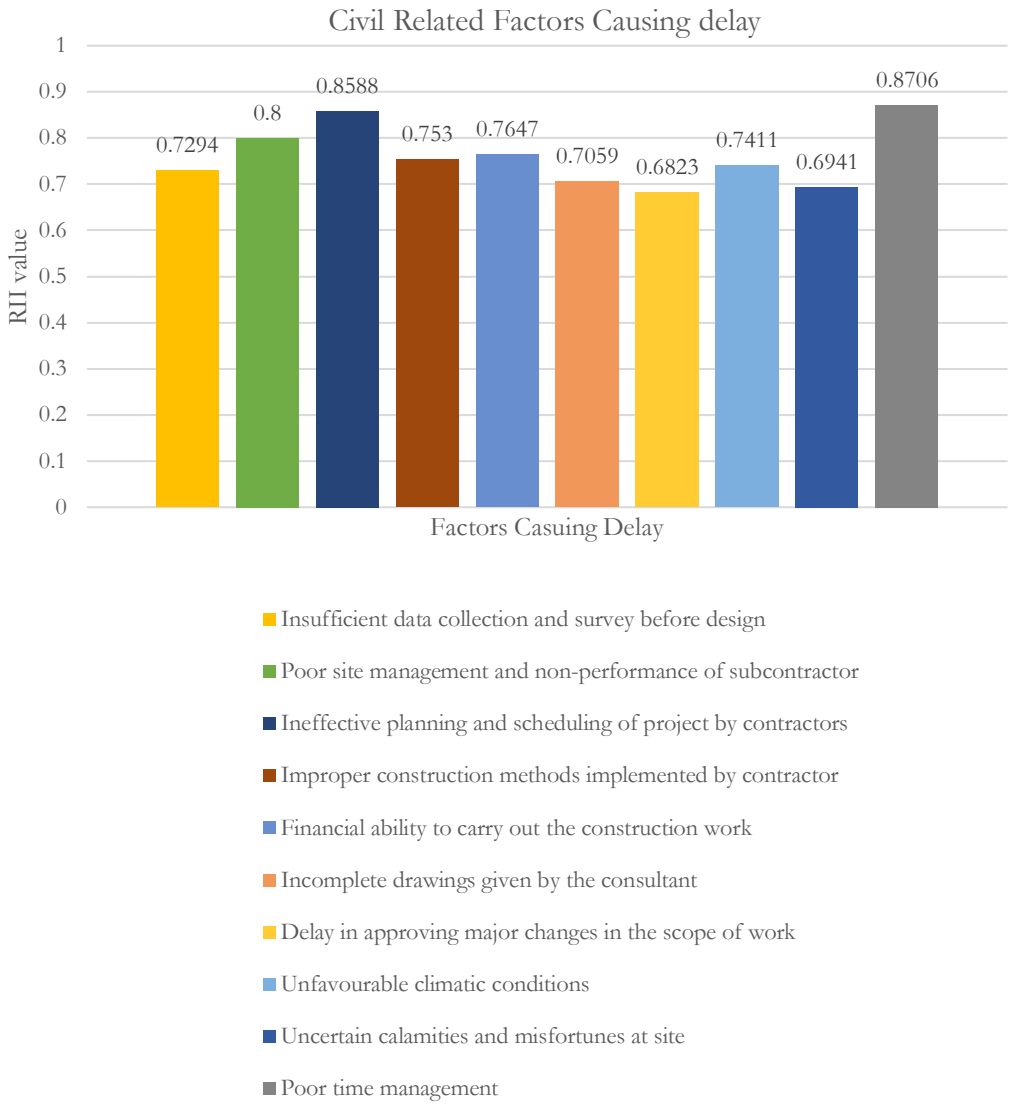


Figure 1. Civil related factors causing a delay in construction

The graph in figure 1. labels the ranking of civil related factors adding to a construction delay. On analyzing the factors by calculating their RII value and on ranking them, it was noted that of twenty-one (21) factors, the top five factors with their crucial contribution to delay are *poor time management, ineffective planning and time framing of projects by contractors, poor site management and non-performance of subcontractors, financial ability to carry out the construction work* and *improper construction methods practiced by contractors.* Figure 1, which exhibits the causes of delay in graphical form also indicated the minor factors causing a delay which are; *late*

bills payment, unstable relationships, sub-contractors with employees, conflict among Joint proprietorship and *unavailability of conveniences in site (such as water, electricity).*

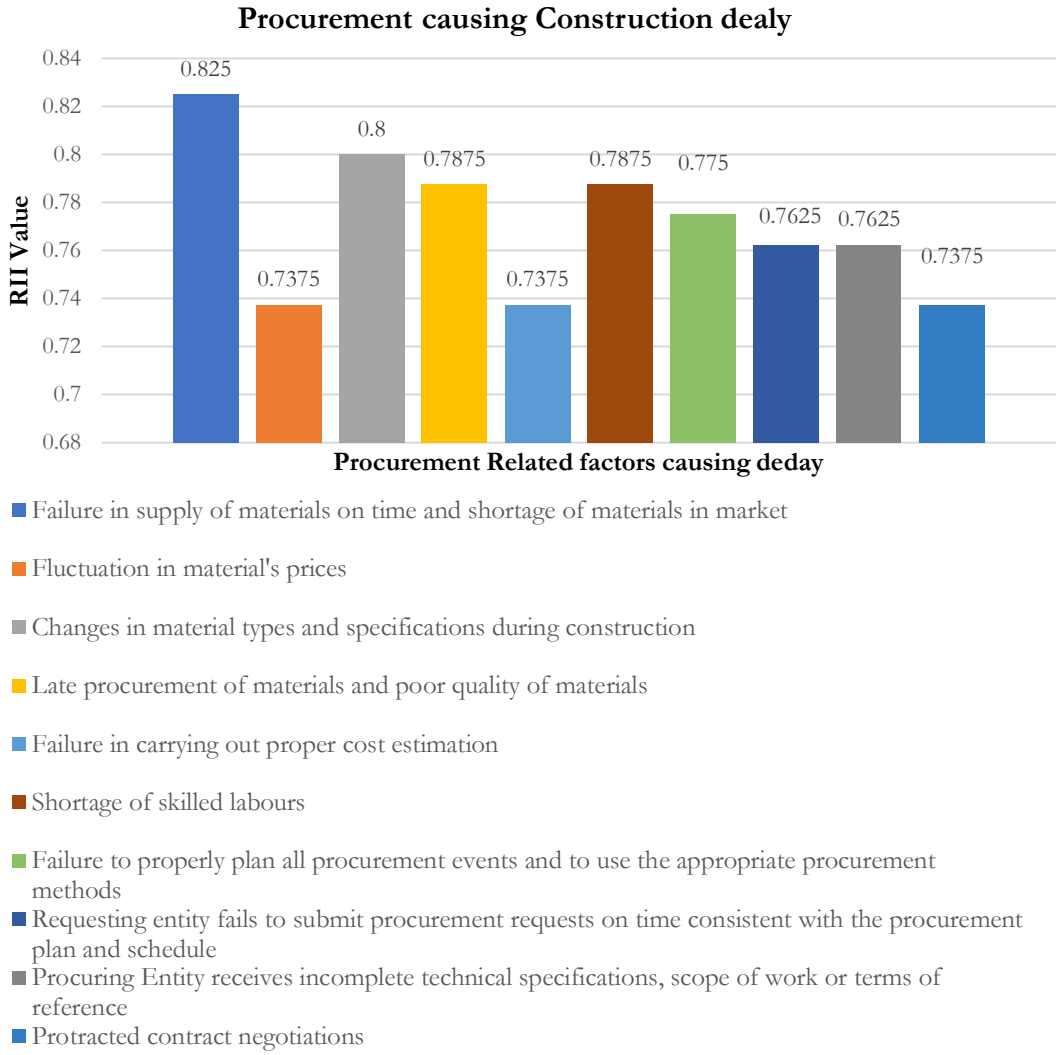


Figure 2. Procurement related factors causing a delay in construction

The graph in figure 2. describes the ranking of materials and procurement related factors contributing to a construction delay. On analyzing the factors by calculating their RII value and on ranking them, it was noted that of the twenty-four (24) factors, the top five factors with their crucial contribution to delay are a *failure in the supply of materials on time and shortage of material in the marketplaces (RII=0.825), changes in material types and specifications during construction time (RII=0.8), late procurement of materials and poor quality of materials (RII=0.7875), shortage of skilled labours (RII=0.7875)* and *failure to properly plan all procurement events and to use the appropriate procurement methods (RII=0.775).*

Top five crucial factors causing delay

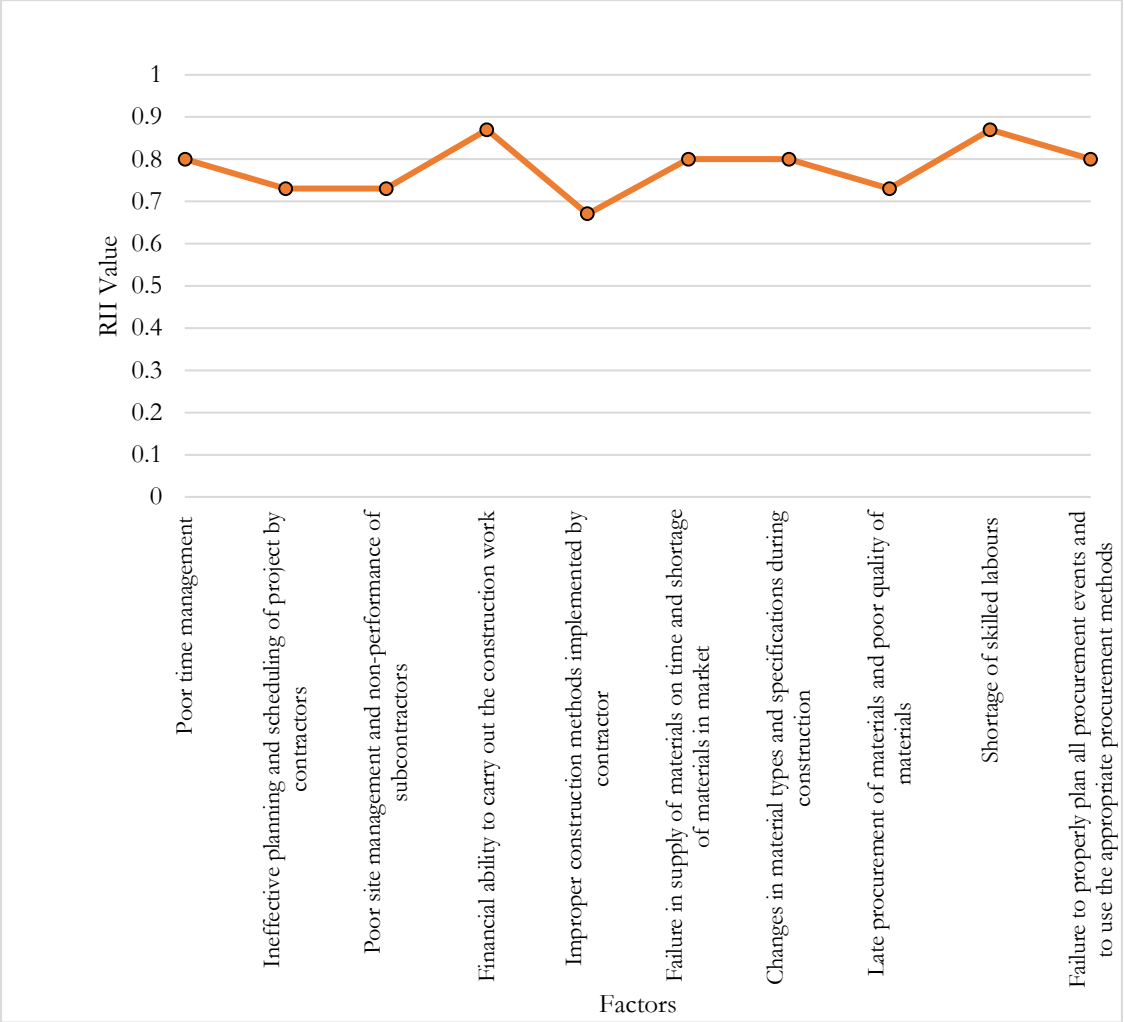


Figure 3. The crucial five factors causing delay in construction from case study

The above figure 3. describes the ranking of the top ten factors contributing to construction delay which is obtained from the civil related and materials and procurement-related questionnaire survey distributed among civil engineers and the procurement managers. As per the viewpoint of the project managers and engineer working at the construction of a hospital at Dewathang, the top five crucial factors contributing grossly to delaying construction project are*; Financial ability to carry out the construction works (0.87), Shortage of skilled labourers (RII=.87), Poor time management (RII=0.8)*, *Failure in the supply of materials on time and shortage of materials in the market (RII=0.8)* and *Changes in material types and specifications during construction (RII=0.8)*. The graph in the figure clearly shows the comparison of the factors concerning their RII value. The factor with a higher value of RII is ranked at the top as the most principal factor affecting the period of the construction project. The factors which are having the least RII value (i.e., Inappropriate construction methods

practiced by contractor, RII=0.67) is ranked the last, which states it has very less effect on the time duration of the construction project.

Measures to minimize delay

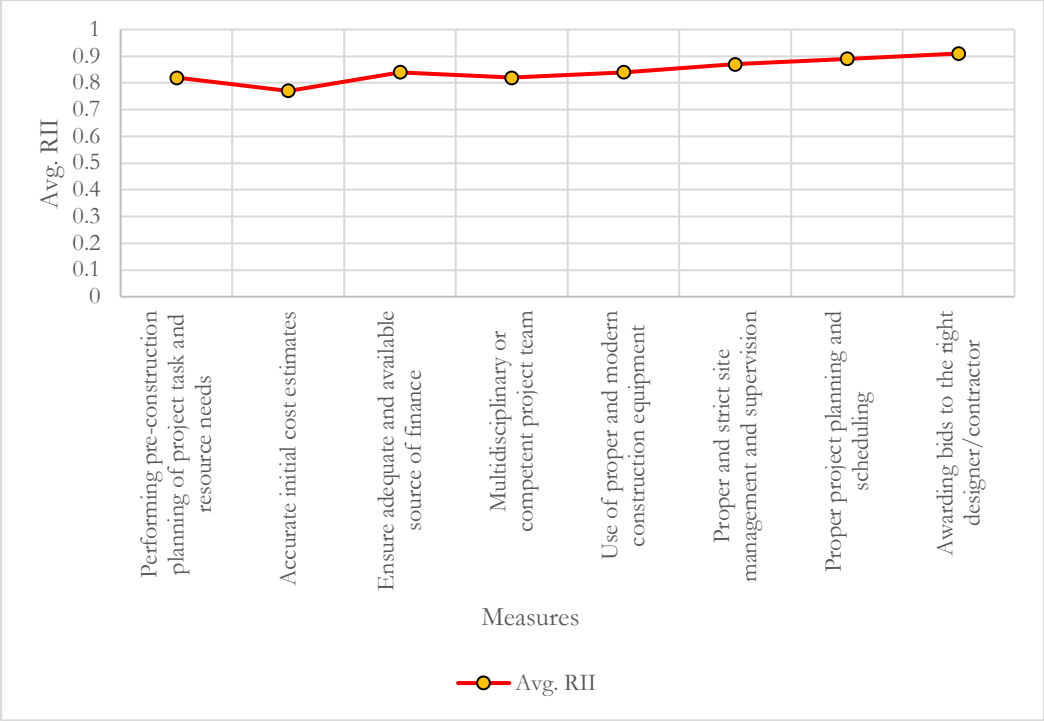


Figure 4. Top four effective methods of minimizing delay.

The above graph in figure 4. shows the calculation of the average RII value for the measures to minimize construction delay. The average of the RII value obtained from the questionnaire survey distributed to civil engineers and procurement managers and from the case study done vie interview questions, we have come out with the most suitable and effective methods of controlling construction delay in the Bhutan. The final top four measures are*; Awarding bids to the right designer/contractor (RII=0.91), Proper project planning and scheduling (RII=0.89), Proper and strict site management and supervision (RII=0.87)* and *Use of proper and modern construction equipment (RII=0.84)*. The graph in the figure shows the comparative analysis of the various methods that could help reduce future delays in any construction project if adopted correctly. The result displayed in the graph is based on the average RII value. The measure with the highest RII value is the most suitable method that any construction unit can practice to avoid future delay in construction.

When interviewing the project managers and engineers working in the construction of Dewathang hospital, it was found that the MS-Project is the most commonly used software for scheduling construction work activities and estimating the time required for completion. In the work schedule of the hospital, we have prepared, the time duration estimated for completion is approximately two years with two months of additional times for preparatory.

Conclusion

To summarized, the factors causing delays in construction projects were pointed out and ranked based on the Relative Importance Index from the valuation made by the project managers, procurement officers and civil-engineers. From the analysis part, the top five factors with the highest rank are related to the financial ability to carry out the construction work; shortage of skilled labours; poor time management; failure in the supply of materials on time and shortage of materials in the market; and changes in material types and specifications during project constructions.

This study also concluded that various measures such as awarding bids to the right contractor; proper and strict site management and supervision; proper project planning and scheduling; and use of proper and modern construction equipment are to be adopted to enhance the quality of construction projects in the region. Moreover, the researchers have suggested the construction firms to adopt the MS Project software which might determine the project duration.

Acknowledgement

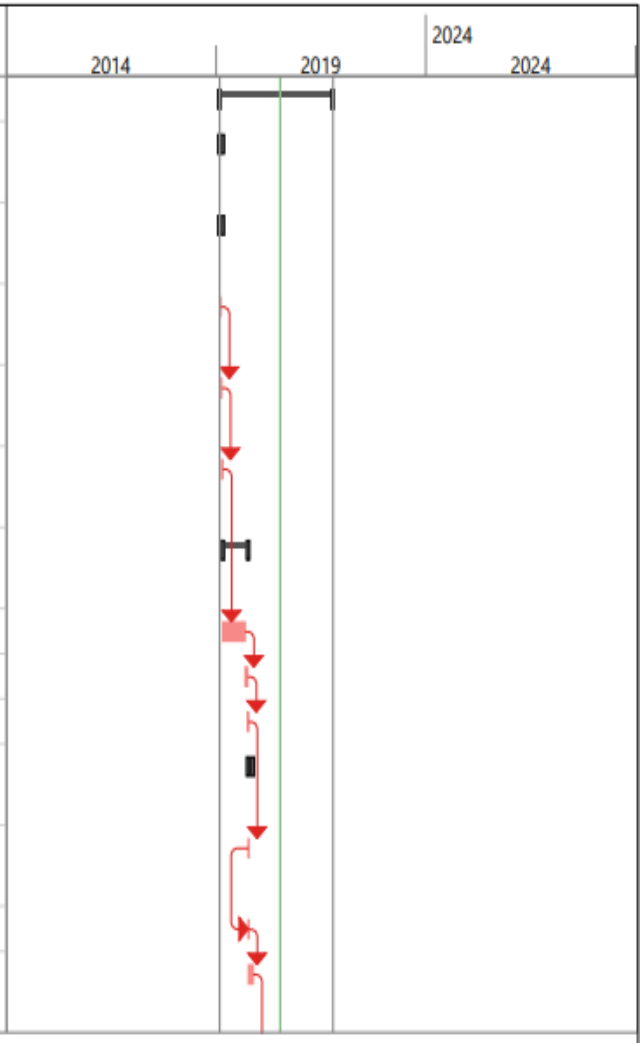
The accomplishment of this study could have not been possible without the participation and backing of so many people whose names may not all be reckoned. Their involvement is sincerely cherished and appreciatively acknowledge. Therefore, the team would like to express our special thanks of gratitude to the college management, project coordinator Mr. Kul Prasad and Mr. Jigme Tenzin, our project guides Mr. Sanjit Kumar Bhattarai (Associate Lecturer of Department of civil engineering and surveying) and Mr. Pema Wangchuk (Associate Lecturer of Department of Humanities and Management) for providing their both insight and wide range of knowledge they willingly shared with us during the study and writing our research. Further, we would like to extend our genuine gratitude to the respondents of the questionnaire survey (i.e., project managers, engineers and procurement managers) for contributing all necessary information in the achievement of the objectives of our study. We also convey our appreciation to library management staff and all the authors of the literature.

Conflict for interest: The authors declare no conflict of interest.

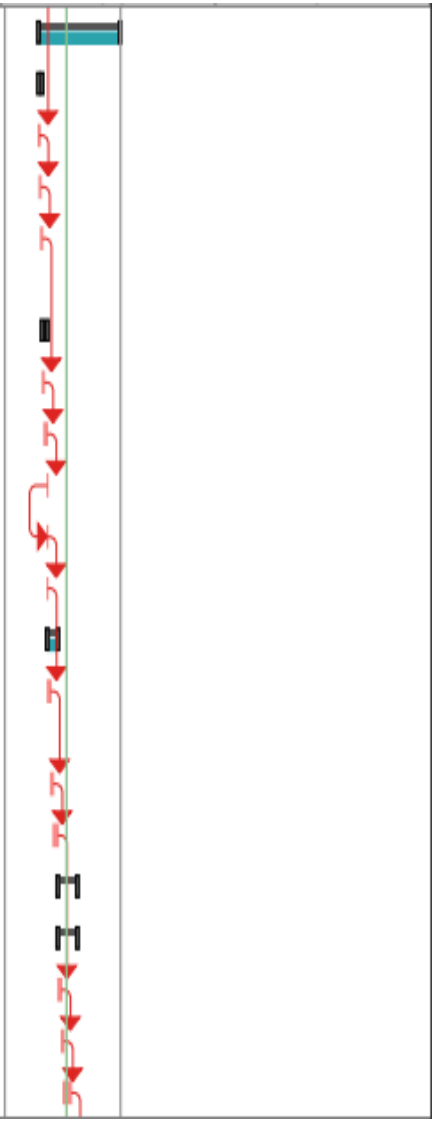
Appendix

Determination project time duration using MS-Project

ID	Task Mode	WBS	Task Name	Duration	Start	Finish
1		**1**	**Total Duration**	**704 days**	**Fri 01/02/19**	**Wed 13/10/21**
2		**1.1**	**Bid Procurement and Tendering**	**18 days**	**Fri 01/02/19**	**Tue 26/02/19**
3		**1.1.1**	**Contractors Pre-qualification**	**18 days**	**Fri 01/02/19**	**Tue 26/02/19**
4		1.1.1.1	Receiving Pre-qualification	6 days	Fri 01/02/19	Fri 08/02/19
5		1.1.1.2	Analysis of Pre-qualification	6 days	Mon 11/02/19	Mon 18/02/19
6		1.1.1.3	Selection of pre-qualified	6 days	Tue 19/02/19	Tue 26/02/19
7		**1.2**	**Contractors qualification**	**159 days**	**Wed 27/02/19**	**Mon 07/10/19**
8		1.2.1	Tender Floating	140 days	Wed 27/02/19	Tue 10/09/19
9		1.2.2	Tender analysis	14 days	Wed 11/09/19	Mon 30/09/19
10		1.2.3	Tender Negotiation	5 days	Tue 01/10/19	Mon 07/10/19
11		**1.3**	**Contractor award Recommendation**	**31 days**	**Tue 08/10/19**	**Tue 19/11/19**
12		1.3.1	Contract Terms and condition	1 day	Tue 08/10/19	Tue 08/10/19
13		1.3.2	Award of contract	1 day	Tue 08/10/19	Tue 08/10/19
14		1.3.3	Labours and Materials	30 days	Wed 09/10/19	Tue 19/11/19



15	**1.4**	**Execution/Construction**	**496 days**	**Wed 20/11/19**	**Wed 13/10/21**	
16	**1.4.1**	**Preparatory works**	**21 days**	**Wed 20/11/19**	**Wed 18/12/19**	
17	1.4.1.1	Mobilazation	1 day	Wed 20/11/19	Wed 20/11/19	
18	1.4.1.2	site clearance	10 days	Thu 21/11/19	Wed 04/12/19	
19	1.4.1.3	site layout and Preparation	10 days	Thu 05/12/19	Wed 18/12/19	
20	**1.4.2**	**Sub structure**	**30 days**	**Thu 19/12/19**	**Wed 29/01/20**	
21	1.4.2.1	Earthwork	10 days	Thu 19/12/19	Wed 01/01/20	
22	1.4.2.2	Excavation	18 days	Thu 02/01/20	Mon 27/01/20	
23	1.4.2.3	Levelling	2 days	Tue 28/01/20	Wed 29/01/20	
24	1.4.2.4	Backfill	1 day	Tue 28/01/20	Tue 28/01/20	
25	1.4.2.5	Disposal	1 day	Wed 29/01/20	Wed 29/01/20	
26	**1.4.3**	**Foundation**	**65 days**	**Thu 30/01/20**	**Wed 29/04/20**	
27	1.4.3.1	Stub columns and footings	20 days	Thu 30/01/20	Wed 26/02/20	
28	1.4.3.2	Plinth beams	15 days	Thu 27/02/20	Wed 18/03/20	
29	1.4.3.3	Shear wall	30 days	Thu 19/03/20	Wed 29/04/20	
30	**1.4.4**	**Super Structure**	**119 days**	**Thu 30/04/20**	**Tue 13/10/20**	
31	**1.4.4.1**	**Structure element**	**119 days**	**Thu 30/04/20**	**Tue 13/10/20**	
32	1.4.4.1.1	Ground slab	20 days	Thu 30/04/20	Wed 27/05/20	
33	1.4.4.1.2	Columns	15 days	Thu 28/05/20	Wed 17/06/20	
34	1.4.4.1.3	Walls	45 days	Thu 18/06/20	Wed 19/08/20	



35		1.4.4.1.4	Roof slab	25 days	Thu 20/08/20	Wed 23/09/20
36		1.4.4.1.5	Beams	14 days	Thu 24/09/20	Tue 13/10/20
37		**1.4.5**	**MEP works**	**77 days**	**Wed 14/10/20**	**Thu 28/01/21**
38		1.4.5.1	Wirings	15 days	Wed 14/10/20	Tue 03/11/20
39		1.4.5.2	Electrical appliances	20 days	Wed 04/11/20	Tue 01/12/20
40		1.4.5.3	Circuit Breaker installation	10 days	Wed 02/12/20	Tue 15/12/20
41		1.4.5.4	Piping	12 days	Wed 16/12/20	Thu 31/12/20
42		1.4.5.5	Sanitary Fittings	20 days	Fri 01/01/21	Thu 28/01/21
43		**1.4.6**	**HVAC**	**19 days**	**Fri 29/01/21**	**Wed 24/02/21**
44		1.4.6.1	Ducting	9 days	Fri 29/01/21	Wed 10/02/21
45		1.4.6.2	Equipment fittings	10 days	Thu 11/02/21	Wed 24/02/21
46		**1.4.7**	**Finishing**	**165 days**	**Thu 25/02/21**	**Wed 13/10/21**
47		1.4.7.1	Block Masonry	30 days	Thu 25/02/21	Wed 07/04/21
48		1.4.7.2	Doors/Window frar	35 days	Thu 08/04/21	Wed 26/05/21
49		1.4.7.3	Plastering	15 days	Thu 27/05/21	Wed 16/06/21
50		1.4.7.4	Doors/window pan	30 days	Thu 17/06/21	Wed 28/07/21
51		1.4.7.5	Flooring and Tiles	25 days	Thu 29/07/21	Wed 01/09/21
52		1.4.7.6	Paints	30 days	Thu 02/09/21	Wed 13/10/21

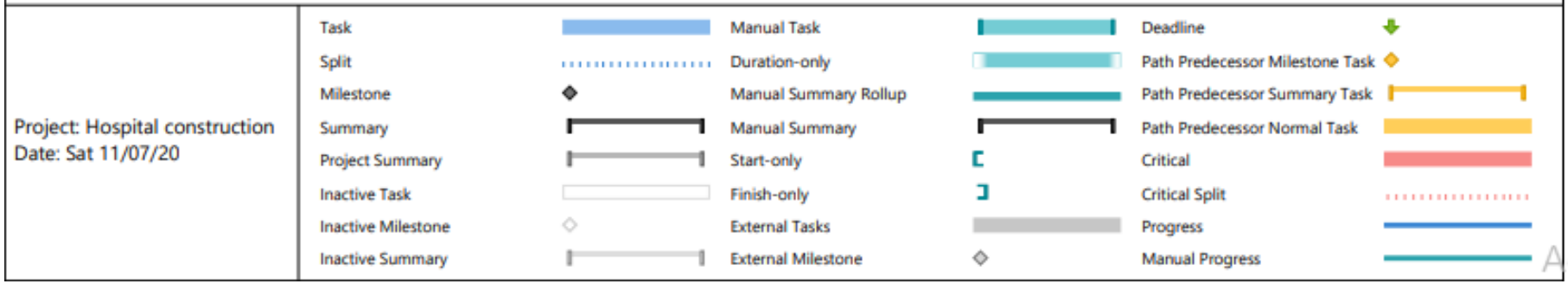


Figure 5. work schedule in MS-Project

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