

Limitations Of Pert/Cpm In Construction Management Planning: Inputs To Mathematics In Architecture Education

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Abstract: This research identified the roadblocks or shortcomings of PERT/CPM in the context of a construction company and suggested a plan to address the identified gaps. The researchers used a descriptive research design to discover the shortcomings of the PERT/CPM in construction management planning, especially in the Cabanatuan City, Nueva Ecija, Philippines construction industry. As a result, PERT/CPM is a project management approach that is useful in the basic administrative functions of planning, scheduling, and control. These days, business houses undertake massive projects that take years to complete before commercial development can begin. While this tool can be very useful, the majority of respondents agreed that it has limitations, such as; PERT/CPM can become ineffective and difficult to manage if it is not well-defined and stable for active control of a project; PERT/CPM requires frequent updating and revising of calculations, which is an extensive and time-consuming exercise that requires highly specialized knowledge; PERT/CPM requires frequent updating and revising of calculations, which is an expansive and time-consuming exercise that requires highly specialized knowledge; Furthermore, it is unable to efficiently accommodate abrupt shifts in the ground plan's execution. However, despite its limitations, PERT/CPM is still recommended for construction management planning, especially in large projects. The project manager must always have a contingency plan in place so that the quality of his or her work and projects won't be jeopardized. In order to make the best use of all available resources in their production, a cost-benefit analysis must be performed, as well as additional research about PERT/CPM. The study's findings have implications for mathematics education in architecture.

Keywords: Architecture education, construction, limitations, management planning, PERT/CPM

1. Introduction

It is an arduous and costly job to finish a project on schedule and within budget. This is why time, effort, consistency, and quality are the primary concerns of any construction firm for maximizing the output in terms of quality, profit, and efficiency. In relation to this, a variety of techniques and tools have been developed to assist project managers in creating proper project planning, especially a project schedule, such as the Gantt chart and PERT/CPM (Yang, 2007).

Critical Path Method (CPM)/Program Evaluation and Review Technique (PERT) or PERT/CPM is one of the tools to withstand the quality of construction which was learned in related mathematics courses in engineering and architecture education. As a matter of fact, it has been found useful in project management to provide efficient resource scheduling (Gray, 1981). According to Kelly and Walker (1959), PERT/CPM is a tool for efficient management of all types of projects such as construction, engineering, facility maintenance, research and development. It is a scheduling approach that was originally developed to schedule a construction project as well as evaluate and represent the tasks involved in completing a given project by using a network of related and similar activities while coordinating optimal cost and time criteria (Uka, 2008). It is truly one of the most efficient and useful methods for handling projects in the construction industry by allocating resources optimally (Gido and Clements, 2011).

Indeed, PERT/CPM is a useful tool because it provides an easy way to determine the effects of shortening various jobs in the project, and it enables the users to evaluate the costs of a 'crash' program (Augustine, 1989). According to Badiru and Osisanya (2013), this is a widely-used method in the construction industry, as it helps in the planning and coordination of large-scale construction projects.

Besides, applying this tool in construction firms gives a more sophisticated output of production for the reason that this tool will allow the firms to organize intricate activities that require a comprehensive analysis of prioritizing and optimizing the best set of steps and actions to be implemented to obtain the optimum production. The key components of PERT/CPM are time; optimistic time, pessimistic time, and expected time. All these components are considered critical for organizations associated with the construction industry (Mubarak, 2015).

In application, construction firms were probably organized all due out because of business, hence, by dissecting the innermost objective of any businesses and organization, it is identifiable that business exists because it aims to

have profit out of revenues extracted from rendered productions and activities to keep the operation eloquent at all time. However, considering the unforeseen events and circumstances must be incorporated in the planning of activities because those unforeseen events might affect the operation and contraction that can cascade tremendous impact in terms of profit maximization and cost minimization.

At the bottom-line, proper activity management is the key to improve the above-cited objectives of firms and businesses most especially for firms and companies that require extreme manpower mobilization such as construction firms and the like. This is possible by the adequate implementation of the PERT/CPM tool all due because this can provide a proper way of activity listing, precedence diagram, estimated time for each activity (that can be used for project projection of completion), identify the critical path, and the slack of each activity.

Although the PERT/CPM seems to be the best tool for proper organizing of activity, this particular tool still has its limitations due to limited quantifiable human ways of gauging the time duration of a certain activity and to large scale projects that require conflicted and simultaneous diagram that becomes incomprehensible due to overwhelming information. One of the most serious flaws with this current approach is that it has a restricted scope of implementation, even though most construction projects have a mix of features that go beyond the capabilities of this tool (Virine and Trumper, 2007). Subsequently, all the existing methods have some fundamental limitations that restrict their capacity in the modeling of many realistic situations (Powell and Buede, 2009).

Given these enumerated facts and concerns aligned to the benefits and limitations of the tool, this study aims to identify the limitations of PERT/CPM in project management planning in Cabanatuan City. Appropriate action to solve the enigma by proposing a strategic plan and courses of action that will enable the tool to gel to become more applicable in mathematics (Salangsang & Subia, 2020) in engineering and architecture education, application, and practice was the highlight of this study.

2. Methodology

The researchers utilized the descriptive research design using the survey-questionnaire technique to gather the necessary information. According to Aggarwal (2008), descriptive research is devoted to the gathering of information about prevailing conditions or situations for the purpose of description and interpretation. This type of research design is not simply amassing and tabulating facts but includes proper analyses, interpretation, comparisons, identification of trends and relationships. In this study, the researchers utilized the descriptive research design to describe the limitations of the PERT/CPM in construction management planning in the construction field and then later proposes a strategic action plan to address these limitations.

This research was conducted on the different construction firms located at Cabanatuan City, Nueva Ecija. A researchers-made questionnaire was used to describe the respondent's profiles who are the project managers of the different construction firms at Cabanatuan City, Nueva Ecija. The questionnaire was conceptualized and constructed based on the readings of the literature and studies conducted.

The rating scale of the close-ended questionnaire and corresponding verbal description was presented in the table below:

Scale for the Limitations of PERT/CPM in Construction Management Planning		
Scale	Range	Verbal Description
4	3.26–4.00	Strongly Agree
3	2.51–3.25	Agree
2	1.76–2.50	Disagree
1	1.00–1.75	Strongly Disagree

The questionnaire was content validated by experts in the field while the internal consistency method of establishing test reliability was employed using the Cronbach's alpha formula. The computed reliability coefficients of the questionnaire for the limitations of PERT/CPM in the construction management planning of project managers was 0.941 which means that it is reliable.

The researchers personally administered the instruments to eighty (80) architects, civil engineers, and other practitioners in the field of construction after permission was granted by the construction firms. An appropriate statistical tool such as weighted mean was used to analyze the data collected.

3. Results and discussion

Table 1. Obstructions/Limitations of PERT/CPM

No.	Indicators	Weighted Mean	Verbal Description
1	Drawing a PERT/CPM diagram can take a lot of time and effort for the manager	3.30	Strongly Agree
2	Identifying which of the paths is critical may be difficult for the project manager	2.70	Agree
3	The project manager has to guesstimate a lot of the project task durations, making the timetable less reliable and PERT/CPM less useful	2.85	Agree
4	The project may be hopelessly optimistic if the manager has to control the resources and staff he needs to complete the critical path on deadline	3.15	Agree
5	For large projects with thousands of activities, it may be difficult to print the project network diagram	3.10	Agree
6	It does not account for resource and resource allocation	2.85	Agree
7	The estimate of time and resources can be assumed but the results can only be as good as the assumptions	3.00	Agree
8	The costs may be higher than the conventional methods of planning and control because of the nature of networking and network analysis because it needs a high degree of planning skill and a greater amount of details which would increase the cost in time and manpower resources	3.05	Agree
9	It is not suitable for relatively simple and repetitive processes such as assembly line work which are fixed–sequence jobs	3.00	Agree
10	The assumption that a project can be subdivided into a set of predictable and independent, activities may not hold true always	3.05	Agree
11	PERT/CPM emphasizes only on time and not the costs	3.20	Agree
12	PERT/CPM is based on time estimates and there may be an error in estimating time	3.20	Agree
13	For active control of a project, the PERT/CPM requires frequent updating and revising of calculations which is an expansive and time-consuming exercise that required highly trained personnel	3.45	Strongly Agree
14	In a big project, a PERT/CPM can become extremely complicated and difficult to fathom for the new recruits to the project team	3.25	Agree
15	If the project is far too bulky and lengthy, the Critical Path Method requires software to monitor the plan.	3.25	Agree
16	PERT/CPM can become ineffective and difficult to manage if it is not well–defined and stable.	3.60	Strongly Agree
17	It cannot effectively handle sudden changes in the implementation of the plan on the ground.	3.30	Strongly Agree
18	It is very difficult to redraw the entire PERT/CPM chart if the plan of the project suddenly changes midway	2.95	Agree
19	The PERT/CPM cannot form and control the schedules of the persons involved in the project	2.75	Agree
20	The allocation of resources cannot be properly monitored.	2.75	Agree
21	The critical path of the PERT/CPM of a big project is not always clear	2.85	Agree
22	The project managers have to spend a lot of time to calculate it carefully	3.05	Agree
23	The PERT/CPM takes longer to identify and to monitor the critical path when the project is of big dimension	3.20	Agree
24	Using PERT/CPM, identifying and determining a critical path is difficult when there are many other similar duration paths in the project	3.15	Agree

25	It is also difficult to estimate the activity completion time in a multidimensional project.	3.05	Agree
	Average Weighted Mean	3.08	Agree

Table 1 shows the limitations of the PERT/CPM in Construction Management Planning as perceived by architects, civil engineers, and other practitioners in the field of construction. As perceived by the respondents strongly agreed that PERT/CPM can become ineffective and difficult to manage if it is not well-defined and stable with a weighted mean of 3.60. According to Punmia and Khandelwal (2006), the Program Evaluation and Review Technique (PERT) is a widely used method for planning and coordinating large-scale projects. As Kerzner (2003) explained in his book Project Management, PERT is basically a management planning and control tool. It can be considered as a road map for a particular program or project in which all of the major elements (events) have been completely identified, together with their corresponding interrelations. PERT charts are often constructed from back to front because, for many projects, the end date is fixed and the contractor has front-end flexibility." A basic element of PERT-style planning is to identify critical activities on which others depend. The technique is often referred to as PERT/CPM, the CPM standing for "critical path method."

Also, the respondents strongly agreed that for active control of a project, the PERT/CPM requires frequent updating and revising of calculations which is an expansive and time-consuming exercise that required highly trained personnel with a weighted mean of 3.45. They act as the basis both for the preparation of a schedule, and resource planning. During the management of a project, they allow you to monitor the achievement of project goals. They help you to see where remedial action needs to be taken to get a project back on course.

Within a project, it is likely that you will display your final project plan as a Gantt Chart (using Microsoft Project or other software for projects of medium complexity or an excel spreadsheet for projects of low complexity). The benefit of using CPA within the planning process is to help you develop and test your plan to ensure that it is robust. Critical Path Analysis formally identifies tasks that must be completed on time for the whole project to be completed on time. It also identifies which tasks can be delayed if resources need to be reallocated to catch up on missed or overrunning tasks. The disadvantage of CPA, if you use it as the technique by which your project plans are communicated and managed against, is that the relation of tasks to time is not as immediately obvious as with Gantt Charts. This can make them more difficult to understand (Mind Tools, n.d.). It can be noted from the data above that this tool is very useful yet there were limitations, especially in construction management planning.

Table 1. Proposed Strategies to Address the Identified Limitations of the PERT/CPM in Project Management

Constraints/Problems	Intervening Strategies	Responsible Unit/Person
For active control of a project, the PERT/CPM requires frequent updating and revising of calculations which is an expansive and time-consuming exercise that required highly trained personnel	The firm must set high job qualifications for applicants.	Human Resource Department
Drawing a PERT/CPM diagram can take a lot of time and effort for the manager	Cluster simple stages to minimize the number of task with a high level of occurrences	Scheduler Architect Project Manager Engineer Draftsman
PERT/CPM can become ineffective and difficult to manage if it is not well-defined and stable	The firm must assign individuals and employees with direct immersion	Scheduler Architect Project Manager Engineer Draftsman

In a big project, a PERT/CPM can become extremely complicated and difficult to fathom for the new recruits to the project team	Hire applicants aligned to the identified need of the firm	Human Resource Department Project Manager
If the project is far too bulky and lengthy, the Critical Path Method requires software to monitor the plan.	The firm must hire competent IT specialist to execute massive projects, and; If there is any, the firm can also execute seminar or workshop for continuous learning updates of IT specialist	Human Resource Department Management Information Systems Manager

1. The firm must set high job qualifications for applicants.

The back of labor-intensive industries is the manpower helping together behind the scene of the success stories. Thus, it is appropriate to job qualification as part of the screening process to assess the readiness and the capacity of the applicants in terms of knowledge and skills that they can contribute to the future endeavors and milestones of the firm. Also, setting high qualifications such as working experience, nature of specialization and the like can refuel the firm using new knowledge from new applicants.

2. Cluster simple stages to minimize the number of task with a high level of occurrences

The function of PERT/CPM is to attain the optimum output without any recurring mistake due to conflict of schedules and the like. However, there are some instances that intricate projects demand intricate diagrams that are often incomprehensible for some individuals involved in the firm. For this reason, it is advised to cluster similar activities to shorten and unclog irresolute diagrams with repetitious activities and steps.

3. The firm must assign individuals and employees with direct immersion

Skill requires series of training to acquire a sufficient adaptation to a certain activity or step. Precisely, this is the justification of this strategy for the reason that individuals with direct immersion with a particular project that are synonymous or most likely the same with the concept of nature of his previous assignment or designation has higher skills due to experiences and actual practices.

4. Hire applicants aligned to the identified need of the firm

Human resources were stated in any book of account in accounting and yet the most valuable asset of a certain firm or organization. The hiring process plays a vital role in the industry. In fact, in actual practice, there is a certain department within the organization dedicated to managing employees—the Human Resource Department. One of the main functions of this department is to hire, select and retain the best out of the pool of applicants. Thus, this department imposed different standards, qualifications, and guidelines to choose the best individual suitable to the need of the firm or the organization.

5. The firm must hire competent IT specialist to execute massive projects, and; If there is any, the firm can also execute seminar or workshop for continuous learning updates of IT specialist

Massive projects require massive and creative cerebra to obtain the ultimate objective of the firm at a right time and using the right resources. The role Information Technology specialist is to navigate the system of the firm to avoid internal conflicts such as proper payroll management, resources management, and records management. Moreover, if the firm already has a competent IT specialist, the management should also execute sustainable programs intended for learning and development.

4. Conclusion and recommendation

The capacity of a profitable construction business to provide quality products while avoiding a shrinking profit margin is the determining factor. However, this is only possible if management employs effective tools, especially in terms of scheduling and time management, such as the PERT/CPM. Based on the data gathered by the researchers, they discovered that if PERT/CPM is not well-defined, it is inept and difficult to handle. This study also found that the PERT/CPM requires frequent updating and revisions because uncertain activities cannot be navigated using this tool; however, it is recommended that the PERT/CPM concept be preserved because it is still useful, but it does require a sufficient contingency plan to handle unforeseen events and circumstances. A cost-benefit analysis must also be carried out in order to make the best use of all available resources in their development, and further research into PERT/CPM must be carried out.

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