Application of Program Evaluation and Review Technique (PERT) and Linear Programming (LP) in Project Management

by

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Aplikasi Teknik Penilaian Program dan Pengulangkajian (PERT) dan Pengatucaraan Linear (LP) di dalam Pengurusan Projek

ABSTRAK

Setiap tahun, perniagaan memberi perubahan yang sistematik, seperti membina bagunan, bergabung sesama syarikat atau membuat produk baru. Perubahan ini membawa kepada pengurusan projek. Untuk membina sesuatu projek, pelbagai jenis data yang diperlukan. Namun, pengurusan projek pada masa kini menuntut produk yang lebih kompleks, output yang berkualiti tinggi dan kitaran pembangunan yang lebih cepat. Ini akan menyebabkan perancangan projek dalam skala yang besar yang membawa kepada kos yang tinggi. Oleh itu, kajian ini bertujuan untuk pengoptimuman projek. Dengan mengkaji semula Teknik Penilaian Program dan Pengulangkajian (PERT) yang asalnya direka untuk merancang suatu projek yang menekankan hubungan antara setiap masa yang diambil oleh setiap aktiviti dan penghasilan masa dan kos keseluruhan projek yang dijangka siap. Dalam PERT, rangkaian grafik digunakan untuk menggambarkan keutamaan atau hubungan selari antara aktiviti. Ia juga mengenal pasti masa projek yang dijangka siap dan laluan kritikal di mana lebih banyak sumber perlu ditumpukan untuk menyelesaikan projek itu pada masa yang ditetapkan. Namun, masa yang dijangka untuk sesuatu projek juga boleh dipendekkan ke tahap yang tertentu dengan menggunakan sumber tambahan yang dipanggil 'terhempas'. Pengurangan tempoh mungkin merangkumi penggunaan masa yang lebih, menugaskan lebih banyak pekerja dan menggunakan lebih banyak sumber seperti bahan, peralatan dan sebagainya. Tindakan ini boleh menyebabkan kos yang lebih tinggi dan kualiti yang rendah. Oleh itu, keputusan 'terhempas' boleh dirumuskan dengan menggunakan Pengatucaraan Linear (LP). Teknik LP bertujuan untuk menentukan pengoptimuman kos projek. Ia juga mempunyai kecekapan pengiraan algoritma bagi masalah dengan ribuan kekangan dan pembolehubah yang dianalisis menggunakan Penyelesai Excel. Dalam kajian ini, PERT dan LP diguna pakai bagi projek yang berskala besar untuk membina sebuah bangunan baru iaitu Pejabat Pentadbiran dan Medan Selera di Kampus Induk Universiti Malaysia Perlis (UniMAP), Mukim Padang Siding, Pauh, Perlis.

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ABSTRACT

Throughout the years, businesses execute a systematic change, such as constructing a building, merging with another company or making a new product. These changes lead to the management of a project. To construct a project, various dataflow are required. However, project management nowadays demand more complex products, higher quality outputs and faster development cycles. This will cause massive scale of planning a project which leads to massive cost. Therefore, this study aims for an optimization in managing a project. The Program Evaluation and Review Technique (PERT) which originally designed to plan a project that emphasizes the relationship between the times each activity takes and the resulting time and cost for the expected completion of the entire project. In PERT, a graphical network is used to illustrate the precedence or parallel relationship among the activities. It's also identifying the expected completion time of a project and the critical path where more resources should be concentrated to finish the project on time. However, the expected time of a project can also be shorten to a certain level by the used of additional resources which is called crashing. Reducing the duration might include using overtime, assigning more labour and using more resources such as material, equipment and so on. These actions may result in higher cost and lower quality. Thus, crashing decision can be formulated by using Linear Programming (LP). LP technique seeks to determine the optimization project cost. It is also boast efficiency of computational algorithm for problems with thousands of constraint and variables which analyse by using Excel Solver. In this research, PERT and LP are applied on a large-scale of projects which construct a new building consist of Administration Office and Medan Selera at the Main Campus of University Malaysia Perlis (UniMAP), Mukim Padang Siding, Pauh, Perlis.

CHAPTER 1

INTRODUCTION

1.1 Overview

Project managers nowadays need to use optimization when managing a project. This management is either to produce a concrete or improving the performance. The purpose of mathematical approach is to enable businesses to reduce costs, improve profitability, use resources effectively and reduce risks. Furthermore, optimization can make decision processes to improve the speed of responses and allow managers to focus their attention on critical uncertainties. However, these benefits have been demonstrated in various real-world implementations. Therefore, in order to enable the above issues to be studied, it is important to further the study in the following issues.

It is important to know the types, objective and scope of project management (Subhash, 2012). Thus, the concepts of various phases of the project will be easy to understand. The preparation of detailed project report and project selection also needs to be included to enable the evaluation of the financial, cost and time over-runs. Implementation phases of the project management are also an important issue to consider. Furthermore, other issues can also be included such as contracting and contract specifications, import control and foreign exchange, lack of facilities (power, fuel, etc), labour and tax preparation.

These issues involve various data flows which are required for the relevant people at the right time. This is why in project management, the planning and the professional management are detailed, and the implementation of the project is made effective to achieve proper management of cost, performance and time (Subhash, 2012).

1.2 Background of Research

Managing a project always is a hard task for the manager especially for a large-scale project. It is because they need to complete it on time and within budget. For example, an industrialisation programme in a State may consist of setting up of one or more power project, steel plant, fertiliser project, etc. (Subhash, 2012). To do that, the manager needs to consider in reducing the risks within the project and maximize the benefits. This is why basic managerial functions of planning, scheduling and control are important to the manager.

A project is unique and has discrete set of task. That is why listing of various task involve will made the planning easy to be complete. On the other hand, laying out the actual task of the project in the time order, along with the expected completion time is useful when it comes to scheduling. Once the project begin, the basics aspect of control is important. It is associated within the analysis and correction of the different between the schedule and actual performance.

The fundamental concept use in PERT, an acronym for Program Evaluation and Review Technique, is to plan and accelerate the development of a project. It is developed in US Navy for integrated planning and control of Polaris weapon system (Subhash, 2012).

In LP, an acronym for Linear Programming, involves the planning of activities to obtain optimal result. So, by combining both PERT and LP, managing a large-scale project would be bearable to the manager to complete a project on time and within budget.

1.3 Problem Statement

A project is an organized programme of activity carried out with specific schedule to attain a specific objective corresponding to successful completion of work. However, in managing a project, understanding the framework of planning, scheduling and controlling technique is essential. If the manager do not concerned about these technique, the project probably will not complete on time and encounter several problem in monetary.

In planning a project, independent activities and the order of precedence for these activities are important. It is because, the need to know which activity to be completed before other can be started. So, the project can be displayed graphically to better visualise the flow of the activities. We know that basic concepts of PERT are to reach a certain stage of completion time of a project. That is why the total time required completing the project need to be found if no delay should occur. Besides that, the individual activities need to start and finish to meet this project's completion time also can be found. This is due to the completing the framework of scheduling.

To avoid any misleading of an activity in meeting the deadline, the most critical activities need to be determined. This finding is important to avoid an unnecessary delay in completing a project. By fully controlling the project, it is also a necessary to know the least expensive way of attempting in meeting the target completion time, if we want to expedite the project deadline.

1.4 Research Objective

The objectives of this study are:

1) To minimize the cost of a project.
2) To find the critical activities to avoid an unnecessary delay in completing a project.
3) To estimate the deadline of a project.

1.5 Research Scope

This study seeks to control the management of a project and optimizing the cost by using Program Evaluation and Review Technique (PERT) and Linear Programming (LP). Data used is taken from a large-scale construction projects a new building consists of two floors which are Administration Office and Medan Selera for the new residential student's college project at the Main Campus of University Malaysia Perlis (UniMAP), Mukim Padang Siding, Pauh, Perlis.

1.6 Significance of Study

Sometimes, conducting a large-scale project could be troublesome to the project manager. However, this study on project management will give a good body of knowledge to the project manager when it comes to controlling a project.

Furthermore, this study also aims to minimize the cost of a project. Thus, the result in constructing a model in minimizing the cost could serve as a benefit for the project manager to control the cost for a large project without wasting anything.

1.7 Organization of Dissertation

This dissertation report can be divided into five chapters which include the background of research, literature review, research methodology, case study and conclusion with recommendations for future works. The summary of all five chapters will be explained to facilitate better understanding.

Chapter one, which explains about the background of research sheds light on the framework of the study which includes the overview of the research work, problem statement, research objective, research scope and the significance of the study.

Chapter two is the literature review that consists of method that is related in solving the project management problems.

Chapter three which is the research methodology consists of the explanations offered for Program Evaluation and Review Technique (PERT) and Linear

Programming (LP) in solving the project management problem. This is the chapter consisting of various equations and assumptions.

Chapter four is the explanations on the scope of the study. This chapter highlights the presentation of the applications of PERT and LP methods in real situations. The construction of the two floors namely the Administration Office and *Medan Selera* (students' eatery) for the new residential student's college is our main focus in this study.

Chapter five consists of the conclusion for this study. We also provide a recommendation for future work in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Managing a large-scale project is always a tough challenge to the project manager because needs to make sure that the project can be completed on time and within budget. Yanwen (2012), states that for most parts, this is not a problem for small projects. It is the large projects, and especially the medium-sized projects, that present various challenges. However, by using a good technique of planning, scheduling and controlling phase, the project manager will be able to manage the project excellently. Thus, this chapter will begin with a brief overview of these functions by reviewing other research journals, books and other reading sources. The overview can be examined in terms of the plan, schedule and control while the act of managing a project is described.

2.2 Definition of a Project

A project is a collection of activities which serve to accomplish a specific objective. The activities are interrelated in a logical sequence in the sense that some activities cannot start until others are completed. Every organization may be involved at any time in a project of any size, duration, and at any complexity level. From Subhash (2012), perspective, a project is defined as a one-shot, time tested, goal directed, major

undertaking, requiring the commitment of various skills and resources with a combination of human and non-human resources to achieve a specific purpose.

A project can also be classified as new project, modernisation projects, expansion projects, diversification projects and other miscellaneous projects. Regardless of the types of the project, each of them must require multiple activities which include the acquisition of land, building, plant and machinery, the arrangement of funds, receiving various clearances from the government and statutory bodies, etc- all to meet the objectives intended earlier (Subhash, 2012).

2.3 Definition of Project Management

A project management is a detailed scope of planning, professional management, and effective implementation of a project to achieve the management of cost, performance and time. In order to achieve a good project management and subsequently making the profit, the managers need to steer clear of delays in the execution, avoid causes of delays and identify technical flaws and difficulties in executing the project (Subhash, 2012). According to Omar (2012), the project management balances competing demands throughout the project lifecycle and involves the interaction of three elements, one of which includes the people who perform the work and determine the success or failure of a project. The processes specify products or deliverables required for the project and identify who will perform the work and when. Furthermore, the tools that people use to manage the project are also an important element in project management.

Subsequently, Chris & Tung (2008) also list the functions of project management for construction which generally include the specification of the project objectives and plans including the delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants. Furthermore, managing a project maximizes the efficient resource utilization through the procurement of labour, materials and equipment according to the prescribed schedule and plan. It is also the implementation of various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process. The development of effective communications and mechanisms for resolving conflicts among the various participants also serves as an important function in project management.

However, according to Heizer & Render (2014) the management of project involves three phases which are planning, scheduling and controlling. Thus, using these basic elements, this study will be properly constructed.

2.4 Solution Techniques for Project Management

The application of the project management has been used for several years as it is seen to help in scheduling and controlling a project. They are not only used in construction, but also used in a public health project carried out by Carolina et al. (2014). In this study, the Gantt chart, Milestone, Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) will be reviewed as technique in managing a project.

2.4.1 Gantt charts

A Gantt chart devised by Henry Gantt is commonly used in project management to display the progress of a project in a timetable for each activity, against time. Since they are viewed as small manageable items where the dependencies are visually illustrated, parallel processes are discovered, the overall processing time determined and progress tracked, managing a project is seen as easier.

A project management tool, such as the Gantt chart makes all subtasks of a task able to be viewed graphically despite the tasks of a project which can be quite complex and dependent on each other as shown in Figure 2.1 (Serge et al. 2005). A Gantt chart usually has the timescale drawn horizontally, while the different activities are displayed on the vertical axis and shown as a block or a bar.

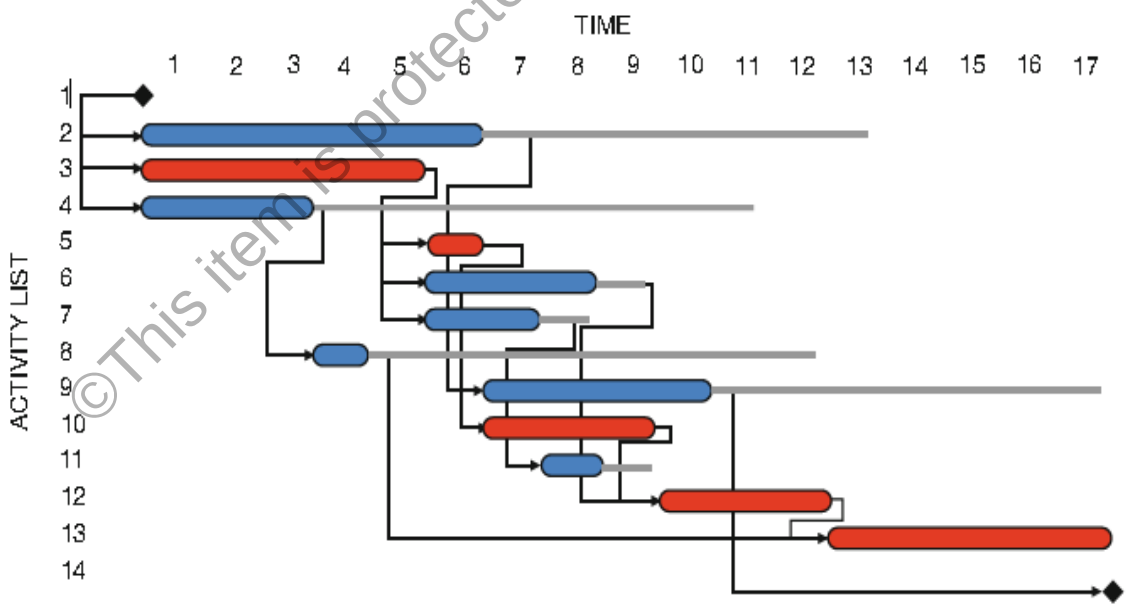

Figure 2.1: An example of the Gantt chart of a project.

However, this method is not designed to be the cure-all for an organization's project management problems. There are some situations where other tools may indeed be more effective because the project manager does not include a particular milestone or critical task. Other limitations are when it is unable to include certain constraints like time, scope, and costs. It also cannot graphically represent the relationship between different project activities (Subhash, 2012). However, Gantt chart advantages have been realized by all types of organizations for their applications.

2.4.2 Milestone

The general definition of milestone is a sub-objective or stage, in which a program is divided in order to monitor and to measure the work performance. When they are used in managing a project, it becomes the schedule event that indicates the completion of a major deliverable event of a project. They are, by definition, independent of time. Therefore, no work or consumption of resources is associated with them. In project management, milestone is used to mark specific points along a project timeline. Since milestones do not impact the project duration, they focus on major progress points that must be reached to achieve success (Verzuh, 2008). An example of milestone chart can be seen in Figure 2.2. Milestone can add a significant value to the project scheduling by combining it with the PERT or CPM method which allows the project management to more accurately determine whether the project can be finished on time or not. Since milestones are very much like a goal, they are traits to make the milestone actionable and effective (Hut, 2010).

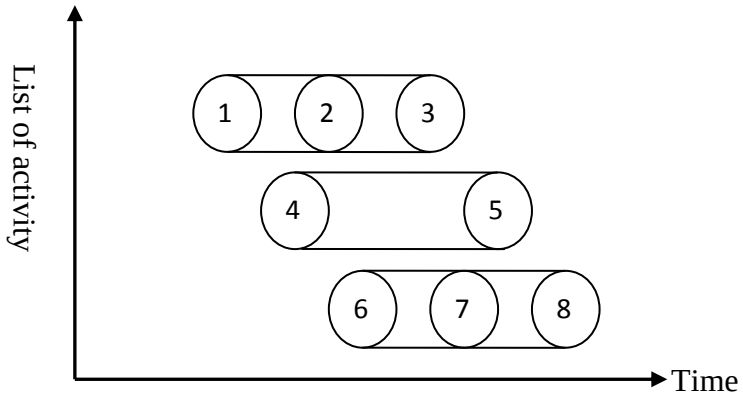

Figure 2.2: Milestone chart.

An effective milestone should be specific in the scope of a project. It should be grounded in a foundation in order to measure it by making a to-do list. When the milestone is too convoluted to actually get done, it is not attainable. It needs to be more digestible to be finished. This is why it needs to be relevant to the project at hand. In conducting a milestone, it needs to be open and presentable, so that there is no confusion or misinterpretation. Furthermore, it should follow a linear path of progression: this means that towards the end of the project, it is dependent on the one at the beginning.

Since milestones are usually used to monitor the progress of a project, there are limitations to their effectiveness. They only show progress on the critical path, and ignore non-critical activities. It is common for resources to be moved from non-critical activities to critical activities to ensure that milestones are met. Thus, it gives the impression that the project is on schedule when actually some activities are being ignored.