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Application of Multiple Regression and Artificial Neural Networks as Tools for Estimating Duration and Life Cycle Cost of Projects

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ABSTRACT

Project managers face complex challenges when planning project stages because contract durations and project costs are difficult to predict accurately. The purpose of this study is to investigate statistical tools and concepts that can be integrated in the second phase of the project life cycle: the planning stage. Furthermore, this study aims to compare the accuracy of multiple regression and artificial neural network models, as well as the application of simulation in construction models used in predicting project duration and cost. This paper will also discuss the industry's current estimation methods, the use of statistical approaches, simulation, and the relationship between the application statistical tools and project success. Thus, this review identifies the trending statistical tools used by scholars to develop regression and neural models to solve the complexity of cost and duration estimation. The findings indicate that although the industry needs more accurate predictions and estimating tools, and regardless of the investigations and advancements made with integrating statistical tools, implementing these statistical approaches is faced with barriers.

KEYWORDS

Duration Estimation, Life Cycle Cost, Multiple Regression, Neural Networks, Project Management, Simulation

INTRODUCTION

In the field of project management, the life cycle of a project is composed of the following phases or stages: initiation, planning, execution-monitoring, and project closure. The focus of my investigation is concerned with the planning stage, namely cost estimating and duration estimation. This paper intends to provide an understating of the application of statistical methods and concepts used in the forecasting of cost and durations in construction projects.

The project life cycle, as described previously, lacks the phase of project implementation or post-occupancy planning. Construction projects, such as power plants, treatment plants, buildings, dams, factories and other types of structures, undergo a period of implementation. This paper explores the application of statistical tools for forecasting the running cost for operating and maintaining completed projects. In the context of this paper, operation and maintenance is treated as the last phase of the project life cycle prior to retiring the asset or terminating an initiative.

Furthermore, this paper reports on existing literature, concerning the application of statistical models by industry professionals, to determine duration of contracts, manage cost, and estimate

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cycle costs. Additionally, we will discuss the steps involved in developing regression and the neural network model. We compare the view of researches and results of regression and neural networks, as well as the advantages and disadvantages of each method.

The literature appears to share the same concept of significant items. Cost significant items refer to elements of the work that influence cost and duration when compared to others. The identification of these items is essential for developing models of high accuracy. Researchers have developed models for various project types, but implementing statistical principles to determine project cost and duration during the planning phase remains low among professionals.

The difficulty of estimating project cost and durations accurately results in a dilated schedule; longer durations will require additional resources, and project cash flows may be impacted. Nonetheless, computer technology advancement and the integration of applications and software have made statistics helpful in estimating project success factors, such as cost estimating, duration, and scheduling. The wide implementation of statistical approaches to estimating is hindered by cost of technology, skill level, and awareness.

Scholars agree that cost is a life cycle constituent of great importance. A poor estimate can make the difference between success and failure, so the accuracy of cost estimates and monitoring is essential to avoid cost overruns (Chew, 2017; Burnes, 2014; Galli, Kaviani, Bottani, & Murino, 2017). As a response to this problem, the industry is adopting modern simulation tools that are gaining ground, as computing power can handle large amounts of data and can perform advanced mathematical and statistical analysis.

A typical construction contract is coupled to a construction schedule that is legally binding. The duration of projects is determined by the owner and consultants. Once the contractor is selected and the contract is awarded, then the contractor must finish on or before the stipulated date. This research will report on the quantitative data processing methods and techniques, such as stepwise regression, multiple regressing, and artificial neural networks. Researchers agree that regression and neural networks are viable methods for estimating project cost and project duration (Adjei-Kumi, 2017; Marcelino-Sádaba Pérez-Ezcurdia, Lazcano, & Villanueva, 2014; Schwedes, Riedel, & Dziekan, 2017).

The current method of estimating durations represents a risk to the contractor, as there is a high probability that the project duration determined by the owner is not reasonable, which makes the contractor liable for penalties and liquidated damages (Jin, 2016; Zwikael, & Smyrk, 2012; Todorović, Petrović, Mihić, Obradović, & Bushuyev, 2015; Medina & Medina, 2015). Furthermore, unplanned durations increase litigation and compromises construction quality. Similarly, if duration is overestimated, then the client will incur damages, so the difficulties of projects are unique and require high-level customization.

Deviation from planned duration in developing parts of Africa ranges from 51% to 92%. This affects building and transportation projects that are reported to deviate from the stipulated completion date by 20%. Stakeholders, project owners, the government, and construction professionals will benefit from more accurate project durations (Mensah, 2016; Galli & Hernandez-Lopez, 2018; Easton & Rosenzweig, 2012; Brown & Eisenhardt, 1995). Overall, there is consensus in the literature that the duration of projects is strongly related to the quantities of work, rather than to the project cost. Popular scheduling computer programs are based on the Gant Chart, the critical path method. The Gant Chart illustrates the project schedule and the dependency relationship between items of work, and cost is not influential. Developed countries, such as the U.S Japan, Hong Kong, and countries in Europe, have developed models for estimating the construction duration of bridges, roads, and buildings (Ahmadu, 2015; David, David, & David, 2017; Galli & Kaviani, 2018; Hartono, FN Wijaya, & M. Arini, 2014; Parast, 2011).

Moreover, the literature improves the analysis of the quantities of work for non-significant items to be identified. Only the most important items are considered for study. Also, this paper will report on statistical significant work items that impact the duration of bridge construction projects. The

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