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A Reflection Note on Applying Quantitative Decision-Making Approaches to Engineering Management

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ABSTRACT

Engineering management is a project management activity full of information composed of specific engineering technology and different social factors. The basic knowledge of quantitative decision-making technology and management economics is conducive to project decision-making, project investment, financing in engineering construction, and real estate. With the development of modern engineering management, quantitative decision-making has become increasingly important. This article discusses quantitative decision-making's significance, importance, and potential limitations in engineering management activities. Different quantitative decision tools have other effects on engineering management and technical management. This article also suggests that effective engineering management needs to combine scientific quantitative analysis methods and quantitative decision-making tools and comprehensively consider the engineering implementation background, the project's technical requirements, and resource sources.

KEYWORDS

Decision-Making, Engineering, Engineering Management, Quantitative Decision-Making

INTRODUCTION

Background Information

There are many tasks within project management. However, the core tasks include target control, schedule target, quality target, cost target, and safety target. On the other hand, the technical elements of engineering management include the core professional knowledge of Engineering Management deliverables, which needs quantitative analysis knowledge in requirements identification, solution development, design, and technical specification control, especially in engineering management projects. The quantitative decision is also called the measurement decision. Project management decision-makers can express the collected engineering information in the form of quantity and can make accurate conclusions for various engineering situations with mathematical methods (Angelou, 1998; Hoon Kwak & Dixon, 2008; J. W.,

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2018; Labedz & Gray, 2013; Lee, Lapira, Bagheri, & Kao, 2013; Sharon, Weck, & Dori, 2013; Xiong, Zhao, Yuan, & Luo, 2017; Xue, Baron, & Esteban, 2016). The engineering objective of quantitative decision-making requires a certain degree of accuracy, and the optimal engineering management scheme can be obtained through mathematical methods. With the development of technology, the cognition of engineering managers is constantly improving. Thus, the project management method of transforming the non-quantitative form into the quantitative form is also developing. Overall, quantitative decision-making is a significant development trend in scientific engineering decision-making.

Essentially, the quantitative decision-making method can be used to solve problems in the field of engineering management. These problems are solved with mathematical models and formulas to establish and reflect the mathematical model of engineering factors, as well as the relationship between engineering projects (Terweisch, 2002; Almeida & Simões, 2019; Amalnik & Ravasan, 2018; Andersen, 2014; Lichtenthaler, 2020; Marcelino-Sádaba, Pérez-Ezcurdia, Lazcano, & Villanueva, 2014; Xue, Baron, & Esteban, 2017). Quantitative analysis of engineering decision-making can improve the timeliness and accuracy of conventional engineering decision-making. Furthermore, quantitative decision-making can free engineering management to focus on overall major project implementation and strategic decision-making (Stryker, 2008; Arumugam, 2016; Aslani, Akbari, & Tabasi, 2018; Azar, 2012; Badi & Pryke, 2016; Loyd, 2016; Medina & Medina, 2015; Milner, 2016). The advantages and disadvantages of various project implementation schemes can be compared through quantitative decision-making. Each project scheme's success probability and failure risk can be shown through specific data, and the expected project income and cost of different project schemes can be calculated. Also, the potential loss can be calculated, which can be widely used in the decision-making analysis of multi-level quantity, the cost of civil engineering projects, the construction investment, and financing.

LITERATURE REVIEW

Quantitative Decision-Making Tools

Quantitative decision-making in the field of engineering management includes risk decision-making, deterministic decision-making, and nondeterministic decision-making. Risk decision-making refers to the method by that project management decision-makers predict unlikely situations (Terweisch, 2002; Galli, 2018a; Galli, 2018b; Galli, 2018c; Parast, 2011; Parker, Parsons, & Isharyanto, 2015). The most commonly used method to address risk decision in engineering management is the decision tree. The decision tree method is used to express the relationship of various states of different project management decision-making schemes to indicate the corresponding probability of booming construction, as well as the expected project reward value to select the optimal project decision-making scheme (Panitas, 2014; Galli, 2018d; Galli, 2019a; Galli, 2019b; Galli, 2019c; Usman Tariq, 2013; Von Thiele Schwarz, 2017). Additionally, the decision tree method is widely used in quantitative analysis of engineering management decisions (Angelou, 1998; Galli, 2020a; Galli, 2020b; Galli, 2020c; Schwedes, Riedel, & Dziekan, 2017; Winter, Andersen, Elvin, & Levene, 2006a).

Furthermore, there is the deterministic decision-making method. This method emphasizes that there is only a specific natural state of project management, and the decision-makers can act by the methods of scientific projects. The deterministic decision-making methods include linear programming, network technology, other engineering mathematical model methods, the differential extremum method, engineering break, and the analysis method.

Lastly, there is the uncertain decision-making method. This method is a scientific method for project management decision-makers to estimate the possible state of biological engineering projects. This is done to calculate the project profit and loss value of each construction scheme under various natural states by analyzing various factors of the change of project decision-making problems when the decision-making problems cannot be determined (Bosch-Rekveldt, 2011; Galli & Battiloro, 2019;