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Time-Cost-Quality-Risk of Construction and Development Projects or Investment

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Abstract: In this paper, the survival pyramid including time, cost, quality and risk in construction and development projects and investment has been taken into consideration and explanation. The results for other industries such as automotive, appliances and electronic devices, leading industries and etc can be used. The purpose of considering them is to create balance among time, cost, quality and risk to make the best level of customers' satisfaction and end users and to obtain the most optimal level of value for organization. In recent years, examining the relationship between competitive advantages in the leading industries and industrialized countries are still under discussion. Every year, large companies spend large sums on the research and development about the most optimum combination of production or the most optimum function and feature of their products and services. The impact of poor quality on the price of products and organization earnings and the amount of cost should be paid for high quality has raised many important issues affecting cost accounting, quality control, repairs and maintenance, supply chain, production management, stores, safety and health, education and improvement and so forth.

Key words: Time · Cost · Quality · Risk · Survival pyramid · Construction · Project · Investment

INTRODUCTION

Initiating to implementing an investing plan or a project is the first step to entry the business world competition and survival in this complex and uncertainty environment needs to step steady and intelligently by optimized decision making. A project is an organization of people dedicated to the deployment of a set of resources for a specific purpose or objective [1]. Project management is defined as planning, directing and controlling resources to achieve specific goals and objectives of the project [2]. Construction and project planners often face the challenge of optimum resource utilization to compromise between different and usually conflicting aspects of projects and one important aspect of project management is to know about the information related to the optimum balance between the project's objectives [3]. Time, cost, quality and risk as four critical objectives of construction project management, are not independent but intricately related. Trade-offs between project duration, total cost, quality and risk are extensively discussed in the project scheduling literature because of its practical relevance and it is one of the highly important issues in project accomplishment and has been ever taken into consideration by project managers. Heretofore, extensive researches to develop time-cost-quality trade-off problems have been conducted. Nowadays, in engineering contracts, the risk of projects is also added to them. The aim of time-cost-quality-risk trade-off problem is to accomplish the project or to select a set of activities by considering the minimal cost, time and risk and the maximal quality simultaneously.

Quality: Improving quality is considered by many to be the best way to enhance customer satisfaction, to reduce manufacturing costs and to increase productivity. Any serious attempt to improve quality must take into account the costs associated with achieving quality, since nowadays it does not suffice to meet customer requirements, it must be done at the lowest possible cost as well. This can only happen by reducing the costs needed to achieve quality and the reduction of these costs is only possible if they are identified and measured [4]. Quality is said to be an ambiguous term understood differently by different people. It is sometimes defined as activities designed to improve organization and its services and also known as achieving pre-defined standards. It is also believed that quality is the characteristics of a product or service that bear on its ability to affect customers' buying decisions and

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satisfaction which is a determining factor influencing activities of entities [5]. It recognized four categories of quality costs: (1) prevention; (2) appraisal; (3) internal failure; and (4) external failure. These categories have been well accepted within the quality and accounting professions and have been included in international. However, in many companies quality costs are not calculated explicitly but are simply absorbed into other overheads.

In order to improve quality an organization must take into account the costs associated with achieving quality since the objective of continuous improvement programs is not only to meet customer requirements, but also to do it at the lowest cost. There is no general agreement on a single broad definition of quality costs. CoQ is usually understood as the sum of conformance plus non-conformance costs, where cost of conformance is the price paid for prevention of poor quality (for example, inspection and quality appraisal) and cost of non-conformance is the cost of poor quality caused by product and service failure (for example, rework and returns) [6].

Quality is the degree of excellence or superiority is a combination of attributes, properties, or characteristics that give each commodity value in terms of its intended use or may mean beauty, function and performance. If a product fulfils the customer's expectations, the customer will be pleased and consider that the product is of acceptable or even high quality. If his or her expectations are not fulfilled, the customer will consider that the product is of low quality. This means that the quality of a product may be defined as "its ability to fulfill the customer's needs and expectations". Quality needs to be defined firstly in terms of parameters or characteristics, which vary from product to product. For example, for a mechanical or electronic product these are performance, reliability, safety and appearance. For pharmaceutical products, parameters such as physical and chemical characteristics, medicinal effect, toxicity, taste and shelf life may be important. For a food product they will include taste, nutritional properties, texture and shelf life and [7] and for investment plans and construction projects it should be defined. Customers seek for maximum quality and if they able to pay its price then it would tell that quality is free. Because of trade off between cost and quality to maximize the profit, this theory is not true everlasting [8]. Sometimes quality is more important even though it costs more and take more time. It was mentioned that the Project Quality Management includes the processes to ensure that the project will satisfy the needs for which it was undertaken [9].

It is believed that quality is a factor affecting decision making and paying attention to it can make our decision economic. In other words, avoiding quality, as a worthwhile investment, is not economic. Quality is not an abstract, instrumental, luxurious and unnecessary characteristic of the business, but it is a culture, life style, paradigm and new approach to the managerial thinking. Giving serious attention to quality is found to be the main success factor of those organizations which are undisputed economic power in today's world and have a high share of global market [5]. Quality management points to the strategic policies, methods and procedures assuring production of high quality products and services cover customers' demands. The concepts of quality and quality management dates back to the era of constructing Takht-e-Jamshid in Iran and Pyramids in Egypt [10]. It is noteworthy to say that employer's level of satisfaction, quality of finished product and the extent to which customers' needs and demands are satisfied are considered as quality measurement indicators.

The broad concept of the "economics of quality" can be traced back to the early 1950s when the "cost of quality" (CoQ) was first propounded in Juran's Quality Control Handbook and in Feigenbaum's Total Quality Control. Since then, many quality-control experts have written about quality-cost systems and the importance of quality-related costs has been increasingly recognized. Quality-related costs represent a considerable proportion of a company's total costs and sales [6].

Internal failure costs are the costs that would disappear if no defects existed prior to shipment to the customer. These costs include rework, scrap, re-inspection, re-testing, corrective action, redesign, material review, material downgrades, vendor defects and other like defects. External failure costs are the costs that would disappear if no defects existed in the product after shipment to the customer. These costs include processing customer complaints, customer returns, warranty claims and repair costs, product liability and product recalls. Appraisal costs are the costs incurred while performing measuring, evaluating, or auditing to assure the quality conformance. These costs include first time inspection, checking, testing, process or service audits, calibration of measuring and test equipment, supplier surveillance, receipt inspection etc.. Prevention costs are the costs related to all activities to prevent defects from occurring and to keep appraisal and failure to a minimum. These costs include new product review, quality planning, supplier surveys, process reviews, quality improvement teams, education and training and other like costs [11].

Many economic and mathematical models have been developed to find the optimum COQ. The traditional model detailed by Brown and Kane [12] [13] has got widespread acceptance. According to this model there is an inverse relationship between prevention and appraisal effort and failure cost. The optimum conformance to quality or defect level is where the increasing costs of the prevention and appraisal curve converges with the curve of decreasing failure costs. Total quality costs are minimized to the point where the cost of prevention plus appraisal equals the cost of failure. The total quality cost curve represents the sum of the other two curves and the location of the minimum point on the total quality cost curve, sometimes referred to as the optimum point [13].

In order to improve quality an organization must take into account the costs associated with achieving quality since the objective of continuous improvement programs is not only to meet customer requirements, but also to do it at the lowest cost [6].

No matter which quality costing approach is used, the main idea behind the COQ analysis is the linking of improvement activities with associated costs and customer expectations, thus allowing targeted action for reducing quality costs and increasing quality improvement benefits. Therefore, a realistic estimate of COQ, which is the appropriate tradeoff between the levels of conformance and non-conformance costs, should be considered an essential element of any quality initiative and a crucial issue for any manager. A number of organizations are now seeking both theoretical advice and practical evidence about quality related costs and the implementation of quality costing systems [4].

Time: In today's competitive business world, time management is a key factor to success. The organizations are required to reduce the time they spend responding to customers and developing new products. Less time means faster response to customers' and market conditions changes [8], i.e. feasibility of operational efficiency. Paying attention to the three dimensions of time including time of new product and service development, time of response to customer and time of product delivery may cause activities to have timely measurable goals and it may improve responses and determine and remove reasons for poor quality [5]. There is a close relationship between time of response to customers and product delivery and customers' satisfaction. It is generally realized that when project duration is compressed, the project will call for an increase in labor and more productive equipment and require more demanding procurement and construction management and then the cost will increase.

To solve the problems of optimizing investment projects, one should consider delivery time to customer that is the result of time of doing each level of project in turn. On the one hand, very short time may have negative effect on the quality and cost and on the other hand, very long time may also have negative effect on the cost and often doesn't have much impact on quality. However, both cases, especially long time, may increase the risk of project. In the initial assessment of the project, time is supposed to be the most important factor calculating the present value and other time-based indicators and any changes in the time may turn the investment project into a non-economic one. During various stages of project implementation, time is considered based on shift work. In the case used in this study, each shift work is known as a day. If a day is consisted of a morning and a night shift, the work time is considered as two days, but if there is only one morning shift, time is regarded as one day; or if there is only one night shift, the time is also known as one day.

Cost: Cost is traditionally known as price of making goods or doing the services by which cost accounting considers various approaches and in new paradigm, management accounting deploys knowledge of cost management. There is a direct relationship between cost and organization efficiency. From this perspective, efficiency means the ability to convert input to the output with the lowest cost [8]. Cost management is an approach used to realize decisions made for planning, controlling and developing competitive strategies and it is noteworthy to say that making balance between this factor and other dimensions of competition such as quality and time is required to apply management on it aiming to help maximize the profits and value creation of the organization in current activities and future [14]. Project costs include direct and indirect (overhead) costs of project. After revenue, cost is one of the main characteristics of any business. All organizations, keeping and improving their quality, are seeking to reduce their cost to finally be able to optimize wealth of shareholders and to create value.

The cost of a given project is usually computed by enumerating its features. You can't reduce the cost without sacrificing features or deadlines. You can't increase features without incurring extra costs. Everyone likes to control the cost factor because it is the easiest one to see the effect on bottom-line profitability.

Cost management is found to be a major tool to achieve strategic goals. Cost is the result of resource consumption and actually is regarded as those resources made sacrifice to gain value. To save resources and costs

in the course of this process, it is necessary to remove those activities without value added and to strengthen and combine parallel activities seeking to create value. It should also be noted that those activities required to improve and complete the quality of services must be added to the organization activities. In this study, the concept of cost is considered as both direct and indirect costs.

Risk: Risk has been successfully used in theories of decision making in economics, finance and the decision science [15]. Risk has different meaning to different people; that is, the concept of risk varies according to viewpoint, attitudes and experience. Engineers, designers and contractors view risk from the technological perspective; lenders and developers tend to view it from the economic and financial side [16]. There is no construction project with risk free [17], but it can be managed, minimized, shared, transferred or accepted. It can not be ignored.

As the underlying concept of risk management is to manage risks effectively, risk management is a critical part of project management [18]. The economical crisis situations and the environmental and society complex processes as risk management systems in the past years indicate new mathematical model constructions to predict their effects. Project risk is defined by Project Management Body of Knowledge [19] published by the Project Management Institute (PMI) as an uncertain event or condition that, if it occurs, has a positive or a time, cost, span or quality, which implies an uncertainty about identified events and conditions. PMBOK describes risk through the notion of uncertainty. Ward and Chapman [20] criticize the use of Probability-Impact grid to size risk, arguing that it generated unnecessary by over-simplifying estimates of impact and probability. As an alternative to probability-impact grid based approaches, they propose six steps 'minimalist' approach for estimating uncertainty.

Jannadi and Almishari [21] attempt to assess risks associated with various constructions project activities, defining risk as the potential damage that may affect personnel or property. They model risk by probability, severity of impact and exposure to all hazards of an activity and provide software to generate risk scores. However, they do not provide a methodology for aggregating risk ratings. It is important to consider the risk of project, insomuch Chapman and Cooper [22] as pioneers introduced the risk engineering and discussed about the needs for structuralizing of different project risk.

A three dimensional risk model: Significance-Probability-Impact is presented by Han *et al*. [23]. They define 'risk significance' as the degree to which a practical expert feels risk intuitively (as it is used in this paper), this includes a general recognition of risk, the difficulty of gaining information and implementing management skills, the degree of indirect or potential loss and the relationship between project profitability and attitude toward risk. The output of a risk assessment task is a risk rating score related to a specific risk path source-event, or project scenario; however one of the major steps in project risk management is to identify and assess the potential risks [24]. As a probabilistic approach cannot be utilized to quantify risks, individual knowledge, experience, intuitive judgment and rules of thumb should be structured to facilitate risk assessment [25]. To evaluate project risk, Dikmen *et al*. [25] suggested a fuzzy approach based on difference between actual cost and expected cost. It is interesting to note that what distinguishes this approach from others is the research emphasis on the control capability and risk management.

Some risk quantification methods include using mental estimation methods, analytical hierarchy process, fuzzy techniques and various algorithms such as risk-pricing algorithm, risk cost, threats and opportunities. To add risk to the existing technical sample (Table 1) and to increase the validity and reliability, this study enjoys a fuzzy analytical hierarchy process, though the calculations are not included in this paper.

Survival Pyramid: In today's developing business environment resulted from globalization and competitive conflicts, organization survival depends on paying attention to value creation management and establishing optimum relationship between optimal value and customer satisfaction and optimal value for organization. Quality and delivery time along with cost are among elements of survival triangle considered as one of the major approaches of management accounting in value creation cost management [5] to which the factor of risk is added and the result would be "Survival Pyramid" shown in fig. 1. These factors consume organizational resources and affect the organization's value creation. The component of the survival pyramid are among essential factors determining strategies for achieving success and it is interesting to note that their relationship with each other and their effect on profitability and rate of return on investment as measure of success have drawn researchers' attention.

According to Hilton *et al*. [8], high quality has a direct relationship with high productivity and is the result of shorter time periods and high throughput. They consider combination of quality, time, productivity and capacity to be the same as on time production management. In view of operation, quality may cause promotions in the functional and structural features of the products and services and activities occurring along these actions are maintained to consume organizational resources. It is interesting to note that individuals are not willing to pay more for certain level of quality and time (performance). Additionally, customers usually expect that new products should have higher quality and functional capabilities without being subjected to additional costs. Optimization can be considered as a tool for value engineering among time (performance), cost and quality considered as the elements of survival pyramid.

More specially, the Society of American Value Engineers (SAVE) defined value engineering as the systematic application of recognized techniques by a multi-disciplined team which identifies the function of a product or service; establishes a worth for that function; generates alternatives through the use of creative thinking; and provides the needed functions, reliably, at the lowest overall cost. The goal of value engineering is not only to reduce costs, but also to increase "value". By the way, optimization is resource allocation, input assimilation and functions performed to achieve pre-defined goals of project. On the other hand, in the competitive environment, economic enterprises take advantage of three strategies for competition.

The first strategy known as cost leadership aims to provide products with lower price, function and cost. The second strategy is product differentiation. These strategies include steps to meet customers' requirements, supply products with best function and higher prices and provide idiosyncratic services. Strategy focusing on the market and specific competitive advantages comprise the third strategy. Due to the changes in the economic conditions and the globalization of the market, the strategies of cost leadership and product differentiation do no longer meet the present conditions and the new economic environment requires that organization take advantage of confrontation strategies in which economic entities compete with each other based on the principles of survival pyramid and try to produce goods with good quality, high function and low cost value [5].

RESULTS AND DISCUSSION

The present research considered the problem of balance between time, quality, cost and risk. Nowadays, production and delivery time, price, risk and quality are considered as the most important competitive advantages in industries. Hence, in recent years, examining the relationship between competitive advantages in the leading industries and industrialized countries are still under discussion. Every year, large companies spend large sums on the research and development about the most optimum combination of production or the most optimum function and feature of their products and services. The impact of poor quality on the price of products and organization earnings and the amount of cost should be paid for high quality has raised many important issues affecting cost accounting, quality control, repairs and maintenance, supply chain, production management, stores, safety and health, education and improvement and so forth.

Project managers and management accountants perform crashing with the aim of reducing the total cost, time and risk along with maximizing the total quality. It is noteworthy to say that the balance between various components of survival pyramid is not only interesting to production and operational activities, but such a balance may guarantee the long-term success of organization in service and support activities affecting the amount of increase and decrease in cost and achieving success. It is interesting to note that new business strategies are formed based on these factors.

REFERENCES

1. KarimiAzari, A. *et al*., 2011. Risk assessment model selection in construction industry, Expert Systems with Applications, 38: 9105-9111.
2. Fan, M., N. Lin and C. Sheu, 2008. Choosing a project risk-handling strategy: An analytical model, International Journal of Project Management, 112: 700-713.
3. Afshar, A., A. Kaveh and O.R. Shoghli, 2007. Multi-objective optimization of time-cost-quality using multi-colony ant algorithm, Asian Journal of Civil Engineering, 8(2): 113-124.
4. Schiffauerova, A. and V. Thomson, 2006. Managing cost of quality: Insight into industry practice, The TQM Magazine.

5. Rahnamayroodposhti, Fraydoon, 2008. Strategic Management Accounting: Creating Value Cost Management Emphasis: Science and Research Branch, Islamic Azad University, Tehran, Iran.
6. Vaxevanidis, N.M. and G. Petropoulos, 2008. A Literature Survey of Cost of Quality Model. Annals of the Faculty of Engineering Hunedoara-Journal of Engineering. Tome VI, pp: 274-283.
7. UNIDOU, 2006. Product quality, A guide for small and medium-sized enterprises, Working paper, United Nations Industrial Development Organization, Vienna.
8. Hilton, R., M. Maher and F. Selto, 2008. Cost Management, Strategies for Business Decision, 3rd edition. Irwin/McGraw-Hill.
9. Refaat, H. Abd El Razek, Ahmed M. Diab, Sherif M. Hafez and Remon F. Aziz, 2010. Time-Cost-Quality Trade-off Software by using Simplified Genetic Algorithm for Typical-repetitive Construction Projects, Journal of World Academy of Science, Engineering and Technology, pp: 61.
10. Collier, D. and J. Evans, 2009. M, Ed. 1. Cengage Learning.
11. Zimak, Gary, 2000. Cost of Quality (COQ): Which collection system should be used?, ASQ's 54th Annual Quality Congress Proceedings, pp: 18-24.
13. Kazaz, *et al.,* 2005. Cost-Based Analysis of Quality in Developing Countries: a Case Study of Building Projects, Building and Environment, 40: 1356-1365.
14. Rahnamayroodposhti, Fraydoon and Jalili, Mohammad, 2009. Target Costing, (first ed.), Terme Publication: Tehran.
16. Baloi, D. and A.D.F. Price, 2003. Modelling global risk factors affecting construction cost performance, International Journal of Project Management, 21: 261-269.
17. Lam, K.C., D. Wang, P.T.K. Lee and Y.T. Tsang, 2007. Modelling risk allocation decision in construction contracts, International Journal of Project Management, 25: 485-493.
18. Lyons, T. and M. Skitmore, 2004. Project management in the Queensland engineering construction industry: A survey. International Journal of Project Management, 22: 51-61.
19. Project Management Institute, 2004. A guide to the project management book of knowledge (PMBOK), (3rd ed.). Newtown Square, PA: Project Management Institute.
20. Ward, S. and C. Chapman, 2003. Transforming project risk management into project uncertainty management International Journal of Project Management, 21: 97-105.
21. Jannadi, O.A. and S. Almishari, 2003. Risk Assessment in Construction, Journal of Construction Engineering and Management, 129(5): 492-500.
22. Chapman, C. and D. Cooper, 1983. Risk Engineering: Basic Controlled Interval and Memory Models, Journal of the Operational Research Society, 34(1): 51-60.
23. Han, S.H., D.Y. Kim, H. Kim and W.S. Jang, 2008. A web-based integrated system for international project risk management, Automation in Construction, 17: 342-356.
24. El-Sayegh, S.M., 2008. Risk Assessment and Allocation in the UAE Construction Industry, International Journal of Project Management, 26: 431-438.
25. Dikmen, I., M.T. Birgonul and S. Han, 2007. Using fuzzy risk assessment to rate cost overrun risk in international construction projects, International Journal of Project Management, 25: 494-505.

In the course of development, each project undergoes several stages (Vilensky, Livshits, and Smolyak 2002). Their combination is called the project life cycle or life period, that is, the period of time between the creation of the project and its completion. Each stage is characterized by its own set of risks.Â obligations by the project participants; 8. The risk of increased schedule cost can be caused by incorrect project design, inefficient.Â At the phase of direct financing, the main role is played by measures such as ensuring the timely completion of the project, the exact implementation of the contract terms for construction and installation works and supply of fixed assets, insurance, etc.Â In practice, when analyzing risk of investment projects, quantitative and qualitative methods are applied.