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COST MANAGEMENT OF PROJECTS USING A STANDARD PMBOK IN ENGINEERING PROJECTS

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ABSTRACT

Management method of cost project always is a key and effective agent on the success or defeat of a project. PMBOK describes all sciences related to project management cycle that contains some conventional styles as well as some initiative and modern sciences. Using PMBOK to understand about implementation of projects by confirmed budget is one of main benefits so. That is why, the cost management has been based on four plans include the resource, cost estimation, budget planning and cost control. On the other hand, each plan contains three parts such as input, output and processing. Therefore, all plans and parts help to operate the system in a framework of strategy defined and systematic idea so this trend indicates that each plan can be an input for next plan. In current study was surveyed a standard PMBOK in some of civil engineering and industrial projects in Iran. The actual concepts of the PMBOK were studied on the projects implemented to manage the cost. Obtained results of parametric models and cost estimates indicated that management of projects has been based on a standard PMBOK in Iran. Employers also observed a management view-point on implementation of projects instead of control as well as a systematic view on the projects ingredients.

KEYWORD: Cost management, projects, Project Management Body of Knowledge

Nomenclature	
PMBOK	Project Management Body of Knowledge
EFQM	European Federation for Quality Management
KBEM	Kanji's Business Excellence Model
BE	Business Excellence
OE	Organization Excellence
TQM	Total Quality Management
CSF_S	Critical Success Factors

INTRODUCTION

Project management is defined in the PMBOK of the Project Management Institute to as (Duncan 1996) "Project Management is the application of knowledge skills tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands among: (1) Scope, time, cost and quality (2) Stakeholders with differing needs and expectations (3) Identified requirements (needs) and unidentified requirements (expectations)." These frameworks can investigate in excellence and economic of the project or business [1,2]. The first time, the Peters and Waterman were introduced the concept of excellence in relation to management and organizational performance about 25 years ago. Using EFQM for organizational self-assessment has started in 1992 in Europe. [2,3]. After studies at higher education institutions in Northern Ireland, it was concluded that the EFQM in different ways for different purposes are used in an organization. Senior executives from 40 European Companies such as Renault, Fiat, Philips, British Telecom, and others were based on the EFQM [4]. These models have been used in various countries such as USA, UK, Malaysia and Japan. EFQM was based by 14 European large Companies and at first was implemented as a model to measure the European quality award in 1998. European universities have used EFQM as the discipline for the measurement of their performance [5,6]. Tambi et al. (2008) has suggested the use of KBEM as a tool for quality review and enhancement of higher

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education institutions [7]. The study of Hassanpour (2014) has reported the trend of sustainable development using KBEM in used motor oil industries. These excellence models are used for any service or department is depending on scores against criteria or factors [8].

Based on the study of Damjan et al. (2005) many definitions of sustainability include the environmental performance, societal responsibility and economic evaluations. Economic estimates of indices concerns the impacts of the industry on the economic identity of its stakeholders on layout feasibility to establish [9]. Walter et al. (2004) were explained the knowledge economy as production and services based on knowledge-intensive activities that help to an accelerated step of technical, scientific advance and rapid obsolescence [10]. The will follow societal responsibility the both quality of products and solving the environmental problems of industry. The research of Fagerberg (2000) reported that growth and development of industries have an important and significant role to achieve stable and rapid economic growth and development. Exports have a positive impact on the industries [11,12]. The economic benefit of any project is a vital requirement for its viability. The major costs can be divided into organization and control costs incurred by the central office, collection cost and operational costs of the final storage facility prior to reprocessing costs. Cost estimates are based on a detailed evaluation that reflects typical investment costs, interest rates, overhead costs, transportation costs, materials, equipments and fixed, working costs and etc to establish and recover [13,14]. Kasteren et al. (2007) have studied on the conceptual design of a production process with economic indices such as the raw material price, plant capacity, production price and capital cost in the conversion of waste cooking oil to biodiesel [15]. Marchetti et al. (2008) have studied the economic indices such as evaluate productivity, raw material consumption, economic competitiveness and environmental impacts of each process [16]. Bradley et al. (2007) have studied on the relationship between oil prices and some of key macro-economic variables. [17]

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METHODS

Project management based on PMBOK	1- Project management in term of cost. 2- Project management in term of area 3- Project management in term of defining, designing and integrating. 4- Management of human resource. 5- Quality management. 6- Project management in term of time. 7- Project management in term of selling and preparing the equipments. 8- Management of risks. 9- Management of relations and equipments
Project management in term of cost	1- Planning resources 2- Cost estimation 3- Observe of budget 4- Cost control
Planning resources	Inputs : 1-Work Breakdown Structure (WBS) 2-Work Experience 3-Documents of work area 4-Explaining of initial resources 5-Organization policies 6- Estimation of activities time Outputs: (required resources) Techniques and tools of processing: 1-(Excellence justice by: active units, consultants, professional persons, especial assemblies, industrial groups) 2-Knowing of cases

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Cost estimation	Inputs : 1-WBS 2-Required resources 3-Resource rates 4-Estimation of activities time 5-Work experience 6-Accounts inventory 7- Risks Outputs: 1-Cost estimation 2-Planning of cost management 3- Other cases Techniques and tools of processing: 1-Comparison estimation 2- Parametric models 3- Estimation of down to up 4- Computer techniques
Planning resources	Inputs : 1-Cost estimation 2-WBS 3- Time project 4- planning of risk management Techniques and tools of processing: 1-Comparison of estimations 2- Parametric models 3- Estimation of down to up 4- Computer techniques Outputs: 1- cost baseline
Cost control	Inputs : 1-Cost baseline 2-Performance report 3-Required changes 4- Planning on cost management Techniques and tools of processing: 1-Control system of cost change 2- Performance assessment 3-Earned value management (EVM) 4- Computer tools 5- Extra planning Outputs: 1-Revision on estimated cost 2- Applied budget 3- Performance correction 4-Total cost estimation 5- Learning 6- Finishing the project.

RESULTS AND DISCUSSION

3.1-Project management based on PMBOK

Many models have been developed to measure the BE. The EFQM is a non-prescriptive of TQM framework based on nine criteria. The EFQM has been based on the assumption that excellence of project is achieved through leadership driving policy and strategy that are delivered through people, partnership, resources and processes. There are important similar concepts between main models of BE in term of factors such as leadership, management and human resource development, processes management, training and learning [18,19]. The road construction Companies are large group from Companies that are active as private or part of government organizations. An uncountable group of Companies participate in the field of roads construction in Iran [20]. Table 1 shows the list of completed projects by three Companies. There were 30 staffs in workshops. Also, there were more than 45 completed projects by these Companies.

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Table 1 List of completed projects by three companies

Performed project	Location	Year	Project time	Workshop No.	profit%	Companies
Landscaping	Shiraz	2014	2 months	4650002530	30	Hamta Rah Tasbit Aria
Landscaping	Shiraz	2013	3 months	4650002382	30	Imen Rah Kavosh Fars
Landscaping	Shiraz	2013	2 months	4690008619	33	Hamta Rah Tasbit Aria
Pavement and asphalt	Shiraz	2013	2 months	4650002530	25	Hamta Rah Tasbit Aria
Pavement and asphalt	Shiraz	2012	1 month	4650002382	20	Imen Rah Kavosh Fars
Pavement and asphalt	West Azarbaijan	2012	5 months	2880007188	18	Imen Rah Kavosh Fars
Landscaping	West Azarbaijan	2012	6 months	2860005299	22	Imen Rah Kavosh Fars
Landscaping	Shiraz	2012	1 month	4690008619	28	Imen Rah Kavosh Fars
Pavement and asphalt	West Azarbaijan	2011	2 months	2880007188	35	Imen Rah Kavosh Fars
Pavement and asphalt	West Azarbaijan	2011	2 months	2900000335	15	Imen Rah Kavosh Fars
Landscaping	West Azarbaijan	2011	3 months	2980004320	29	Imen Rah Kavosh Fars
Pavement and asphalt	West Azarbaijan	2011	7 months	2860005299	24	Imen Rah Kavosh Fars
Pavement and asphalt	West Azarbaijan	2010	8 months	2880007188	14	Imen Rah Kavosh Fars
Pavement and asphalt	West Azarbaijan	2013	2 months	2940005793	10	Zamen Rah Gharb
Landscaping	West Azarbaijan	2013	6 months	2810025970	23	Zamen Rah Gharb
Pavement and asphalt	West Azarbaijan	2012	1 month	2948005793	11	Zamen Rah Gharb
Pavement and asphalt	West Azarbaijan	2011	2 months	2848005792	8	Zamen Rah Gharb
Landscaping	West Azarbaijan	2010	3 months	2850005783	17	Zamen Rah Gharb
Landscaping	West Azarbaijan	2009	2 months	2744005763	21	Zamen Rah Gharb
Pavement and asphalt	West Azarbaijan	2008	4 months	2740005793	16	Zamen Rah Gharb
Pavement and asphalt	West Azarbaijan	2006	2 months	2744005793	13	Zamen Rah Gharb

Every one of KBEM factors has a worth equal with 50 scores in EFQM. Therefore, in the suggested system were added 900 scores for criteria in EFQM until KBEM be enable to measure OE rates in a diagram. Every one of criteria of the EFQM must be matched with more than one dimension of KBEM. KBEM framework is depends on CSFS. CSFs include the required activities to get the project objectives. Therefore, CSFS are related with key motors of performance. OPI is the final outcome of overall OE in leading all CSFS. In order to survey different criteria together were used multiple weighting systems. Results study of Hassanpour et al (2014), showed the comparison of scores system in three companies using models (Business excellence) based on PMBOK (Table 2) [21].

Table 2 Comparison of scores system in three companies

KBEM (Hamta Rah Tasbit Aria)		EFQM	
Criteria	Score	Criteria	Score
Leadership	75.66	Leadership	94.16
Satisfy the citizen and customers	100	Policy and strategy	91.66
Satisfy the external customers	100	Employees	92.5
Satisfy the internal customers	100	Resources and partnership	60
Fact-based management	100	Process	82
Process or total work	60	Customer results	100
Measurement	50	Employees results	85
Management relies on employees	50	Community results	100
Team work	50	Key performance results	87.5
Employees make quality	90	-	-
Continuous improvement	88.33	-	-
Continuous improvement cycle	90	-	-
Prevention	74	-	-
OPI or performance excellence index	840.66	OPI	753.15
KBEM (Imen Rah Kavosh Fars)		EFQM	
Criteria	Score	Criteria	Score
Leadership	74.66	Leadership	90.16

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Satisfy the citizen and customers	100	Policy and strategy	92.66
Satisfy the external customers	100	Employees	82.5
Satisfy the internal customers	100	Resources and partnership	60
Fact-based management	100	Process	85
Process or total work	62.67	Customer results	100
Measurement	50	Employees results	65
Management relies on employees	50.25	Community results	100
Team work	52.8	Key performance results	80.33
Employees make quality	90.5	-	-
Continuous improvement	88.33	-	-
Continuous improvement cycle	90.5	-	-
Prevention	74	-	-
OPI	844.53	OPI	738.44

KBEM (Zamen Rah Gharb)		EFQM	
Criteria	Score	Criteria	Score
Leadership	79.66	Leadership	90.16
Satisfy the citizen and customers	100	Policy and strategy	93.66
Satisfy the external customers	100	Employees	82.9
Satisfy the internal customers	100	Resources and partnership	60
Fact-based management	100	Process	88
Process or total work	62.67	Customer results	100
Measurement	50	Employees results	68
Management relies on employees	53.25	Community results	100
Team work	52.8	Key performance results	83.33
Employees make quality	91.5	-	-
Continuous improvement	88.33	-	-
Continuous improvement cycle	93.5	-	-
Prevention	74	-	-
OPI	849.53	OPI	748.44

Table 3 Comparison of scores system in a Hospital

KBEM		EFQM	
Criteria	Score	Criteria	Score
Leadership	63.4	Leadership	63.9
Satisfy the citizen and customers	70.5	Policy and strategy	64.2
Satisfy the external customers	64.6	Employees	62
Satisfy the internal customers	68.3	Resources and partnership	57.3
Fact-based management	59	Process	59.9
Process or total work	59.2	Customer results	68.5
Measurement	48.4	Employees results	63.1
Management relies on employees	62.7	Community results	67.1
Team work	66.2	Key performance results	63.3
Employees make quality	60.3	-	-
Continuous improvement	67	-	-
Continuous improvement cycle	62.8	-	-
Prevention	63.5	-	-
OPI	744	OPI	633

Table 3 shows the results of case study the Amiri. (2005) in an Hospital. In the case study the both factors of focus on customer and social results were strength points but process management, resources and partnership the weakness points. The weakness points need to boost and improve [22, 23]. The study of Arjomandi et al. (2009) using EFQM showed that implementation of policies and methods will guarantee the quality in all aspects of its activities in universities [24]. Tambi (2000) has suggested the use of KBEM to explaining the values of improved indices and corresponding performance indicators as a method to improve quality and study of higher education

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departments [25]. The study of Dahlgaard, (2007) to interpret excellence by focusing on some of the CSF_S showed that the results will have great advantages both for researchers and practitioners as well as organizations [26]. The study of Baidoun, (2003) presents the full agreement results of TQM about 100 percent in 78 organizations, 78 targets, with 78 usable questionnaires, 19 factors from through three tiers in Palestinian [27]. Gopal et al. (1999) had reported good fit for the supply chain activities of 139 companies in relationships between supply chain management and TQM using KBEM on supply chain activities in Hong Kong [28].

The survey Tutuncu et al. (2007) showed relationship significant between EFQM and organizational commitment of Meyer & Allen Organizational Commitment scale. Leadership, partnerships and resources, policy and strategy, affective commitment, processes, results, people development and involvement and continuance commitment were the determinants of the organizational commitment and EFQM respectively [29]. The study of Hendrics (2000) on 600 awards winning companies in North America with selected companies from the same industry were founded relationship significant in the post implementation period (5 years after the award). The same companies experienced 8% mean increase in 1 year after the award in sales revenues to 17%, 3 years after the award and 77%, 5 years after the award. Also, there was a higher mean increase of 18% in operating income, 40% in total assets and a 4.4% reduction in cost over sales 5 years after the award [30]. The results of study Ritchie D, (2000) in 10 companies on the self-assessment practices using business excellence model showed that potential to analyze organizational performance and areas to improve and promote the commercial aspects were underestimated by leaders and the quality award process was diluting their effects. [31]. Dong-Ling et al. (2006) used of multiple criteria by software on business excellence model. The results showed handling different types of uncertain and incomplete data and wide range of information such as scores, performance diversity, strength and weakness profile and graphics [32].

3.2-Estimation, control and observation of cost

Studies of economic evaluation are performed with empirical equations 1 to 10 and professional experiences in industries and etc [33,34]. Table 4 shows steps of an economic estimation in industries.

1-Estimation of requirements from projects
2-Estimation of fixed and working capital
3-Estimation of depreciation costs, maintenance, operational and non-operational fixed annual capital
4-Estimation of total fixed and variable manufacturing costs
5-Estimation of total manufacturing price
6-Estimation of economic indices

$$W = 0.75(\sum e) \times A \quad \text{equation (1)}$$
$$C = 0.005 \times P \quad \text{equation (2)}$$
$$V = p - ((\sum)e + A' + F + Cf) \quad \text{equation (3)}$$
$$\%V = V \times 100 / p \quad \text{equation (4)}$$
$$Qp = V - ((\sum)I + L + D + S) \quad \text{equation (5)}$$
$$Cv = Cvd / Cp \quad \text{equation (6)}$$
$$Ph = Tf / Cv - Cs \quad \text{equation (7)}$$
$$Cpi = Cvp + Cfp \quad \text{equation (8)}$$
$$Ai = Ts - Cpi \quad \text{equation (9)}$$
$$Vt = If / Ai \quad \text{equation (10)}$$

In equations 1 to 10, W, e, A, C, P, V, A′, F, C_f, Q_p, I, L, D, S, C_v, C_{vd}, C_p, P_h, T_f, C_s, C_{pi}, C_{vp}, C_{fp}, A_i, T_s, V_t and I_f, are the required electrical energy, sum of electrical energy consumption (facilities, manufacturing line apparatus, building and campus), area (m^2), selling costs, selling price, value-added, initial materials (Additives, materials, boxes and barrels), maintenance, unforeseen costs, profit, insurance, cost of interest and fees, depreciation, salary, variable costs of good unit, variable project costs, production capacity, breakeven point, total fixed costs, selling cost of good unit, manufacturing costs, variable manufacturing costs, fixed manufacturing costs, annual income, total selling price, time of return on investment and fixed capital respectively [35,36]. The equipments cost which

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contributes to the capital cost was calculated from the data of DACE price book (DACE (Dutch Association of Cost Engineers)).

Table 4 Economic estimation in industries

Requirements from projects
Preparing inventory
Fixed capital
Required land and landscaping
Investment in facilities
Investment in equipment and the installations costs
Investment in transportation
Unforeseen costs
Costs before of the operation
Total cost
Working capital
Required materials
Energy consumption (water, fuel, petroleum and electrical costs)
Staffs salary
Other costs
Cost of sales
Total cost
Depreciation costs, maintenance, operational and non-operational fixed annual capital
Landscaping, buildings, pavement and asphalt
Facilities and equipments
Equipments without installations costs
Office equipment, furniture, etc
Transportation cars
Unforeseen cost
Total cost
Depreciation costs of fixed capital
Equipments without installations costs
Landscaping, buildings, pavement and asphalt
Office equipment, furniture and etc
Transportation
Facilities and equipments
Costs before of the operation
Unforeseen cost
Total cost
Total fixed and variable manufacturing costs
Required materials
Maintenance
Energy consumption (water, fuel, petroleum and electrical costs)
Unforeseen cost
Staff salary
Depreciation of fixed capital
Interest and fees
Insurance
Unforeseen costs of working capital
Total cost
Total manufacturing price
Required materials
Staffs salary
Energy consumption

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Maintenance cost	
Depreciation of fixed capital	
Cost of insurance	
Cost of interest and fees	
Unforeseen costs	
Total cost	
Economic indices	
Data value	
Total value of annual selling of products	
Output value	
required materials	
Maintenance	
Energy consumption	
Unforeseen costs of fixed capital	
Total cost	
Value- added	
Value- added percent	
Profit	
Variable cost of good unit	
Breakeven point	
Production cost	
Annual income	
Time of return on investment	

The study of results research of Hassanpour et al (2014) on the survey of economic indices of the used motor oil industry equipped to acidic sludge recycling unit indicated the economic success of this project [37]. Other Study of Hassanpour et al. (2014), based on the economical point of view, the indices values such as value-added percent, annual income, breakeven point, value-added indicated monetary success for the acidic sludge recycling process. Table 5 shows the results of studies. The low breakeven point of about 14.7% and the time of return on investment 1.05 (about 13 months) demonstrated the fiscal success of this project. Further validation comes from the research of Iranian industrial organization which shows that low breakeven point of about 22.5% and the time of return on investment 0.9 (about 11 months) implied economic success of project for used motor oil reprocessing industries without acidic sludge recycling unit. [38].

Table 5 Economic indices of industrial projects

Economic indices of the used motor oil industry equipped to acidic sludge recycling unit	**Cost $**
Data value	
Grease	703125
Bitumen 54/130	417656.3
Motor oil	4125000
Total value of annual selling of products	5245781.3
Output value	
Additives, barrels and required materials	2240498.4
Maintenance	1624.075
Energy consumption	14814.1
Unforeseen costs of fixed capital	33049.43
Total cost	2289986
Value- added	2955795.3
Value- added percent	56.34 %
Profit	2795396.8
Variable cost of good unit	535
Breakeven point (6%)	260.83
Production cost	2470258.36
Annual income	2775522.94

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Time of return on investment	0.26 (3.2 months)
Economic indices of recycling acidic sludge project of reprocessing industries to bitumen	
Data value (value of annual selling of the product: bitumen)	417656.25
Output value	
Additives and barrels	108843.75
Maintenance	8214.77
Energy consumption	7407.125
Unforeseen costs of fixed capital	8055.85
Value- added	285134.75
Value- added percent	68.2%
Profit	249552.5
Variable cost of goods unit	141.8
Breakeven point (14.7%)	131.4
Production cost	169285.7
Annual income	248370.5
Time of return on investment	1.05
Economic indices of used motor oil industry (study of industries organization (2000))	
Value- added	73941.8
Value- added percent	36.3%
Breakeven point (14.7%)	22. 5%
Production costs	-
Annual income	-
Return time on investment	0.9

Table 6 shows the results of case study the Hassanpour (2014) in a case study of used motor oil industry. Based on the models criteria and results the industry was in sustainable development condition.

Table 6 Comparison of scores system in the used motor oil industry

KBEM		EFQM	
Criteria	Score	Criteria	Score
Leadership	90.33	Leadership	90.55
Satisfy the citizen and customers	77.5	Policy and strategy	87.7
Satisfy the external customers	60	Employees	85.83
Satisfy the internal customers	60	Resources and partnership	90
Fact-based management	74.16	Process	81.66
Process or total work	80	Customer results	78.33
Measurement	60	Employees results	73.88
Management relies on employees	70.41	Community results	70
Team work	98	Key performance results	49.42
Employees make quality	70	-	-
Continuous improvement	70.4	-	-
Continuous improvement cycle	70.8	-	-
Prevention	80	-	-
OPI	768.2	OPI	806.77

The economic assessment of kasteren et al. (2007) showed that biodiesel can be sold at US$ 0.17/L (125000 tons/year), US$ 0.24/L (80,000 tons/year) and US$ 0.52/L for the smallest plant capacities (8000 tons/year) with the existing alkali, acid catalyzed and a supercritical trans-esterification process. The study of Zhang et al. (2003) showed that for three biodiesel plants with capacities 100000 (1994), 7800 (1996) and 10560 (1999) tons/year the breakeven prices in $/ton were 340,763, 420 respectively which used both alkali- and acid-catalyzed processes with waste cooking oil as the raw material. Based on the study of Moosavi et el. (2013) which had reported that the value-added will increase almost equal to the average annual growth rate of 18 percent for industries sector since 2009 to 2025 years in Iran [39]. According to the research of Richard et al. (2006) which dealt with the four indicators of water quality (sediment yield, surface runoff, Nitrate in surface runoff and edge-of-

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field erosion), the Switchgrass grown on the cropland in Delaware basin in Kansas had a production between 527000 and 1.27 million metric tons of Switchgrass per year. The break-even price for Magnesium was calculated to be around $ 41 without used nitrate and slightly less than $ 25 at 224 kg of used Nitrate per ha K h^{-1}. Thus, the produced Switchgrass had a break-even price of $ 30 Mg^{-1} or less [40]. The economic analysis of Haenlein (2014) demonstrated that the breakeven point of 30, 37, 38% of total milk production (840.44, 991.16 and 982.87 liters) was obtained in commercial factories with three types of classification such as large, medium and small factories respectively. These results show that small Livestock owners can cover the total costs substantially in comparison with Livestock owners of medium and large easily [41].

CONCLUSION

These models were enabled to determine the strength and weakness points to improve and management costs. ***The objective to use these models was*** present a realistic strategy for continuous improvement of projects. The study showed that three Companies had suitable performance. The study of economic indices represent the confidence of performance the industries, excellence business and job opportunities. Economic indices are criteria to study of economic cycle of industry sector as main base of sustainable development. Generally, we can say that has been observed the framework of PMBOK in these projects.

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