Six Sigma project selections by using a Multi Criteria Decision making approach: a Case study in Poly Acryl Corp.

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Abstract
Six Sigma may be named as a powerful and comprehensive management tool which is necessary in order to bring changes in organization and also in making conformity with customer needs. Despite of other quality approaches, Six Sigma is not only a method, but it contains a vision, a goal and a symbol.Beside the six sigma, symmetrical valuation method is interpreted as a tool to collect strategy. This system offers a method to converge occupation's activities with strategy, and also it offers a method in order to watch the operation of strategic goals during time.Undoubtedly, the first step in reducing the risk failure of the Six Sigma projects is selecting the optimal choices.

In this paper, the effectiveness of criteria in choosing Six Sigma projects are identified and defined and the case study in Poly Acryl Corp is illustrated to demonstrate the effectiveness and practicality of the multi-criteria decision making approach to select six sigma projects. In fact, we evaluated how the multi-criteria decision making technique to select Six Sigma projects and goals will affect the organization.

Keywords:
Multi-Criteria Decision Making and Decision Analysis - Quality Management

1- Introduction

Over the past few years, manufacturing companies have been successful in leveraging six sigma, as a corporate strategy,to reduce the number of defective units from manufacturing processes thereby reducing costs and improving profits.Six sigma is now often thought of as the new mantra in the corporate world.The benefits of six sigma are extensively reported in the literature Hendricks and Kelbaugh, 1998; Harry, 1998; Hahn et al., 1999; Lanyon, 2003; Robinson, 2005). However, there are noticeable cases where Six Sigma failed to deliver the desired results. A survey conducted by the Aviation Week magazine among major aerospace companies reported that less than 50 percent of the companies expressed satisfaction with results from six sigma projects, nearly 30 percent were dissatisfied and around 20 percent were somewhat satisfied (Zimmerman and Weiss, 2005).Of significant note, the study identified that 60 percent of the companies in the survey selected opportunities for improvement on an ad hoc basis, while only 31 percent relied on a portfolio approach. However, the study shows that companies actually achieve better results when applying the portfolio approach. Among all, the process improvement techniques used in the last five decades, six sigma has clearly emerged as the most effective quality improvement technique as pointed out in a survey conducted by DynCorp (Dusharme, 2003).

In essence, six sigma is an extension of other quality initiatives such as Deming’s statistical quality control and total quality management (TQM). Six sigma, as with most of the management strategies on quality initiatives is focused around meeting the customer requirements as its main objective. Six sigma can be defined as a strategy that includes TQM, strong customer focus, additional data analysis tools, financial results and project management (Anbari, 2002; Kwak and Anbari, 2004). Although six sigma originated in the manufacturing industry to reduce the wastes due to manufacturing process deficiencies, it is now used by almost all industries including service industries such as health care management (Krupar, 2003; Antony, 2004; Antony and Fergusson, 2004; Moorman, 2005). Contrary to this wide application potential, none of the other quality improvement initiatives received such high application outside the manufacturing industry.(Dinesh Kumar,Saranga ,H., 2007),

For many companies, the question is not whether or not to implement six sigma, but how to implement a successful six sigma process improvement project. The selection of process improvement projects is probably the most difficult aspect of six sigma(Pande et al., 2000; Snee, 2001). Bertels (2003) point out that the key characteristics differentiating successful six sigma projects from unsuccessful projects is a well-defined project based on the clear and concise description of the project objectives. Selecting six sigma projects is one of the most frequently discussed issues in the six sigma literature today (Goldstein, 2001; Fundin and Cronemyr, 2003).Whenever different six sigma projects are competing for implementation, management is interested in identifying those projects that result in the maximum benefit to the organization. Table 1 provides the list of tools used for six sigma project selection (Banuelas et al., 2006).

Author	*Tool(s)*
Pyzdek (2000, 2003)	Pareto priority index (PPI), AHP, QFD, theory of constraints (TOC)
Breyfogle et al. (2001)	Project assessment matrix
Pande et al. (2000)	QFD
Kelly (2002)	Project selection matrix
Adams et al. (2003)	Project ranking matrix
Larson (2003)	Pareto analysis
De Feo and Barnard (2004)	Reviewing data on potential projects against specific criteria
Dinesh Kumar et al. (2006)	AHP

Table 1: Methods used for selection of six sigma projects

In this paper firstly the AHP method uses the pairwise comparisons of the multiple criteria to collect the data from the decision-makers, after that TOPSIS software is used to rank the project which are selected in six sigma committee in Poly Acryl corp.

2.methodology

Analytical Hierarchy Process

The AHP, introduced by Saaty (1980), which is a measurement method for determining the relative importance or preference of a set of activities in a multiple criteria decision-making (MCDM) problem.It can incorporate judgments on intangible qualitative criteria as well as tangible quantitative criteria. This method uses the pairwise comparisons of the multiple criteria to collect the data from the decision-makers. Using the AHP, the evaluation team can systematically evaluate and determine the priorities of the criteria and subcriteria. Based on this information, the team can evaluate several potential projects for Six Sigma effectively and select a best project. The AHP has been successfully applied to widespread problems including the multimedia authoring system selection (Lai, Trueblood ,Wong,1999), resource allocation problems (Ramanathan,Ganesh, 1995), etc. The following list provides a brief summary of all processes involved in AHP application (Lai,Trueblood ,Wong,1999):

(1) Formulate the decision hierarchy by specifying a hierarchy of interrelated decision elements.

(2) Collect input data by performing a pairwise comparison of the decision elements.

(3) Estimate the relative weights of decision elements by using an eigenvalue method.

(4) Aggregate the relative weights up the hierarchy to obtain a composite weight, which represents the decision-maker's opinion of the relative importance of each decision alternative.

TOPSIS

TOPSIS (technique for order preference by similarity to an ideal solution) method is presented in Chen and Hwang 1992, with reference to Hwang and Yoon 1981. TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives. The basic principle is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. The procedure of TOPSIS can be expressed in a series of steps:

1. Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as:

$$r_{ij} = \frac{f_{ij}}{\sqrt{\sum_{j=1}^{J} f_{ij}^2}} \quad , j = 1,\ldots,J;\ i = 1,\ldots,n.$$

2. Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as

$$v_{ij} = w_i \times r_{ij} \ , j = 1,\ldots,J;\ i = 1,\ldots,n \ ,$$

where wi is the weight of the ith attribute or criterion, and $\sum_{i=1}^{n} w_i = 1$

3. Determine the positive ideal and negative ideal solution.

$$A^+ = \{v_1^+,\ldots,v_n^+\} = \left\{\left(\max_j v_{ij} \middle| i \in I'\right),\left(\min_j v_{ij} \middle| i \in I''\right)\right\},$$

$$A^- = \{v_1^-,\ldots,v_n^-\} = \left\{\left(\min_j v_{ij} \middle| i \in I'\right),\left(\max_j v_{ij} \middle| i \in I''\right)\right\},$$

where *I* is associated with benefit criteria, and *J* is associated with cost criteria.

4. Calculate the separation measures, using the n-dimensional Euclidean distance. The separation of each alternative from the ideal solution is given.

$$d_j^+ = \sqrt{\sum_{i=1}^{n} \left(v_{ij} - v_i^+\right)^2} \ , j = 1,\ldots,J.$$

Similarly, the separation from the negative ideal solution is given as

$$d_j^- = \sqrt{\sum_{i=1}^{n} \left(v_{ij} - v_i^-\right)^2} \ , j = 1,\ldots,J.$$

Calculate the relative closeness to the ideal solution. The relative closeness of the alternative A_j with respect to A^+ is defined as

$$D_j = \frac{d_j^-}{\left(d_j^+ + d_j^-\right)} \ , j = 1,\ldots,J.$$

Rank the preference order. For ranking DMUs using this index, we can rank DMUs in decreasing order.

The basic principle of the TOPSIS method is that the chosen alternative should have the ‘‘shortest distance’’ from the positive ideal solution and the ‘‘farthest distance’’ from the negative ideal solution. The TOPSIS method introduces two ‘‘reference’’ points, but it does not consider the relative importance of the distances from these points.

Input parameters for selection of six sigma projects using MCDM

The impact to the corporate bottom-line ultimately measures the success of six sigma.Selection of an appropriate six sigma project requires careful analysis. The chosen project should align with the strategic objectives of the organization. Pande et al. (2000) classify six sigma project selection criteria into three categories:business benefits criteria; feasibility criteria and organization impact criteria.

Business benefits criteria include issues such as the impact on customers, the impact on business strategy, and the impact on core competencies, financial impact and urgency. Feasibility criteria for six sigma project selection include criteria such as resources needed, expertise available, complexity, and probability of success. Learning benefits and cross-functional benefits are listed under organizational impact criteria.

Harry and Schroeder (2000) propose the following criteria for six sigma project selection:
Defects per million opportunities (DPMO); net cost savings; COPQ; cycle time; customer satisfaction ;capacity and internal performance.

Banuelas et al. (2006) list the following six criteria as critical for six sigma project selection:

(1) customer impact;(2) financial impact;(3) top management commitment;(4) measurable and feasible;(5) learning and growth; and(6) connected to business strategy and core competence.

In this paper ten criteria which have been used in the literature are used as Six Sigma project selection criteria:
Project cost,Project duration,Information Availability,Sigma level,top management commitment,team members motivation,The probability of project success,Customer Satisfaction,Rate of return,Cost reduction

Compare and determine the degree of Six Sigma project selection criteria
After identification and selection criteria, the next step is to determine the importance of criteria and prioritize them. Analytical Hierarchy Process method is used to determine the importance and paired comparisons are performed.In this paper determining the importance of criteria is done by Expert Choice software. Figure 1 shows the weights of the criteria.

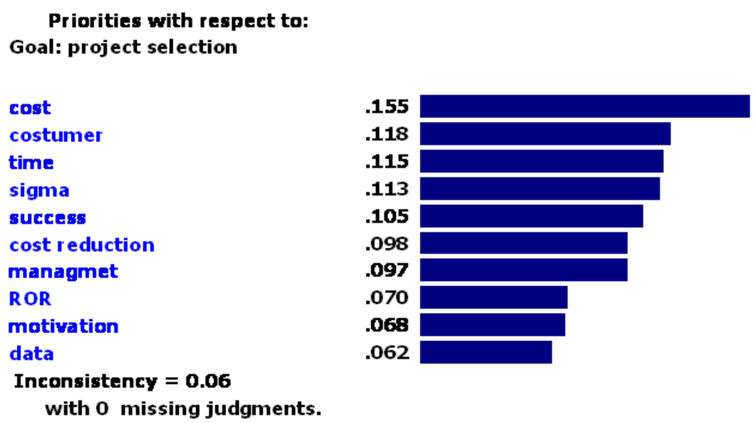

Figure1: ranking criteria

A case study in Poly Acryl corp.
Poly Acryl corp. has been started six sigma methodology since 1994 and one of the big problem in six sigma committee was project selection.Table 2 proposed six projects and its point in each criteria and these projects have been considered in committee to select the best one.

	Cost	*time*	*data*	*sigma*	*management*	*motiuvation*	*success*	*costumer*	*ROR*	*cost reduction*
A1	300	60	50	0.24	50	10	30	10	10	30
A2	250	50	60	0.12	60	25	50	20	20	20
A3	600	30	80	0.15	40	30	80	15	15	45
A4	300	90	40	0.18	50	10	70	12	13	12
A5	450	40	50	0.46	80	8	60	14	18	60
A6	500	50	80	0.11	75	5	45	16	15	15

Table2:Six Sigma projects scores

Six Sigma project selection by using TOPSIS in Poly Acryl corp.
In this section, the steps described in TOPSIS introduction are calculated by using the TOPSIS software. figure 2 and table 3 are shown the project scores and rank the projects:

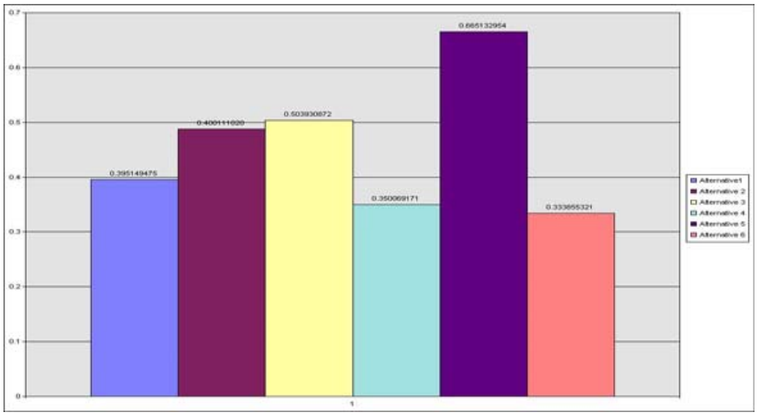

Figure2: six sigma project scores

A1	A2	A3	A4	A5	A6	A6	Project
0/395	0/400	0/503	0/350	0/665	0/333	0/333	Score
4	3	2	5	1	6	6	Ranking

Table3:Six Sigma project ranking

3- Conclusions

The first step in reducing the risk failure of the Six Sigma projects is to select optimal projects, the Projects that gain the maximum benefit and minimum risk are expected.Therefore in this paper the criteria in choosing Six Sigma projects were identified and ranked by using the Analytical Hierarchy Process (AHP) and Expert Choice software. After determining the degree and importance (weight) of criteria,a project was selected by using TOPSIS software in Poly Acryl corp. and the A5 was selected. The use of the proposed model can help company facilitating the decision-making and using a systematic approach to select the appropriate projects.It is recommended that resolve other problems like supplier selection or etc by this methodology.

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