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Prioritizing Projects Using Hybrid Methods of Six Sigma, TRIZ and Gray ANP

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Abstract In this study due to the increasing amount of quality problems that arise in organizations, some of these problems in Tehran municipality are being tested. First, a large number of projects that need to be improved are defined by one of multiple decision-making methods of MCDM named ANP priorities. Then, the most important projects have been selected. For doing this project, some problems arise that parts of their information are known and some are unknown. To identify and select the problems, gray systems are being used, and the main problem can be found by using "gray possible degree" that are the new decision-making techniques and evaluate mathematical data which are vague and uncertain. The identified problem is analysis by using the methodology of Six Sigma and DMAIC cycle. By using Pareto charts and Minitab software the main causes of the issues have been identified and resolved. Finally, by using creative and innovative techniques, the problem-solving capability of TRIZ is improved.

Keyword: Multi Criteria Decision Making (MCDM), Analytic Network Process (ANP), Theory of grey system, Theory of Inventive Problem Solving (TRIZ), Six sigma, Prioritizing projects

1 Introduction

Today's businesses have faced with significant challenges such as rapid changes in customer expectations, global competition, rapid technological innovation, shortening product life cycle and the socio-economic environment. The most important way of providing excellence is undergoing a change in the race conditions. Undergoing a change is possible with creativity and innovation that was realized for processes, products, and strategies. Companies must create dissimilarity to take an important and different place into the global markets that have very sharp competitive factors. Dissimilarity and favorite differences can be obtained by gaining competition power with creative solutions [1]. Moreover, accurate and reliable information is needed to support decision-making processes. Due to a large number of participants typically involved in projects, organizations often find that it is difficult to effectively share information within a supply chain [2]; hence, this research examined ways to develop a new combination method to prioritize projects.

Given the globalization of corporations and the increase in computing power and e-commerce, nowadays organizations can win the competition field with the best solutions and

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the proper use of financial resources, time and manpower. By being close to the competitive environment in the new era, should be familiar with leading methodology and approaches of engineering sciences. Projects are costly and time-consuming, so to do them time, resources and careful planning are required. If planning is done with no prioritization, they face with the deficit. So the selection and prioritization of projects are very great issues in organizations. To do projects in the organization must try that quality become high. Six Sigma is a methodology that will decrease mistakes and the deviation is reduced from the ideal state; it also reduces the time which takes to reach the market, efficiency and capacity will increase and this increase customer satisfaction.

For implementation and enforcement Six sigma methodology, organizations must choose the correct use of these tools which can be effective to solve problems and achieve continual improvement of its action.

2 Review of the Related Literature

In today's world when the rivalry is gathering speed; profit maximization and consumer satisfaction have become the main targets of the enterprises. One of the most important methods affecting these targets of the enterprises is six sigma approach. This approach accepts the consumer as the focal point. Six Sigma approach is such a model that is adapted by various companies throughout the world due to its consumer-oriented approach and this model aims the continuation of company success. Six sigma aims to reach a perfect level by actualizing 3,4 error rate in one million productions. Six Sigma is a strategy using statistical methods to provide a measure, analyze, renovate and control optimal efficiency in business processes. Most important function of Six Sigma is to minimize the variables in the production process. This name of "Six Sigma" is given by Mikel Harry [3] that the variability term is measured by standard deviation in statistics and standard deviation is symbolized by the "small sigma" σ symbol and six sigma approach requires to make the assessment by statistical techniques on behalf of managing and restructuring the business processes. Six Sigma is an optimization technique and its largest difference is to be a flexible system aiming to optimize both the performance and the managerial skill. The primary objection of Six Sigma is to minimize the errors and to actualize a quality level in the groove and its philosophy consists of the aims of reducing costs, increasing customer satisfaction, actualizing the optimization of business processes and increasing the efficiency of the employees. Six Sigma approach, with the most areas of application, is observed in production sector is combined of the junction of the best and most successful sides of the previous methods [4].

2.1 Six Sigma

The term (Sigma) refers to a scale of quality measurement in any processes such as manufacturing, and by using this scale. Six Sigma equates to 3.4 defects per million opportunities (DPMO). There are numerous definitions of Six Sigma in literature; it frequently defined as a methodology for quality improvement with the goal of reducing the number of defects to 3.4 units per million opportunities or 0.0003%. It is a statistics-based approach, which aims to isolate sources of errors and identify ways to exclude them. Six Sigma has approved as an effective approach for quality improvement in service sectors, especially at healthcare and financial services [5, 6]. Aboelmaged [7], defined Six-Sigma as standard deviations, which is a statistical representation of the variance in a process based on the data-driven approach to analyze the root causes of processes problems and solving them.

Six Sigma is a powerful performance improvement tool that is changing the face of modern healthcare delivery today. Six Sigma implemented in diagnostic imaging processes, emergency room, and paramedic backup, and laboratory, surgery room, and radiology, surgical site infections to improve quality, performance and to improve the outcomes of their patients [8].

Since its launch in the 1980s, Six Sigma has generated great expectations and hype in the business world, driven largely by reports of significant business gains; e.g., GE reported 11% revenue and 13% earnings increases from 1996 to 1998, AlliedSignal had savings of $1.5 Billion in 1998, and Harry and Schroeder claimed “10% net income improvement, a 20% margin improvement, and a 10 to 30% capital reduction” for each sigma improvement [3]. These business gains were based on management and technical methods for improving processes with a theoretical aim of a failure rate of 3.4 parts per million (ppm) or 2 parts per billion (ppb), depending on certain assumptions. Important assumptions in Six Sigma are that the process is normal and its specifications are two-sided [9].

By new perspective of current areas of business, organizations are set of processes which aim to create value for customers and the needs of creating value for the customer's its creation is in that organization itself [10].

If an organization wishes to follow this approach, the program which is the first is to enter the field of Sigma and then taking steps to improve the level of 4.3 defects per million opportunities of sigma error [11]. Six Sigma is a process that consists of a set of statistical tools that according to the goals set, is the data collection deals. And then analyze and improve them [12].

Motorola's Six Sigma methodology at first was founded in 1985 and they concluded that the improvement of quality is reducing costs and increase the speed of operation. Using this approach in Motorola factory, gave the company the America National Quality Award (Baldrige) in 1987 [13].

2.2 TRIZ (Creative Problem Solving Method)

Creativity can be defined as follows: Creativity is to find unusual solutions for problems, to gather together in harmony original or called incompatible with each other ideas or to reveal new and useful product. In 1946 Altshuller, [14] a Soviet scientist, develop a technique known as TRIZ for which the technique and applications are easy to follow and to learn. However, being a systematic tool, TRIZ can be used as a useful method in new product development process to generate alternatives. In this study, the methods of TRIZ’s characteristics and tools will be defined and their use will be illustrated.

TRIZ consists of the initials of the original named “Theoria Resheneyva Isobretatelskehuh Zadach” in Russian translated into English as “Theory of inventive Problem Solving and used acronym” TIPS this method is described as “Creative Problem Solving Method” in Turkish. Altshuller obtained that similar approaches, used in many different areas, created very effective solutions in his investigations. The creators have explored these solutions over and over again. During investigations, Altshuller felt the necessity for the theory of creativity for the following conditions:

1. being systematic.

2. Taking the lead for the placing of the ideal solution in very wide solution space.
3. being repeatable and reliable. However, not depending on the psychological tools
4. Reaching creative information.
5. adding creative acknowledge.

TRIZ includes analytical tools that are necessary for problem solving and also it is knowledge-based tools that are necessary for system transformation and their theoretical foundations. Using all the information about the problems of the products, the analytical tools of TRIZ can be used for transforming, modeling and analyzing problems. Also, ARIZ is a special analytical tool that gathers substance-field analysis, conflict analysis, required function analysis and other techniques. TRIZ uses algorithmic approaches for improving legacy systems or designing new systems. Therefore, it includes evaluating the available data rather than estimation [1].

The main goal of TRIZ method is to find the ideal solution or perfection. TRIZ methodology depends on four basic paradigms;

1. Contradictions
2. Perfection
3. Functionality
4. Using resources

Altshuller also described TRIZ in the light of these paradigms by using a four-step process;

1. Describing the problems
2. Matching and comparing the general problem with TRIZ problems.
3. Finding TRIZ solutions
4. Developing the ideal solution for issues.

TRIZ knowledge was founded in 1946 by Gernish aLtsholer4. He defined this science as creative problem solving theory. By this view we can know TRIZ as one of the main and important branches of creative science [14]. We can also say that TRIZ is an innovative approach and an algorithm to solve technical issues.

2.3 Analytic Network Process (ANP)

AHP and ANP are the two most significant and popular MCDM methods aiding the decision makers to select the best choice under situations characterized by having more than one criterion. AHP, introduced by Saaty [15], is a useful approach in solving complex decision problems. ANP was proposed by Saaty [16] for extending the AHP to address restrictions of the hierarchical structure where criteria are independent from each other. The structural difference between AHP (hierarchy) and ANP (network) is shown in figure 1 and 2. As can be seen in figure 1, a hierarchy is the simple and special case of a network.

Fig. 1 AHP structure

ANP method was first introduced in 1997 by Saaty. ANP is a hierarchical analysis which is based on paired comparisons. ANP is made up of a network that within which the number of clusters with elements built into them. Clusters have Internal and external dependence and they communicate with each other [17].

While nodes of the network show components of the system, arcs represent interactions between them. In order to build the decision problem, all interactions among elements of the system should be considered. As shown in figure 2, Goal→Cluster1 means that elements of Cluster1 depend on component Goal, so for example Cluster1 and Cluster2 are interrelated in figure 2 i.e. a two-way arrow or arcs among different levels of elements may graphically represent the interdependencies in an ANP model. If there are interdependencies within the same level of analysis, a looped arc may be used to represent such interdependencies (see figure 2). ANP allows both interaction and feedback within criteria (inner dependence) and between clusters (outer dependence). In fact, ANP uses a network without the need to designate levels as in a hierarchy. A network has two components, i.e. (a) a control hierarchy or network of criteria and sub-criteria that controls the interactions, and (b) a network of influences among the components and their clusters [18].

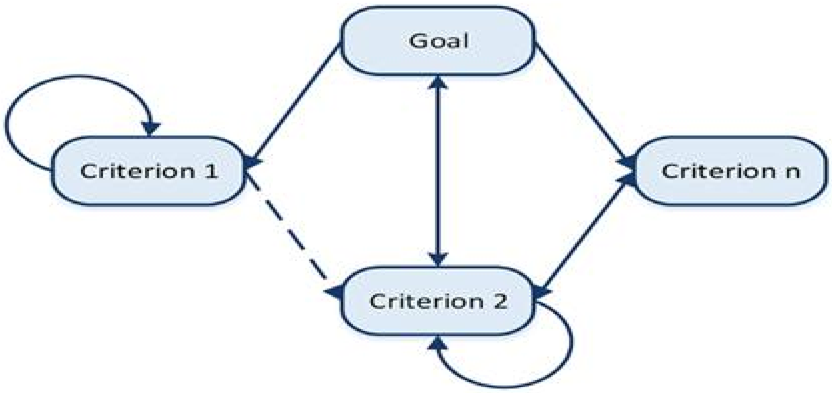

Fig. 2 ANP structure

There are two types of ‘control criteria’ or ‘level criteria’. If the structure is a hierarchy, a control criterion may be directly connected to the decision structure as the goal of a hierarchy. In this case, the control criterion is called a comparison ‘linking’ criterion. On the other hand, a control criterion which does not connect directly to the structure but ‘induces’ comparisons in a network is called an ‘inducing’ criterion. The generic question to be answered by making pairwise comparisons is: Given a control criterion and a pair of components (elements), how much more does a given member of the pair influence that component with respect to the control criterion (sub-criterion) compared to the other member [19]?

2.4 Grey Relational Analysis

Gray system theory was first introduced by Deng [20] under the GRA. If clear information of system visualize with white and unknown information visualize by black color, in this case, there is some information that is not black or white which means that some part of the information is known or unknown that they call it gray systems [10].The main characteristic of gray system is incomplete information of that system [20, 21].

A 'grey number' $\otimes G$ is such number whose exact value is unknown, but a range within which the value lies is known. A grey number $\otimes G$ is defined as an interval with known lower limit and known upper limit as $\otimes G$ $[G, G']$. Such a method supplements the expression of system uncertainties whenever the probability density and membership functions cannot be fully identified [22, 23].

Grey relational analysis (GRA) is part of the grey system theory [24], which mainly involves ambiguous or uncertain problems and situations with discrete data and incomplete information [20]. The traditional GRA addresses uncertainty by considering deterministic numbers [25, 26, 27].

3 Method

This research is following these objectives:
1. Setting model to improve processes and increase the quality and reduce costs by combining TRIZ and Six Sigma.
2. Determine an approach to prioritize projects of Six Sigma by using gray ANP and TRIZ in the municipality.

For data collection, books, electronic journals, articles, websites and questionnaires were used. This study is the combination circular field and library research method. The analysis method is in a way that was used statistical technique to compare the proposed methods with existing methods. For processing, descriptions and data analysis used statistical and engineering software which name is Minitab.

The data are extracted from the contracts of Tehran Municipality between 2012 and 2014.

The statistical population was a number of experts and municipal officials that have had access to the information and full awareness of the Municipality problems.

Dozens of projects that need to be improved by experts in Tehran were determined. These projects include:
1. The need to delegate and outsource some services to private sector contractors
2. Develop the investment in urban management
3. Municipal waste management
4-paved roads and streets
5. Transfer of equipment to municipalities
6. Stable income
7-poor accounting
8-existence of economic studies and research in the field of urban development
9. Research and Quality standards
10. Council oversight and the Ministry of Finance and municipal property

By using one of the multiple-decision making method which called ANP these projects prioritize and is selected one of the most important of them which needs to be improved. The implementation of this project is containing some problems that part of them is well-known and some is unknown.

These problems are defining in four forms and are projects are defined and are analysis by gray systems. These four projects are:
1. Reduce the time of contractor's payments
2. Avoid calling of contractors to municipalities
3. Reverence contractors
4. Reduce the contracts durations

By grey system analysis on the projects, the project of reducing the contracts duration is selected. Six sigma is the most important tool of solving problem and by that the problem is solved and then improved by TRIZ.

3.1 Data Analysis by Using ANP

The first step is to identify the target. The aim here is to use the ANP to select projects on the basis of existing problems. The second step is to identify the criteria. The criteria are the investment costs and operating costs. The third step is to identify options.

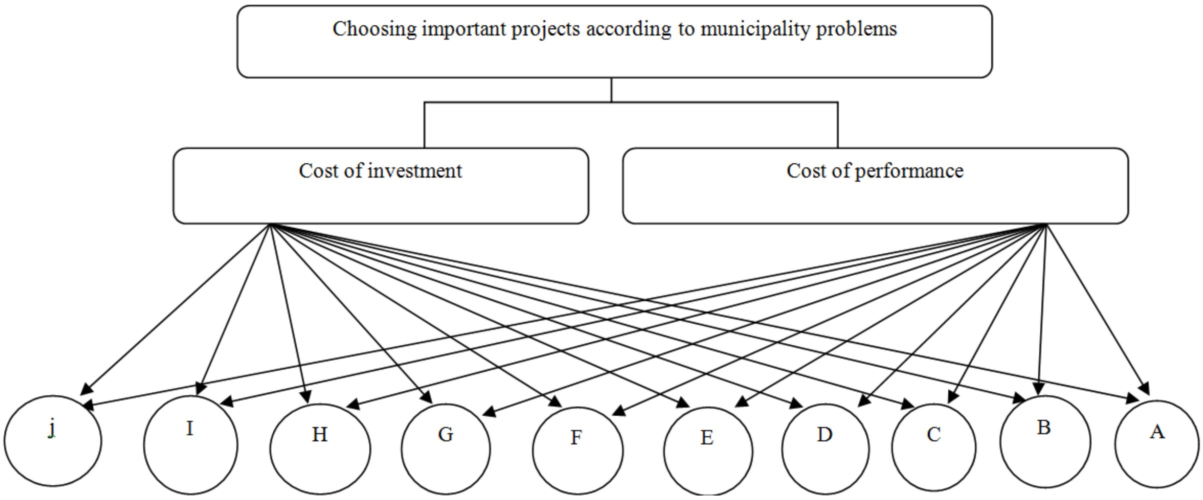

Fig. 3 The model and network of decision-making

Table 1 Project costs

Projects	Cost of investment	Cost of performance	Total costs
The need to transfer some of the municipalities in the private sector and foreign contractors	1000	10000	20000
Improve investment in urban management	50000	30000	80000
Municipal waste management	70000	50000	120000
Paved roads and streets	15000	15000	30000
Transfer mechanisms to municipal	25000	25000	50000
Instant income	20000	40000	60000
Weak points in accountancy	40000	55000	95000
Economic studies and research groups in the field of urban development	55000	45000	100000
Research standards	350000	35000	70000
Supervisory boards and the ministry of finance and municipal property	20000	25000	45000

Table 2 Super paired comparison matrix

	Cost of investment	Cost of performance	A	B	C	D	E	F	G	H	I	J
Cost of investment	0	0	.5	1.66	1.4	1	1	.5	.72	1.22	1	.8
Cost of performance	0	0	2	.6	.71	1	1	2	1.375	.818	1	1.25
A	.021	.04	0	0	0	0	0	0	0	0	0	0
B	.105	.06	0	0	0	0	0	0	0	0	0	0
C	.147	.11	0	0	0	0	0	0	0	0	0	0
D	.31	.031	0	0	0	0	0	0	0	0	0	0
E	.052	.051	0	0	0	0	0	0	0	0	0	0
F	.042	.08	0	0	0	0	0	0	0	0	0	0
G	.084	.11	0	0	0	0	0	0	0	0	0	0
H	.11	.09	0	0	0	0	0	0	0	0	0	0
I	.073	.07	0	0	0	0	0	0	0	0	0	0
J	.042	.05	0	0	0	0	0	0	0	0	0	0

Table 3 Evaluation of alternative options

Element	Weight
C1	.31
C2	.20
A	.84
B	.372
C	.205
D	.63
E	.50
F	.353
G	.52
H	.471
I	.472
J	.48

Alternative option is project A because this project has the highest rating and was selected, improved and transferred the project to the private sector contractors.

3.2 Analysis of Data by Gray System

Collected data will be logged in gray systems. Since some problems arise as part of the information which some are known and some are unknown, Gray systems analysis were used. These problems are identified in four projects forms as follows:
1. Reduce the payments to contractors
2. Avoid calling on contractors to municipalities
3. Reverence contractors
4. Reduce the duration of contracts

Criteria for this project include:
1. The financial savings= Q1
2. Increase revenue= Q2
3. The use of maximum available resources= Q3

4. The comprehensive urban development plan= Q4
5. Commitment Job= Q5
6. Avoid wasting time= Q6

By using studies which has done and surveys dozen experts and scholars points of view appropriate criteria for selecting the most appropriate project were determined. Extracted criteria are Qualitative and the uncertainty of people judgment in determining the importance of each criterion has led one of the methods of decision making under conditions of uncertainty P used.

To determine the importance of the criteria, were used the decision of 10 individuals and used words too much, too much, almost high, medium, relatively low, low, very low, which is done by using the Liker spectrum.

Table 4 Scale to determine the weighting of criteria

Very low	Low	Relatively Low	Medium	Almost high	much	Too much	indicator
VL	L	ML	M	MH	H	VH	
[0.0 , 0.1]	[0.1 , 0.3]	[0.3 , 0.4]	[0.4 , 0.6]	[0.6 , 0.7]	[0.7 , 0.9]	[0.9 , 1.0]	⊗W

3.2.1 Standard Weights

Calculate the weight of indicators

$$\otimes W = \{\otimes W_1, \otimes W_2, ..W_n\} \quad (1)$$

Determine the weight of indicators

$$\otimes W_j = \{\otimes W_j^1, W_j^2, ... \otimes W_j^k\} \quad (2)$$

K is the number of experts and decision-makers of indicators weights of J-th from k-th decision makers is as follows:

$$W_j^k = (j = 1, 2, 3, ..., n) \otimes \quad (3)$$

By the number of gray $W_i^k = [\mathrm{W}_i^k, W_i^{'k}] \otimes$ are shown.

If the number of decision-makers is k = 10 is placed in the formula results will be as follows.

Table 5 standard weights

Q_j	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Q1save money	VH	H	H	MH	M	M	M	H	H	MH
Q2increase revenue	M	H	MH	VH	M	M	H	H	MH	M
Maximum use of available resorcesQ3	H	H	MH	M	VH	H	VH	MH	M	M
Q4comprehensive urban development plan	L	ML	M	MH	H	MH	M	VL	H	VL
Q5creating commitment	VL	ML	L	VL	MH	M	M	H	M	VL
Q6avoid wasting time	VH	H	VH	MH	H	M	H	VH	H	VH

Table 6 Weighting of criteria for decision-makers

Qi	⊗WQi
⊗W1	[0..64 , 0.81]
⊗W2	[0..58 , 0.75]
⊗W3	[0..63 , 0.79]
⊗W4	[0..38 , 0.53]
⊗W5	[0..29 , 0.44]
⊗W6	[0..74 , 0.89]

3.2.2 Identification and Rank Options

The topic has been studied to assess and rank the options. To evaluate options for each of the criteria of gray-scale numbers 1 to10are used. Options are in the research projects.

Table 7 Scale for Assessment of Options

Very weak	weak	Somehow weak	Mediocre	Somehow good	Good	Very good	indicator
VP	P	MP	M	MG	G	VG	
[0 , 1]	[1 , 2]	[3 , 4]	[4 , 6]	[6 , 7]	[7 , 9]	[9 , 10]	⊗G

For doing the Project of municipal affairs to the private sector and foreign contractor's defined four major projects that each of these projects has great influence in the privatization of municipal projects. These projects will be presented in the form of options. Liker scale to evaluate these options and expressive words used by the experts of the municipality and the Interior Ministry were evaluated. For evaluation using gray numbers used in this regard:

$$\otimes G_{ij} = \frac{1}{k}[\otimes G_{ij}^{1} + \otimes G_{ij}^{2} + \ldots \otimes G_{ij}^{k}] \quad (4)$$

$\otimes G_{ij}^{k}$ is the k-th decision maker to evaluate the options of I–th to standard j. It can be grey numbers $G_{ij}^{k} = [a_{ij}^{k}, b_{ij}^{k}]\otimes$ showed.

Total options (projects) p = {P1, P2, P3, P4}

In this state the grey matrix is the evaluation of alternatives (projects) to establish criteria that would be as follows:

$$\otimes D_{11}^{2} + .\otimes D_{11}^{1} + \otimes D_{1}^{1} = \frac{1}{k}\{\otimes..D_{11}^{10}\}\otimes + \quad (5)$$

3.2.3 Evaluation of Municipal Projects to the Criteria

Table 8 Evaluation criteria to avoid calling contractors

Q	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Q1 financial saving	MG	G	F	MP	MP	F	G	MG	G	MG
Q2revenue increase	VP	P	MP	MP	MP	F	VP	P	MP	P

Q	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Q3Maximum use of available resources	MG	G	MP	P	F	MP	G	MG	F	F
Q4comprehensive city development plan	VP	VP	P	VP	MP	P	P	VP	MP	F
Q5job commitment	VP	P	MP	MP	P	VP	F	P	F	VP
Q6avoid wasting time	P	MG	G	F	P	F	MP	P	MG	G

3.2.4 Grey Decision Matrix

Table 9 Grey Decision matrix

Q_j	P1	P2	P3	P4
Q1	[5.5, 3.9]	[6.8, 5.3]	[4.8 , 3.1]	[7.7 , 6.3]
Q2	[3.7, 2.1]	[5.0, 3.5]	[4.9 , 3.3]	[8.2 , 6.6]
Q3	[6.4, 2.8]	[6.1, 4.5]	[5.8 , 4.0]	[8.4 , 6.7]
Q4	[3.0, 1.6]	[6.3, 4.9]	[4.8 , 3.8]	[7.9 , 6.2]
Q5	[5.0, 3.5]	[5.9, 4.4]	[5.2 , 3.4]	[7.7 , 5.9]
Q6	[8.7, 7.3]	[5.7, 4.0]	[4.7 , 3.2]	[7.4 , 5.9]

3.2.5 Normalized Grey Matrix

Since, all parameters are positive, the normalized decision matrix can be formed, Where $\otimes G_{ij}^*$ is calculated by the following:

$$D^* = [\otimes G_{ij}^*]6x$$

$$\otimes G_{ij}^* = [G_{ij}^k / G_i^{\max}, G_{ij}^{'k} / G_i^{\max}] G_i^{\max} = Max\, 1 \le j \le 4 \qquad (6)$$

Table 10 Grey normalized matrix

	P_1	P_2	P_3	P_4
Q_1	[0.506,0.714]	[0.688,0.883]	[0.402,0.623]	[0.818,1.000]
Q_2	[0.256,0.451]	[0.426,0.609]	[0.402,0.597]	[0.804, 1.000]
Q_3	[0.571,0.761]	[0.535,0.726]	[0.476,0.690]	[0.797, 1.000]
Q_4	[0.202,0.379]	[0.620,0.797]	[0.481,0.607]	[0.784, 1.000]
Q_5	[0.454,0.649]	[0.571,0.766]	[0.441,0.672]	[0.766, 1.000]
Q_6	[0.839, 1.000]	[0.459,0.655]	[0.367,0.540]	[0.678,0.850]

3.2.6 Grey Normalized Weighted Matrix

$$\otimes V_{ij} = \otimes W_{Qi} x G_{ij}^*$$

$$\otimes W_{Qi} = [W_{Qi}, W'_{Qi}]$$

$$\otimes G_{ij}^* = [G_{ij}, G'_{ij}]$$

i= 1,2,…,6

j= 1,2,3,4 (7)

$$\otimes V_{ij} = \otimes W_{Qi} x G_{ij}^{*} =$$
$$\{\min[(W_{Qi}\ xG_{ij}),(W_{Qi}\ xG_{ij}^{'}),(W_{Qi}^{'}xG_{ij}^{'}),(W_{Qi}^{'}xG_{ij}),\max[(W_{Qi}\ xG_{ij}),(W_{Qi}\ xG_{ij}^{'}),(W_{Qi}^{'}xG_{ij}^{'}),$$
$$(W_{Qi}^{'}xG_{ij})]\}$$

Table 11 Grey normalized and weighted matrix

	P_1	P_2	P_3	P_4
V_1	[0.323,0.578]	[0.440,0.715]	[0.257,0.504]	[0.523,0.810]
V_2	[0.148,0.338]	[0.247,0.456]	[0.233,0.447]	[0.466, 0.750]
V_3	[0.359,0.601]	[0.338,0.573]	[0.299,0.547]	[0.502, 0.790]
V_4	[0.107,0.200]	[0.302,0.422]	[0.182,0.320]	[0.297, 0.530]
V_5	[0.131,0.285]	[0.165,0.337]	[0.127,0.295]	[0.222, 0.440]
V_6	[0.620, 0.890]	[0.339,0.582]	[0.271,0.480]	[0.500,0.756]

3.2.7 The Determination of the Alternative Option

$$\otimes S^{\max} = \{\otimes V_1^{\max}, \otimes V_2^{\max}, \ldots \otimes V_i^{\max}\} \quad (8)$$
$$V_i^{\max} = [\max V_{ij}, \max V'_{ij}]$$

3.2.8 Calculate the Grey Degree Possible and Likely the Ideal Choice for Each Option

$$P\{P_j < V_{IJ} \otimes P(\sum P^{\max}\} = 1/6 < V_i^{\max}$$
$$V_{ij} \otimes P(< V_j^{\max}) = \otimes \quad (9)$$
$$(V_i^{\max} \otimes V_{ij}) + L + L^{*} = L$$

Table 12 Calculation of possible grey for the project

P_1	P_2	P_3	P_4
1	0.658	1	0.5
1	1	1	0.5
0.813	0.864	0.920	0.5
1	0.655	0.950	0.505
0.83	0.7	0.706	0.5
0.5	1	1	0.741

P (P1 <Pmax) = (1 + 1 + 0.813 + 1 + 0.83 + 0.5) / 6 = 0.857
P (P2 <Pmax) = (0.658 + 1 + 0.864 + 0.655 + 0.7 + 1) / 6 = 0.812
P (P3 <Pmax) = (1 + 1 + 0.92 + 0.95 + 0.716 + 1) / 6 = 0.931
P (P4 <Pmax) = (0.5 + 0.5 + 0.5 + 0.505 + 0.5 + 0.741) / 6 = 0.541

3.2.9 Ranked Projects

Ranking in this case would be that every option that is less than ideal options Or smaller maybe less than ideal option, a higher rank is: P4> P2> P1> P3

3.3 Six Sigma

The Six Sigma methodology is the best and most powerful tool to solve the problem to solve the problem of reducing the duration of the project; contracts are entered into Six Sigma.
Six Sigma has 5 phases and steps including: Definition, measure, analysis, improvement and Control

3.3.1 Definition phase

Defining the problem is the first step. The steps are as follows:
1. Determine the form and fill in forms approved the project as a project by experts
2. Select the project (once the project has been selected as the gray ANP method.)
3. Completion of project charter Form
4. Calculation of benefit which obtained from project and financial approval
5. Preparation of flowcharts and process maps
6. Preparation of SIPOC
7-prepared and hear the voice of the customer CTQ TREE
8-produced by CTQ

3.3.2 Measurement Phase

In this phase the following actions are performed:

3.3.2.1 Collecting Basic Data

The data have been collected in the statistics of the tenders of 2012, 2013 and 2014

3.3.2.2 Preparation of Sampling Strategy

Since sample is individual, histogram is used. For this purpose, the data must be less than 30. Quantitative parameters are continuous.

3.3.2.3 Calculation of Current Capability Process

Collected data are converted into the current process sigma level .in Sigma Six Sigma methodology, the expression sigma level is used to determine process status of the language. Higher sigma is equal to better quality, as a result, fewer defects, and vice versa. In this project, the calculation of Sigma projects is calculated through the normal curve. In this phase, after data collection, the normal test is conducted. Data are quantitative and normal. Histogram and I-MR chart is drawn. Data are normal and under control.

After its overall value, ppm is obtained. Sigma level is determined from the table of Sigma level.

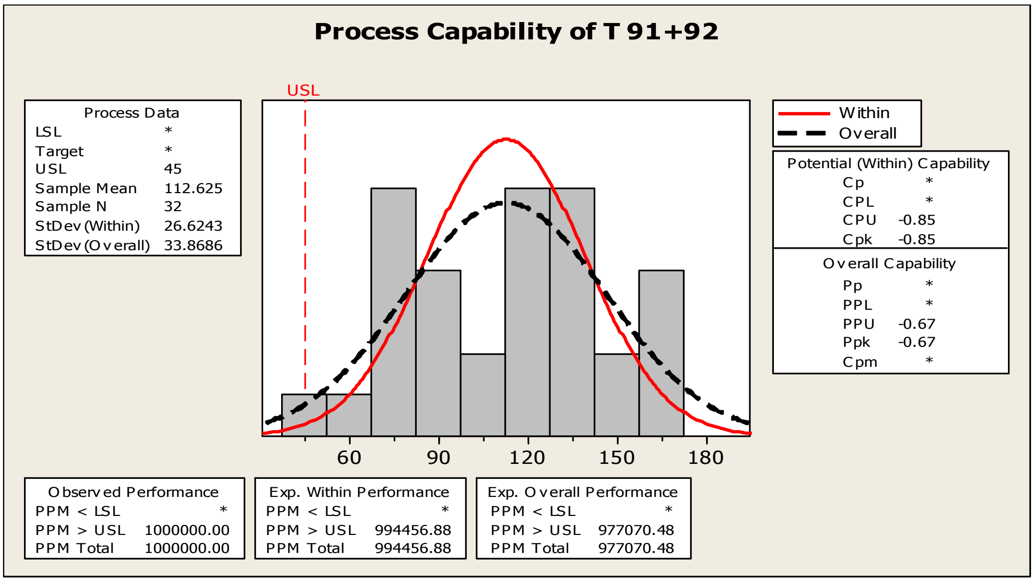

Fig. 4 Capability Graph

3.3.3 Analysis Phase

Actions in this phase are as follows

1. For each t, brainstorming is conducted.
2. Change any t, the change total target T

In this phase, the data are compared with each other in a good way.

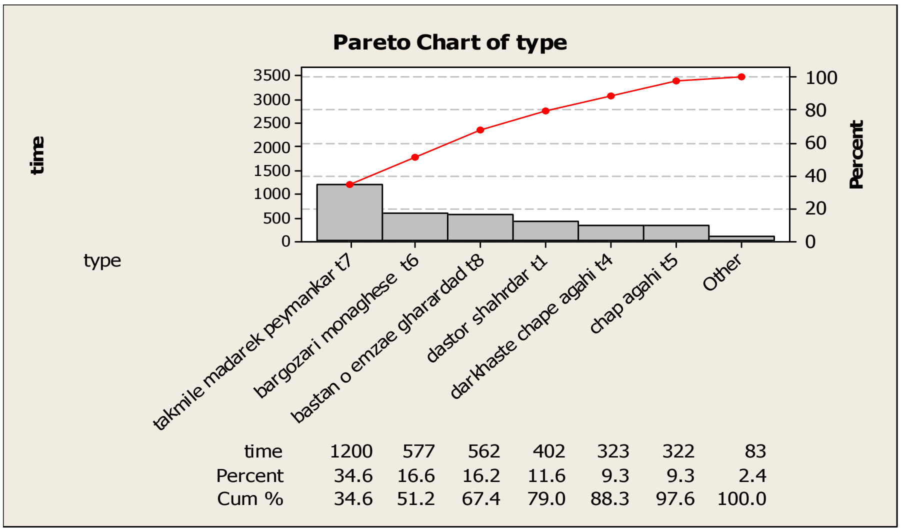

Fig. 5 Pareto chart Graph

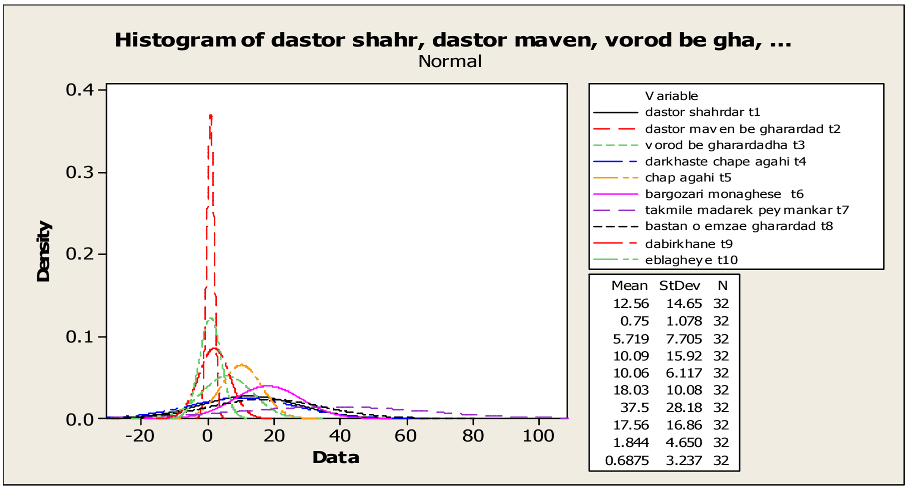

Fig. 6 Histograms

In all comparisons, it can be observed that the factor of the longer duration of the contract is t7. Flowchart t7 is drawn and it is observed that mentioning guarantee and constitution by the contractors allocates the maximum time to itself.

3.3.4 Improvement Phase

Data are entered into the recovery phase. Thus, to solve this problem TRIZ contradiction matrix is used. The intersection of rows and columns of data loss and wasted time are 4, 24, 26 and 28 respectively. The following results are obtained:

Principle 4 asymmetry: We must prepare before. Czech lists can be used for this purpose.

Documents already completed by the contractor.

Principle 24 mediator: A mediator is used to perform the work. For example, one collects information first. The first the contractor's contract enforcement domains receive full evidence and documentation completed delivery to contracts for the signing.

Principle 26 copying: To improve the use of copies of the original contractors. Instead of the original documents, such as articles of incorporation or warranty a copy of it can be given.

Principle 28 replacement of mechanical system: This principle can be used to improve phase the lot. For example, the Internet, fax, etc. can be used instead of calling the contractor. Another way is the change of whole system. The deadline for providing the guarantee period after the contract is renewed.

3.3.5 Control Phase

Results obtained in the project are of data of 2014, which are as follows:

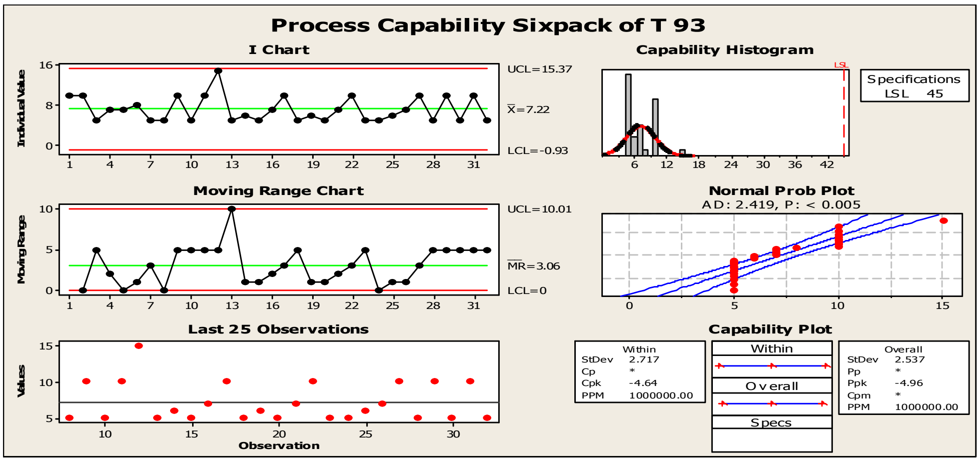

Fig. 7 Six pack Graph

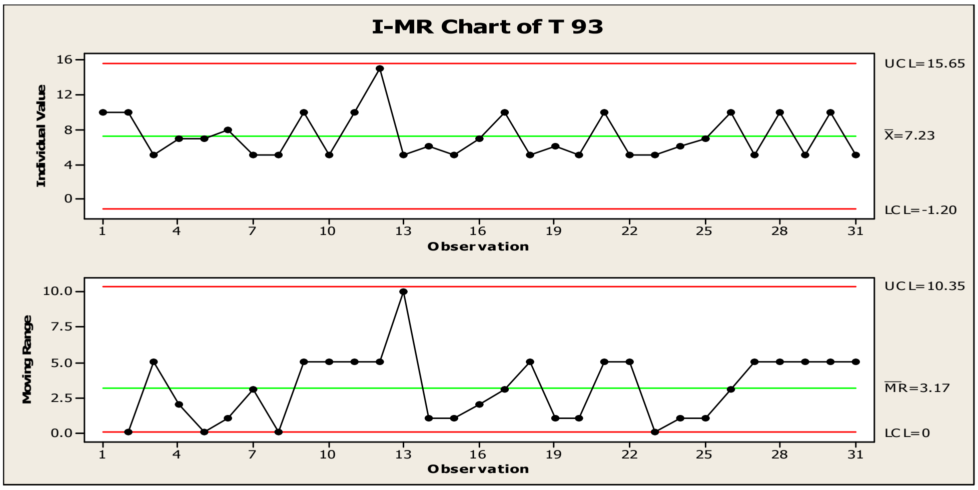

Fig. 8 I-MR chart

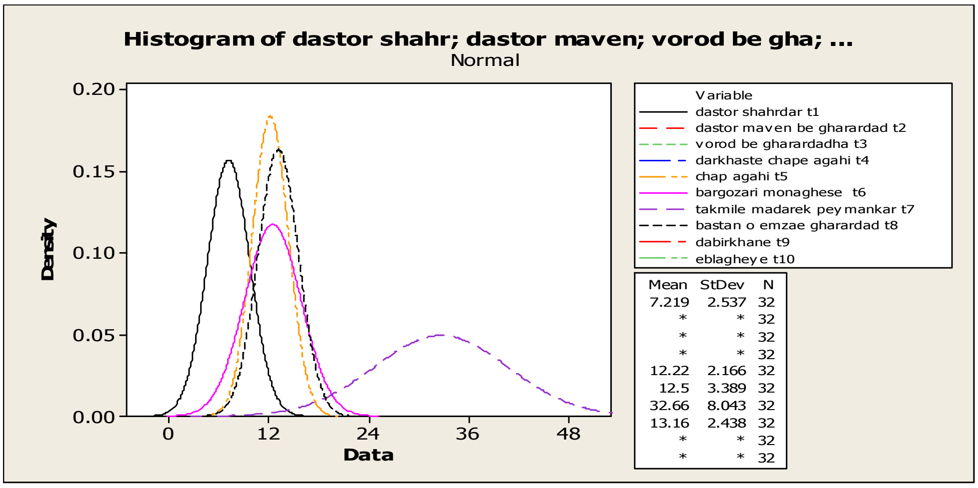

Fig. 9 Histograms Chart

Sigma value derived from the PPM. It can be seen that for 93 years data risen one sigma level.

That amount is less than 1.0 sigma level risen the level of one. This improvement is impressive.

4 Results

After the implementation of model Six Sigma project results is very important and valuable work assignment was made to contractors, including:

1. Reducing the time of contract
2. Conducting works systematically and electronic
3. The decrease of reinventing in the contracts
4. Increasing fiscal revenues at the end of the project

5 suggestions for future research

The issues that seem analyzable for the future researches are as follows:

1. Prioritizing Six Sigma projects using TRIZ and combining them with value engineering
2. In the future researches, the factor of the time reduction of contractors' payments can be taken into account in addition to the factor of the time reduction of a contract period.
3. Improving constructing projects of the Municipality of Tehran using the combination of TRIZ and Six Sigma
4. In this research, the problem arisen from contractors' visit is ignored that it can be regarded in the future researches.
5. In the future researches, the problem of the air pollution of Tehran can be solved through Six Sigma techniques and improved by TRIZ.

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