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Research Article

Cost Management through Using Target Costing, Quality Function Deployment and Value Engineering

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Abstract: The purpose of this study is Cost management through using Target Costing, Quality Function Deployment and Value Engineering. The theoretical principles are initially developed in order to implement the mathematical model for integrating three methods including the value engineering, target costing and quality function deployment and then the method for implementing the conceptual model is presented after developing the conceptual model of research through introducing the new product of acicular concrete sleeper and finally the optimal values are calculated by mathematical programming in Lingo software through an estimation mathematical model and under the responses of engineering workgroup in the field of new product, acicular concrete sleeper and the results are presented by the software.

Keywords: Nonlinear programming, quality function deployment, target costing, value engineering

INTRODUCTION

The first and most important principle of marketing is to pay attention to customer's need without which the organizations will not survive. Before introducing marketing as a science, various organizations satisfied the customer's demand and need. Looking at things from the customer's perspective is considered in new marketing philosophy which is the customer orientation. In fact, the customers' desires, needs and expectations are changeable, thus what the customer wants should be determined and then its research tool or way for achieving it should be sought. Production flexibility reflects the ability of firms to respond changing in customers' needs as well as the unexpected changes due to the competitive pressures. Flexibility in designing new products, flexibility in product delivery and market flexibility (ability of production system to adapt to market changes) are the most important aspects of production flexibility associated with the market and customer. Therefore, the customer should be more understood and his needs be determined in order to create the flexibility and use this competitive propriety in current conditions (Vokurka and O'leary-Kelly, 2000). According to this attitude, the customer should be considered as the foundation of every organization and management should be implemented based on the deep knowledge about the customer's characteristics in three areas of expectations, needs and capabilities. Therefore, it is necessary to understand the customer requirements.

Nowadays, designing based on the customers' needs and demands is the most important aspect of product designing (Ho and Lin, 2009). Therefore, designing and producing new product according to the customers' expectations requires a specific plan and program, so that the product will have desired capabilities and the cost equal to or less than the manufactured products by competitors. Integrating the designing tools such as Value Engineering (VE) and Quality Function Deployment (QFD) is necessary in order to achieve this objective (Jariri and Zegordi, 2008). If an efficient way is applied in cost management such as target costing, designed model will have the high capabilities. Quality Function Deployment identifies the customer needs and links them with engineering demands in order to design then based on the customer needs and reduce the need for change in designing the product. On the other hand, the Value Engineering performs the optimal allocation of resources in accordance with the importance level of product functions. In general, the quality function deployment ensures that the "right product" is designed and the Value Engineering ensures that the "right product design" is done through the best way. According to understanding of subject necessity in this study, we are seeking to provide the mathematical model with a comprehensive and integrated approach to optimize the cost management in line with manufacturing the new product. Therefore, three

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reliable and efficient models including QFD, VE and TC are applied in this regard. Each of mentioned models have weaknesses despite the ability in cost management process in designing the processes and their disadvantages can also be covered through integrating them while preserving the benefits and capabilities of each model. This study applies the optimization method for nonlinear mathematical programming for providing the mentioned integrated model in order to achieve the maximal firm profit, minimizing the costs and covering the customers' needs.

LITERATURE REVIEW

The theoretical principles and research background are presented in this section, respectively. As research suggests, the objective of conducting this study is to do the cost management through integrated designing of quantitative and mathematical models. Hence, the applied models in this study are defined in the research theoretical principles.

Theoretical principles:

Target costing: It refers to the strategic management process in order to reduce the total cost at stages of product planning and designing (Khoshtinat and Jameei, 2002). Target costing is a strong strategic tool which enables the organization to find three dimensions of quality, cost and time simultaneously and controls the costs before occurrence in addition to giving the value to the customer. In fact, the activity-based costing activities focus more on the customers' needs rather than the cost. The increasing rate of technological and economic changes around the world has convinced the organizations to use this system in order to survive in this competitive environment. This system has two main objectives in the organization: First, reducing the manufacturing costs of new products until the profit necessary for survival of company is ensured in the industry and then creating all employees' motivation in order to achieve the higher profit during the product life cycle (Kee, 2010).

Quality Function Deployment (QFD): QFD is a powerful tool to ensure that the customer's voice is heard throughout the design process. The main philosophy of using the QFD is to apply the customer's quality demands at different stages of product design. Therefore, all specifications and properties of product design are obtained according to its customer's points of view. A Matrix called the House of Quality (HOQ) is used at the first stage in all conventional methods for QFD and this matrix applies the customer demands on technical parameters. At the first stage (product planning matrix), the customer's demands and needs are compared with technical requirements of product and the output of this comparison enters the second stage (product designing matrix). At the second stage, the relevant weights are obtained through comparing the qualitative features and properties of components and these are considered as the importance factor at the third stage (project planning matrix). Finally, a independent matrix (Process Control Planning Matrix) is designed in the fourth stage; it multiplies the criteria such as controlling hardness, frequency of expected problems and severity and ability to recognize by the importance degree in order to obtain the measures for manufacturing and production planning (Rezaei and Hosseini, 2006).

Value engineering: The cost, time and quality are considered as the key indicators of project function in project management literature. Value Engineering is one of the tools which are now raised for improving the performance of projects especially the construction projects (Hamilton, 2006). Value Engineering focuses the attention from its components to the functions through interpretation of a system or process in terms of its functions. System/ process view provides the field for creativity in terms of its functions. Thus, the Value Engineering functionalism perspective, which is raised in the form of function analysis, is the basis of value engineering methodology and what distinguishes it from other improvement ways.

RESEARCH BACKGROUND

Previous studies by thinkers about the research subject or similar topics are presented in this section. Goudarzi (2003) Quality cost and costing and employees' and raw material suppliers' participation, (Cooper and Slagmulder, 1997) Target Costing as a structured approach to determine the cost in the product life cycle. Abdi (1994) target costing and relevant strategies. Vokurka and O'leary-Kelly (2000) Creating the flexibility and applying the competitive priority; the need for customer's more knowledge and understanding his needs. Schneider and Bowen (1995) important factors of success in terms of creating new competitive priorities. Roosta *et al*. (1997) Fulfilling the customers' expectations. Mansouri and Yavari, (2003), Comprehensive quality management. Harvey (1998), Chain of providing the high quality product or service. Revelle *et al*. (1998), Using a combination of QFD and creative problem solving. Jebel *et al.* (2001), Loss of delay in launching national projects. Miles (1989) Value engineering as an organized creative approach. Shigeru and Akao (1994) Customer-Driven Approach to Quality Planning and Deployment. Dejmark (1997) Value Engineering methodology. Norton and Elliott (1984) Value Engineering as an structured and multi-disciplinary process. Gholipour and Beyraghi (2004) Value engineering capabilities. Mostofi-Darbani (2005) Percentage of applying the value engineering in various industries around the world. Ravanshadnia (2005) The opportunity to change the method and time of applying the techniques throughout the project life.

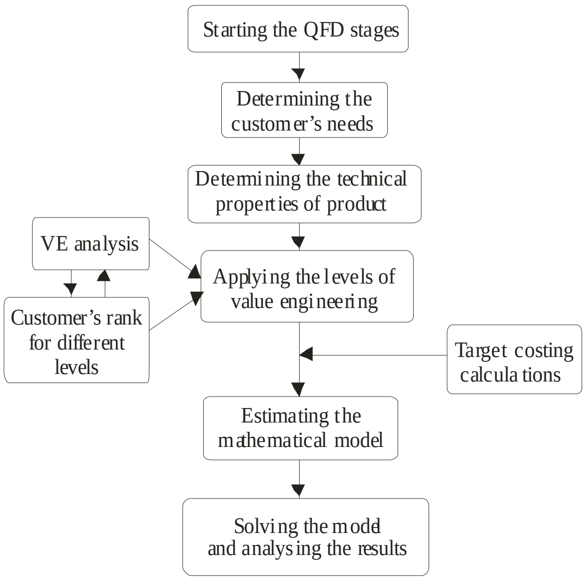

Fig. 1: Conceptual model of research

RESEARCH METHODOLOGY

This study is descriptive with the survey type in terms of research methodology. The research method is also applied based on the objective because application of research results can help the managers and employees in studied company in terms of cost management. Finally, the research has modeling type in terms of data analysis.

Data collection method: The library data collection method is used in terms of theoretical principles of study. Thus, the target data is collected by referring to the relevant books, libraries, Internet, firm archive, etc, at some stages and it is extracted from studied organization through the interview, questionnaire and real data (items recorded in financial statements, costs, etc.) at other stages; thus the results of both library and field methods have been used in this regard.

Data analysis: Descriptive statistics including the demographic data of statistical sample and research variables such as frequency distribution tables, descriptive curve, etc and inferential statistics including the mathematical programming nonlinear optimization technique are used for data analysis and hypothesis test in this study.

Conceptual model of research: Conceptual model of relationship between independent and dependent variables of research is presented in Fig. 1.

RESULTS

Combined mathematical model including the VE, QFD, TC: In this section, the mathematical model study is provided for simultaneous implementation of three approaches including the value engineering, quality function deployment and target costing. It should be noted that the objective of this model is to maximize the customer satisfaction and the objective function of model is designed on this basis. Applied signs in the model are shown in Table 1.

On this basis, the non-linear combined mathematical modeling is provided through using three approaches of value engineering, quality function deployment and costing as follows:

$$\max\ Z = \sum_{i=1}^{n} w_i y_i \qquad (1)$$

$$\sum_{L=1}^{m} x_{kL} = 1 \qquad , k = 1, 2, ..., m \qquad (2)$$

$$y_i = \sum_{k=1}^{m} \sum_{L=1}^{L_k} u_{ikL} x_{kL} + \sum_{k=1}^{m-1} \sum_{j=k+1}^{m} \sum_{L=1}^{L_k} \sum_{v=1}^{L_j} \gamma_{ikj} x_{kL} x_{jv} \qquad , i = 1, 2, ..., n \qquad (3)$$

$$\sum_{L=1}^{L_k} C_{kL} x_{kL} \le TC_k \qquad , k = 1, 2, ..., m \qquad (4)$$

$$\sum_{i=1}^{m} TC_i \le \text{Target cost} \qquad (5)$$

$$x_{kL} \in \{0.1\} \qquad (6)$$

where, the functions of model are as follows, respectively:

1) Objective function of model maximizes the customer satisfaction.
2) The sum of technical property at the level L is considered equal to 1.
3) The sum of technical property effects for customer's need i (y_i) which reflects the impact of customer prioritization in the first term of equation and shows the House of Quality ceiling (*HOQ*) or the relationship between the technical properties in the second term. y_{ikj} refers to the interaction between the technical properties k and j for customer's need i.
4, 5) It ensures that the total cost of all sub-systems is not more than the former amount of objective function.
6) It shows the membership of decision variables in the set of 0 and 1.

Components of main research model: During extraction, 22 needs were determined for this product during the extraction of customer needs for creating the acicular concrete sleeper; they are provided in Table 2 along with the corresponding weights.

Based on the conceptual model, Table 3 compares the wooden and concrete sleepers. As shown, concrete sleeper provides much more customer satisfaction in

Table 1: Signs and properties applied in the research model

Signs	Description
I	Customer's need i. $i = 1, 2, \ldots, n$
k	Technical property k. $k = 1, 2, \ldots, m$
L_{kL}	Number of level for technical property k. $L = 1, 2, \ldots, L_k$
u_{ikL}	Intensity which the level L has from the technical property k on customer's need i.u_{ikL} is the element of House of Quality (HOQ).
w_i	Weight of customer's need i
x_{kL}	Variable of decision is equal to 1 if technical property k is implemented at level L, otherwise it is 0
C_{kL}	Cost for implementing the technical property k at level L
y_i	Total effect of technical property for customer's need i (this parameter is calculated by formula)
γ_{ikj}	Relationship between technical properties (house of quality ceiling)

Table 2: Customers' need for new acicular concrete sleeper product

i	Description	Weight
1	Resistance to weather conditions and corrosion	3
2	Resistance to biological factors (fungi and insects)	4
3	More axial load bearing	5
4	High average lifespan in action	5
5	Resistance to fire	3
6	Less damage in rail accidents	4
7	High bending strength	4
8	Lack of hazardous chemicals in products	3
9	Lack of environmental pollution during the production process	3
10	No need for using the vital natural resources such as forest	4
11	Higher stability in Ballast	4
12	High velocity	5
13	Resistance to longitudinal cracks	4
14	Flat sleeper surface	3
15	Low cost	5
16	Updated traceability of production	3
17	Proper and regular layout	2
18	Proper and safe transportation and loading and unloading	3
19	Short product order to delivery time	3
20	The ability to replace damaged sleeper in railway accidents quickly	5
21	Absorbing the vibration and noise while the train passing	3
22	Resistance to transversal cracks	4

Table 3: Comparing the wooden and concrete sleepers in fulfilling the customers' needs

No	Property	Wooden	Concrete
1	Resistance to weather conditions and corrosion	✗	✗
2	Stable performance in all weather conditions	✗	✓
3	Absorbing the vibrations	✓	✗
4	Resistance to growth of plants	✗	✓
5	Resistance to insect infestation	✗	✓
6	High average lifespan in action	✗	✓
7	Installing the basal sheath with no need for drilling	✗	✓
8	Low final weight of product	100	+300
9	Interchangeable with available sleepers in the market	✓	✗
10	Not producing the smelly materials in operation	✗	✓
11	Lack of hazardous chemicals in sleeper structure	✓	✓
12	Resistance to fire	✗	✓
13	Resistance to longitudinal and transversal cracks due to train movement	✓	✓
14	Ability to manufacture in various sizes for using in two-sided ways	✓	✓
Total		5	10

fulfilling their needs in spite of numerous problems facing the way to meet the customers' whole needs.

Accordingly, it can be concluded that it seems reasonable to choose the concrete sleeper for fulfilling the customers' needs and only the required technical properties should be met in order to fulfill the customers' needs. However, several other technical properties are needed in order to fulfill the customers' other needs as follows:

- Resistance to weather conditions and corrosion
- Flat surface of sleeper
- Updated product traceability
- Low cost

Table 4: Summarizing the values of technical properties C and L for acicular concrete sleeper

Technical property	K	L	Suggestion	C_{kL}	L_{kL}
Resistance to weather conditions and	1	1	Cement type II	C_{11} = 123	L_{11}
corrosion	1	2	Slag cement type SCB	C_{12} = 254	L_{12}
	1	3	Alumina cement (Al)	C_{13} = 320	L_{13}
Flat surface of sleeper	2	1	BHS	C_{21} = 650	L_{21}
	2	2	Lubricant	C_{22} = 342	L_{22}
	2	3	Concrete retarding admixture	C_{23} = 540	L_{23}
Updated product traceability	1	3	Sealing	C_{31} = 130	L_{31}
	3	2	Plaque	C_{32} = 90	L_{32}
	3	3	Painting	C_{33} = 180	L_{33}
Low cost	4	1	Work force adjustment	C_{41} = 375	L_{41}
	4	2	BHS	C_{42} = 110	L_{42}
	4	3	Concrete Automatic Equipment	C_{43} = 80	L_{43}

Table 5: Weight values of customer's preference for needs

i	w_i	i	w_i
1	3	12	5
2	4	13	4
3	5	14	3
4	5	15	5
5	3	16	3
6	4	17	2
7	4	18	3
8	3	19	3
9	3	20	5
10	4	21	3
11	4	22	4

Obtained results in this section can be summarized in Table 4. C_{kL} is the cost for doing the technical property k at the level L.

The next stage after determining the above solution by value engineering is to calculate the customer voice or u_{ikL}. This parameter is among the components of the House of Quality (HOQ) and should be calculated as the model input. u_{111} means that how much the customer satisfaction is if for the first customer's need i = 1, the first technical property k = 1 is done at the first level L = 1. In other words, u refers to the rate of customer satisfaction with implementation of technical property. The relevant Table is not presented due to the large number of extracted customer satisfaction.

The parameter y_{ikj} or the relationship between the technical properties (house of quality ceiling) should be specified after determining the values of u for customer satisfaction with technical properties. This parameter shows the strong relationship between two technical properties and it will have the value equal to 9 if there is a strong relationship between two technical properties. No interaction was identified among four established technical properties above by the working group, thus this parameter was considered equal to zero for all values of i, k and j.

The next stage is to determine the weight of each customer's needs. This stage was implemented at the time of investigating the customer needs and the working group was asked to determine the weights of each need. These weights are listed in Table 5.

The final research model is developed after completing all above cases as follows.

Calculating the final model of acicular concrete sleeper by VE, QFD, TC: As observed, the values of customer preferences are equal to zero in most of cases and this is due to the lack of effect by a specific technical property on customer's special requirement. Therefore, the non-zero values of u are presented for easy writing of final model and then the full model is presented as follows:

$u1, 1, 1 = 9$ $u1, 1, 2 = 6$ $u1, 1, 3 = 7$
$u2, 1, 1 = 3$ $u2, 1, 2 = 1$ $u2, 1, 3 = 4$
$u3, 1, 1 = 4$ $u3, 1, 2 = 2$ $u3, 1, 3 = 3$
$u4, 1, 1 = 9$ $u4, 1, 2 = 6$ $u4, 1, 3 = 7$ $u4, 2, 3 = 4$
$u5, 1, 1 = 9$ $u5, 1, 2 = 9$ $u5, 1, 3 = 9$
$u6, 1, 1 = 6$ $u6, 1, 2 = 4$ $u6, 1, 3 = 2$
$u7, 1, 1 = 8$ $u7, 1, 2 = 4$ $u7, 1, 3 = 5$ $u7, 2, 3 = 4$
$u8, 1, 3 = 9$
$u10, 1, 1 = 9$ $u10, 1, 2 = 7$ $u10, 1, 3 = 8$
$u11, 1, 1 = 8$ $u11, 1, 2 = 9$ $u11, 1, 3 = 7$ $u11, 2, 3 = 4$
$u12, 1, 1 = 9$ $u12, 1, 2 = 9$ $u12, 1, 3 = 9$ $u12, 2, 3 = 4$
$u13, 1, 1 = 9$ $u13, 2, 2 = 9$ $u13, 2, 3 = 4$
$u14, 2, 1 = 4$ $u14, 2, 2 = 9$ $u14, 2, 3 = 5$ $u14, 4, 2 = 4$
$u15, 4, 1 = 9$ $u15, 4, 2 = 4$ $u15, 4, 3 = 5$
$u16, 3, 1 = 6$ $u16, 3, 2 = 9$ $u16, 3, 3 = 5$
$u18, 3, 1 = 4$ $u18, 3, 2 = 8$ $u18, 3, 3 = 5$
$u19, 2, 1 = 6$ $u19, 4, 1 = 9$ $u19, 4, 2 = 6$ $u19, 4, 3 = 4$
$u21, 2, 2 = 4$
$u22, 1, 1 = 9$ $u22, 1, 2 = 7$ $u22, 1, 3 = 6$
$u22, 2, 2 = 9$ $u22, 2, 3 = 4$

Furthermore, the customer's needs 9, 17 and 20 are not satisfied by technical properties and their all values of u are equal to zero, thus they are not appeared in the model. The price equal to 1500 Tomans was proposed for value of target costing, so that it is possible to subtract 1500 Tomans per meter from the current price of acicular concrete sleeper with the price equal to 15000 Tomans. Finally, the ultimate model of sleeper is expressed as follows. It should be noted that the value of $tc4$ is for cost reduction and should be attached to the model with a negative sign:

$$Maxz = 3y_1+4y_2+5y_3+5y_4+3y_5+4y_6+4y_7+3y+4y_{10} +4y_{11}+5y_{12}+4y_{13}+3y_{14}+5y_{15}+3y_{16}+3y_{18}+3y_{19}+3y_{21} +4y_{22}$$

Table 6: Output values of Lingo software for sleeper model

Variable	Value	Variable	Value
Y1	9	X11	1
Y2	3	X12	0
Y3	4	X13	0
Y4	9	X21	0
Y5	9	X22	1
Y6	6	X23	0
Y7	8	X31	0
Y8	0	X32	1
Y10	9	X33	0
Y11	8	X41	1
Y12	9	X42	0
Y13	18	X43	0
Y14	9	X	0
Y15	9	TC1	123
Y16	9	TC2	342
Y18	8	TC3	90
Y19	9	TC4	174
Y21	4		
Y22	18		

s.t.

$$x_{1,1}+x_{1,2}+x_{1,3} = 1$$
$$x_{2,1}+x_{2,2}+x_{2,3} = 1$$
$$x_{3,1}+x_{3,2}+x_{3,3} = 1$$
$$x_{4,1}+x_{4,2}+x_{4,3} = 1$$

$$y_1 = 9x_{1,1}+6x_{1,2}+7x_{1,3}$$
$$y_2 = 3x_{1,1}+1x_{1,2}+4x_{1,3}$$
$$y_3 = 4x_{1,1}+2x_{1,2}+3x_{1,3}$$
$$y_4 = 9x_{1,1}+6x_{1,2}+7x_{1,3}+4x_{2,3}$$
$$y_5 = 9x_{1,1}+9x_{1,2}+9x_{1,3}$$
$$y_6 = 6x_{1,1}+4x_{1,2}+2x_{1,3}$$
$$y_7 = 8x_{1,1}+4x_{1,2}+5x_{1,3}+4x_{2,3}$$
$$y_8 = 9x_{1,3}$$
$$y_{10} = 9x_{1,1}+7x_{1,2}+8x_{1,3}$$
$$y_{11} = 8x_{1,1}+9x_{1,2}+7x_{1,3}+4x_{2,3}$$
$$y_{12} = 9x_{1,1}+9x_{1,2}+9x_{1,3}+4x_{2,3}$$
$$y_{13} = 9x_{1,1}+9x_{2,2}+4x_{2,3}$$
$$y_{14} = 4x_{2,1}+9x_{2,2}+5x_{2,3}+4x_{4,2}$$
$$y_{15} = 9x_{4,1}+4x_{4,2}+5x_{4,3}$$
$$y_{16} = 6x_{3,1}+9x_{3,2}+5x_{3,3}$$
$$y_{18} = 4x_{3,1}+8x_{3,2}+5x_{3,3}$$
$$y_{19} = 6x_{2,1}+9x_{4,1}+6x_{4,2}+4x_{4,3}$$
$$y_{21} = 4x_{2,2}$$
$$y_{22} = 9x_{1,1}+7x_{1,2}+6x_{1,3}+9x_{2,2}+4x_{2,3}$$

$$123x_{1,1}+254x_{1,2}+320x_{1,3} <= tc_1$$
$$650x_{2,1}+342x_{2,2}+540x_{2,3} <= tc_2$$
$$130x_{3,1}+90x_{3,2}+180x_{3,3} <= tc_3$$
$$375x_{4,1}+110x_{4,2}+80x_{4,3} >= tc_4$$

$$tc_1+tc_2+tc_3-tc_4 <= 1500$$
$$0<x_{kL}<1$$

The output values are presented in Table 6 after solving the model in software Lingo 11. The value of objective function is obtained equal to 606 under 26-simplex.

CONCLUSION

In this study, 22 customer's needs were identified for the new product, acicular concrete sleeper, by engineering workgroup of Islamic Republic of Iran railways as follows:

Resistance to weather condition and corrosion
Resistance to biological factors (fungi and insects)
More axial load bearing
High average lifespan in action
Resistance to fire
Less damage in rail accidents
High bending strength
Lack of hazardous chemicals in products
Lack of environmental pollution during the production process
No need for using the vital natural resources such as forest
Higher stability in Ballast
High velocity
Resistance to longitudinal cracks
Flat sleeper surface
Low cost
Updated traceability of production
Proper and regular layout
Proper and safe transportation and loading and unloading
Short product order to delivery time
The ability to replace damaged sleeper in railway accidents quickly

Four technical properties were considered for product in order to implement the project for fulfilling these customer's needs at the second stage and three suggestions were provided for each of these properties by engineering workgroup of manufacturing the new product.

- **Resistance to weather conditions and corrosion:**
  - Cement type II
  - Slag Cement type SCB
  - Alumina cement (AL)
- **Flat surface of sleeper:**
  - BHS
  - Lubricant
  - Concrete retarding admixture
- **Updated product traceability:**
  - Sealing
  - Plaque
  - Painting
- **Low cost:**
  - Work force adjustment
  - BHS
  - Concrete Automatic Equipment

After this stage and after developing the weight for each need by this working group, the mathematical model was developed and solved based on the parameters of Railway Engineering and Production Engineering Working Groups in lingo software. Modeling results for target cost were determined equal to 1500 Tomans cost reduction in each meter of acicular concrete sleeper; the results of modeling and Lingo software output were as follows. At the first stage, the objective function value, which was equal to maximal customer satisfaction, was developed equal to 606 by model and then the customer satisfaction was calculated at second stage based on each need developed by software and the results are as follows:

Y1 = 9 Y12 = 9
Y2 = 3 Y13 =18
Y3 = 4 Y14 = 9
Y4 = 9 Y15 = 9
Y5 = 9 Y16 = 9
Y6 = 6 Y18 = 8
Y7 = 8 Y19 = 9
Y8 = 0 Y21 = 4
Y10 = 9 Y22 =18
Y11 = 8

To better understand these results, they should only be analyzed in descending order. Corresponding descending values are as follows:

1	Y13 = 18	11	Y19 = 9
2	Y22 = 18	12	Y7 = 9
3	Y1 = 9	13	Y11 = 8
4	Y4 = 9	14	Y18 = 8
5	Y5 = 9	15	Y6 = 6
6	Y10 = 9	16	Y3 = 4
7	Y12 = 9	17	Y21 = 4
8	Y14 = 9	18	Y2 = 3
9	Y15 = 9	19	Y8 = 0
10	Y16 = 9		

As shown in table above, the needs 13 and 22 are fulfilled more than other needs; in other words, the need 13 (resistance to longitudinal cracks) and need 22 (Resistance to transversal cracks) will be fulfilled more than other needs by implementing the mentioned technical properties and the need 8 will not be fulfilled and the need 2 (Resistance to biological factors (fungi and insects)), need 21 (Absorbing the vibration and noise while the train passing) and need 3 (More axial load bearing) are satisfied at the lowest level and other customer's needs are met well with an average higher than 6. Then the results for values of *x* were also estimated by model and provided by the software as follows:

$X_{11} = 1$ $X_{31} = 0$
$X_{12} = 0$ $X_{32} = 1$
$X_{13} = 0$ $X_{33} = 0$
$X_{21} = 0$ $X_{41} = 1$
$X_{22} = 1$ $X_{42} = 0$
$X_{23} = 0$ $X_{43} = 0$

In other words, the above table shows that the first item (cement type II) should be implemented in the first technical property (Resistance to weather conditions and corrosion); the second item (Lubricant) should be implemented in the second technical property (Flat sleeper surface); the second item (Plaque) should be implemented in the third property (Updated product traceability); and eventually, the first item (Work force adjustment) should be implemented in the fourth property (Low cost). Furthermore, the output of target costing values is as follows in case of implementing these proposed projects:

$TC_1 = 123$
$TC_2 = 342$
$TC_3 = 90$
$TC_4 = 174$

In other words, an increased cost equal to 123 Tomans will be obtained for the first technical property, 342 Tomans for the second technical property and 90 Tomans for the third technical property and also a decreased cost equal to 174 Tomans for the fourth technical property if mentioned technical properties are implemented based on the suggested model output.

This study measures the optimal values through mathematical programming in Lingo software, which calculates results, by introducing the new product, acicular concrete sleeper, through the estimation mathematical and according to the responses of engineering workgroup in terms of acicular concrete sleeper. Four technical characteristics were considered for product in order to implement the project and fulfill the customer's at second stage and three suggestions in the field of resistance in weather conditions and corrosion, smooth surface of railway sleeper and traceability of updated production were provided by workgroup of Production Engineering of new product for each of these indexes. The main result of this study is to apply the calculated and necessary technical properties in order to satisfy the customers and reduce the ultimate cost of product manufacturing.

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