Identifying the Factors Affecting Manufacturing Investment Projects and Using TOPSIS Method for Prioritizing Projects

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ABSTRACT

For many cases, grading and prioritizing the projects are so important in project-based organizations. In fact, it means prioritizing some projects and allocating organizational resource only to those projects to reach the organization profit up to maximum level through such allocation and decision. There are many different factors contribute in choosing the best project combination for organization too. Considering the fact that the value of criteria in projects are usually unclear and vague, and through observing, studying, interview and top managers' brain storm meetings, the present paper tries to identify the factors affecting manufacturing investment projects, and then to prioritize projects of MAPNA Locomotive Engineering and Manufacturing Company using TOPSIS method. In present study, Shnnon's weight entropy method is used for determination of weight of parameters. The results of this research show that identifying four main economic, technical, manufacturing and marketing criteria are among the factors influence on choosing a project, and of 19 manufacturing projects of MAPNA Locomotive Engineering and Manufacturing Company P19, P1, P2, P12, and P11 are prioritized from 1st to 5th grade, respectively.

Keywords:

manufacturing investment projects, qualitative criteria, quantitative criteria, TOPSIS method

1. Introduction

The importance of investment and its special situation in economics of current world reflects the necessity of different models and technics in this field more and more, so that many researchers have used various methods and technics by now. Issues related to decision making are from main useful tools and scientific management which the right use can help the management of an organization or a company to reach to its predetermined aims (Ghodsipour, 2000).

As a part of this decision making process, one can refer to investment issues and choosing the investment projects in which the investor begin to invest aiming at achieving the positive results (profit) from an investment project (Mellatparast, 1998). Today, study and analysis of investment projects and finally, their prioritizing, regarding the socio-economic criteria (qualitative and quantitative) are among very important issues (Alikhani, 2000).

Generally, for investment related issues, decision makers are going to choose one or certain number of possible choices available for investment considering the target criteria and important limitations of this field. The key point in investment plans evaluation is to consider various criteria for decision making, addition to well- known economic indicators such as net present value, payback period, benefit-cost ratio, etc., that play key role to make the related model more real and to increase precision of decision making considerably. These criteria are different depending on investment nature and field (Trappy, 2007). In the investment issues, it has always been a question that how the effects of qualitative criteria can be contributed in the investment projects.

Investment and choosing the investment projects is a solution that today companies use to reach more productivity and better economic situation. Therefore, the proper methods for decision making about investment projects can bring more productivity for the company, because for some cases, the results of decision is so important that any bias can lead to an irrecoverable loss for company. Thus, designing proper technics to choose the best choice and to make a proper decision is so necessary.

Today, organizations define several projects in order to reach their long term objectives according to a provided outlook. The problem which managers always face with is making a decision for choosing the best set of project. They always face with the question that which project they should choose to gain more profit for organization. Resource limitations, organizational strategies, and the country policies in industry field are among those parameters which contribute in such decision making. Evaluation and choosing the more effective projects and the optimized resource allocation are figured out as the organizational strategic decision making and they are so important. Therefore, using the methods that help to clarifying vague points of human judgments in decision makings is appropriate.

Following questions have been presented considering the subject of the current research:

1) What are the factors affecting manufacturing investment projects of MAPNA Locomotive Engineering and Manufacturing Company?
2) How the projects of MAPNA Locomotive Engineering and Manufacturing Company are prioritized?

2. Literature Review

In traditional approaches, the investment projects were evaluated based on the analysis of discounted financial indicators such as net present value and internal rate of return, and on the other hand, evaluation of projects were become multivariate issues for considering common variables such as quantitative financial parameters and indicators (Jonny et.al. 2008). Today, however, the importance of qualitative criteria in investment projects has been cleared for the companies, and managers consider the qualitative criteria in evaluations.

For many cases, favorite and satisfactory decision makings are those ones which have been analyzed on the basis of different variables. In some cases, with both qualitative and quantitative criteria for decision making, which usually have not the same unit, the proper methods for decision making should be found. Such methods are called multiple criteria decision making methods Partovi, 1996).

TOPSIS method was presented by Wu & Hoang in 1981. It is one of the most applied methods for multivariate model of problem solving. The main concept of this method is based on choosing the choice that has closest *Euclidean distance* to the ideal choice and the farthest *Euclidean distance* to the negative ideal choice (Najafi, 2010)

Project grading and choosing means determination of some choices in order to optimize organization's profit and allocating limited organizational resources only to those projects (Wey et al, 2007). In last two decades, various models have been introduced for choosing projects and allocating resources. Systematic and academic studying, sorting and literature of project choosing have been conducted by (Chu et.al), (Cooper et.al, 2001), and (Zanakis et.al, 1995).

Nandy et.al (2011) used the Analytic Hierarchy Process for choosing civil projects. In their model, they identified 11 main criteria including financial, technical, risk, contract terms and conditions, government policies, situational factors, environmental factors, political factors and project objectives.

Considering the multivariate indicators and opinions of decision makers group, Tan et.al, (2010), used FUZZY TOPSIS method for choosing the civil projects. They used four main criteria including project conditions, company conditions, competitive and risk criteria and for sub-criteria, the project conditions included profitability, difficulty, relationships with owners; company conditions included need to work, resources and capabilities; competition included competitors' eagerness and compatibility; and risk included project executive risk and financial risk.

Karpak and Topcu (2010) used Analytic Network Process and Super Decision software to prioritize the factors affecting on investment in small and medium size industries, and to do this, they considered five clusters of main criteria including success measurement, situation of the country business, internal environment of the company, factors related to the owner, firm skills and the organization supportive factors such as financial situation and accessibility to foreign markets with 31 sub-criteria, and ask the opinions of 3 experts for problem solving and prioritizing.

Sobhani et.al (2016), used the Analytic Hierarchy Process method for prioritizing factors affecting the project choosing. In the current research, the factors affecting the project choosing and evaluating were identified through study and experts interviews. The required information has been gathered by AHP questionnaires for experts, and also their interviews. For evaluation of projects, two financial-economic and technical criteria have been identified that the weight of criteria and sub-criteria have been gained by AHP on the basis of experts opinions. Considering the obtained results, the main financial-economic criteria is more significant than technical criteria.

Mohammadi Bolbolan Abad and Iranmanesh (2009) used FUZZY TOPSIS to choose and manage the investment portfolio. They used five main criteria including financial criteria, organizational needs and business requirement criteria, technical criteria, marketing and project environmental competition criteria, and management criteria for project evaluation. Finally, they concluded organizational needs and business requirement criteria are the most effective criteria to choose the investment portfolio.

Using the FUZZY TOPSIS method, Pahlevani (2008) has presented a model to prioritize investment in different industries related to Industry and Mine Bank working field. In the model, he has used industry efficiency criteria, bank strategy adaptation criteria, and industry history criteria. The obtained results have helped Industry and Mine Bank to prepare plans and to lead short term and long term investment.

Table 1 shows the summary of national and international researches:

Table 1: Criteria presented based on research literature

Row	Researchers	Used criteria	Cases	Method
1	Nandy et.al(2011)	Payback period, benefit-cost ratio, operational risk, omission of wastes, technology accessibility	Civil project	AHP
2	Tan et.al (2010)	Financial risk, operational risk	Civil project	FUZZY TOPSIS
3	Karpak,and Topcu (2010)	criteria of success measurement, situation of the country business, internal environment of the company, factors related to the owner, firm skills, and the organization supportive factors such as financial situation and accessibility to foreign markets	Small & medium size industries	Analytic Network Process & Super Decision software
4	Mohammadi Bolbolan Abad and Iranmanesh (2009)	Payback period, internal rate of return, increasing safety and pollution indicator, , technology accessibility and employees' satisfaction	Water project	FUZZY TOPSIS
5	Sobhani et.al (2016)	Financial risk, estimation of total cost, internal	An active company in	AHP

Row	Researchers	Used criteria	Cases	Method
		efficiency, capital return, benefit-cost ratio, operational risk, omission of wastes, project time, , increasing safety, technology accessibility and employees' satisfaction	stainless steel manufacturing	
6	Razavi et.al (2008)	Increasing safety and decreasing pollution	National investment project	ELECTRE
7	Pahlevani (2008)	Payback period	Investment in industry	FUZZY TOPSIS

2.1. Research suggested model

2.2.1. Identification of qualitative and quantitative criteria affecting evaluation and choosing manufacturing investment project

To do this, and using criteria from research literature, library resources, managers' interviews and the brain storm meetings outputs of the company top managers, four groups of economic, technical, manufacturing, marketing and contractual criteria were identified. Economic criteria depend on sub-criteria of cash flow, benefit-cost ratio, profitability percent and investment for infrastructure of equipment and install; technical criteria depend on sub-criteria of technology and provision dependence and accessible technical knowledge sub-criteria; manufacturing criteria depend on sub-criteria of creating manufacturing value in short term and creating manufacturing value for increasing human resource employment- numerical; and marketing and contractual criteria depend of sub-criteria of customers' contract and confirmation of the board of directors. Figure 1 shows the research suggested model.

Figure 2 shows criteria affecting evaluation and choosing the projects of MAPNA Locomotive Engineering and Manufacturing Company.

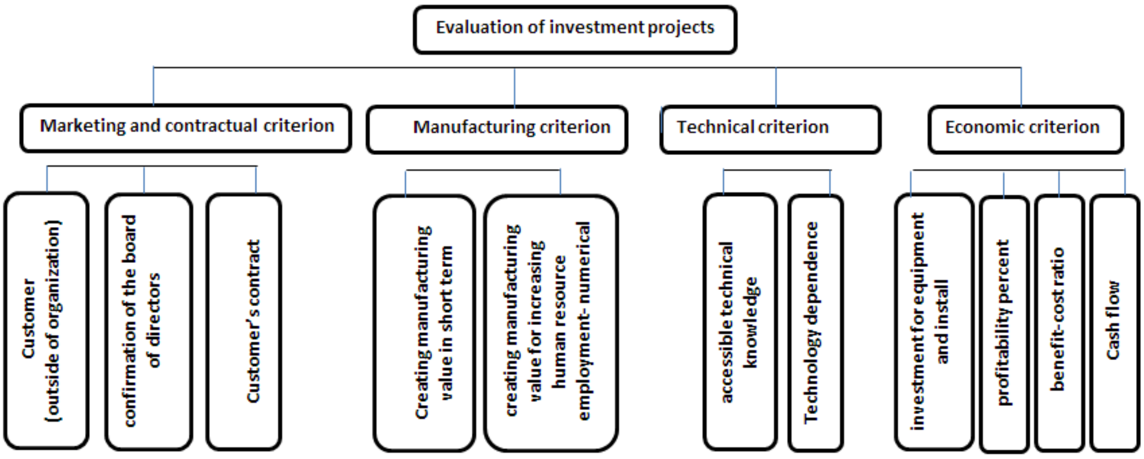

Figure 1: Suggested model for qualitative and quantitative criteria affecting evaluation and choosing the projects of MAPNA Locomotive Engineering and Manufacturing Company

Table 2: Final criteria affecting evaluation and choosing the project

Row	Criterion name	Type	Resources
1	Cash flow	Qualitative	Nandy et.al(2011)
2	Benefit-cost ratio	Qualitative	(Experts)
3	Customer	Qualitative	Nandy et.al (2011)/Sobhani et. al (2015)
4	Cost rate	Qualitative	(Experts)
5	Technology & provision dependence	Qualitative	Sobhani et. al (2015)

Row	Criterion name	Type	Resources
6	Accessible technical knowledge	Qualitative	(Experts)
7	Creating manufacturing value in short term	Quantitative	Mohammadi Bolbolan Abad and Iranmanesh (2009)/ Sobhani et. al (2015)
8	Creating manufacturing value for increasing human resource employment- numerical	Quantitative	(Experts)
9	Confirmation of the board of directors	Qualitative	(Experts)
10	Customer contract	Qualitative	(Experts)
11	Investment for infrastructure to equip and install	Qualitative	(Experts)

2.2.2. Definition of criteria affecting evaluation and choosing investment projects and way of defining

2.2.2.1. Economic criteria

- ✓ **Cash flow:** This criterion is defined as representative of the level of entering cash flow of project, considering the potential infrastructure. The criterion quantifying has been done by the five point Likert Scale.
- ✓ **The cost rate**: This criterion is representative of the percent of cost rate/total rate, considering the potential infrastructure. The criterion quantifying has been done by the five point Likert Scale. Too low (less than % 1), low (% 1-5), middle (% 5-20), high (% 20-40), very high (over %40).
- ✓ **Benefit-cost ratio:** Benefit-cost ratio or cost rate is the rate resulted from subdivision of current value of future cash flow to investment cost (Fadaeinejad, 2003). The criterion quantifying has been done by the five point Likert Scale. Too low (less than % 5), low (% 5-10), middle (% 1-20), high (% 20-30), very high (over % 30).
- ✓ Investment for infrastructure to equip and install: This criterion refers to infrastructure investment required for project operation. The criterion quantifying has been done by the five point Likert Scale. Too low (less than % 1 billion), low (% 1-5 billion), middle (% 5-10 billion), high (% 10-30 billion), very high (over %30).

2.2.2.2. Technical Criteria

- ✓ **Accessible technical knowledge:** How much the project operation, considering the potential infrastructures, is dependent on internal technical knowledge. The criterion quantifying has been done by the five point Likert Scale. Too low (dependent to western countries), low (dependent to accessible countries), middle (domestic companies), high (within the group), very high (within the company).
- ✓ **Technology and provision dependence:** It refers to outsourcing technology and provision. The criterion quantifying has been done by the five point Likert Scale. Too low (full domestic equipment), low (secondary foreign equipluement), middle (average), high (primary foreign equipment), very high (full foreign equipment).

2.2.2.3. Manufaturing criteria

- ✓ **Creating manufacturing value in short term:** This criterion represents how long a project takes to reach up to production phase (in month).
- ✓ **Creating manufacturing value in increasing human resource employment- numerical:** This criterion represents when a project reaches up to production phase how many people would be hired.

2.2.2.4. Marketing and contractual criteria

- ✓ **Confirmation of board of directors:** It refers to the fact that whether the project has been confirmed by board of directors or not. For criterion quantifying, number 7 represents Yes and number 3 represents No.
- ✓ **Customer's contraction:**
- ✓ This criterion represents that whether the project has an executive customer's contract or not. For criterion quantifying, number 9 represents Yes and number 1 represents No.

- ✓ **Customer:** How the relationship with customer would be. The criterion quantifying has been done by the five point Likert Scale. Too low (without certain customer), low (announcing the basic needs), middle (entering a bid), high (beginning a negotiation), very high (final agreement).

3. Methodology

Objectively, the current study is a descriptive-survey research. The sample of the study includes 19 manufacturing projects of MAPNA Locomotive Engineering and Manufacturing Company. This research has been conducted aiming at identifying the factors affecting manufacturing investment projects and using TOPSIS Method for prioritizing projects. To do this, qualitative and quantitative criteria affecting choose of investment projects were identified and chosen using the research literature, library resources, managers' interviews and the brain storm meetings outputs of the company top managers and TOPSIS Method. Also, Shnnon's weight entropy method is used for determination of weight of parameters in present study.

4. Results

After identification of affecting factors in choosing projects, TOPSIS Method was used to prioritize, including following steps:

4.1. Formulation of decision making matrix

Formulation of decision making matrix was done according to table 2 in which the rows include manufacturing projects of MAPNA Locomotive Engineering Manufacturing Company and the columns include effective factors.

4.2. Converting quantitative criteria into qualitative

According to table 2, and explanations of section 2-2-2 of the current study, identified qualitative criteria converted into quantitative ones for each project separately, and the results can be seen in table 3.

Table 2: Formulation of decision making matrix

Criteria / Project	Cash flow	Profitability percent	Customer (outside of organization)	Cost ratio	Technology and provision dependency	Accessible technical knowledge (considering sanctions)	Creating manufacturing values in short term	Creating manufacturing values for increasing employment of human resources/ numerical	Confirmation of board of directors	Customer's contract with a colleague within a group	Investment for infrastructure to equip and install (calculation or estimation)
P1	Good	Very Good	Very Good	Very Good	Not good, Not poor	Very Good	1	300	Yes	Yes	Very Poor
P2	Good	Poor	Very Good	Very Good	Good	Very Good	1	150	Yes	Yes	Very Poor
P3	Good	Not good, Not poor	Poor	Very Poor	Very Good	Poor	15	300	Yes	No	Not good, Not poor
P4	Not good, Not poor	Very Poor	Good	Very Poor	Good	Very Poor	3	5	Yes	Yes	Very Poor
P5	Not good, Not poor	Good	Poor	Poor	Not good, Not poor	Not good, Not poor	15	50	Yes	No	Poor
P6	Not good, Not poor	Poor	Good	Very Poor	Good	Good	23	400	No	No	Good
P7	Poor	Not good, Not poor	Poor	Very Poor	Very Good	Good	9	300	No	No	Not good, Not poor
P8	Poor	Poor	Poor	Poor	Poor	Very Good	1	65	No	Yes	Poor
P9	Good	Poor	Poor	Very Poor	Poor	Very Good	3	65	No	No	Poor
P10	Good	Poor	Poor	Good	Good	Poor	2	5	No	No	Very Poor
P11	Poor	Poor	Poor	Very Good	Very Poor	Good	1	5	No	Yes	Very Poor
P12	Very Poor	Poor	Very Good	Not good, Not poor	Not good, Not poor	Very Good	1	30	Yes	Yes	Very Poor
P13	Poor	Not good, Not poor	Good	Very Poor	Very Poor	Very Good	1	70	No	No	Poor
P14	Very Poor	Poor	Very Poor	Very Poor	Good	Good	24	200	No	No	Very Good
P15	Not good, Not poor	Not good, Not poor	Poor	Very Poor	Very Poor	Very Good	1	5	No	No	Very Poor
P16	Not good, Not poor	Not good, Not poor	Not good, Not poor	Very Poor	Good	Very Good	12	50	No	No	Very Poor
P17	Not good, Not poor	Very Good	Very Poor	Very Poor	Good	Very Good	2	5	No	No	Very Poor
P18	Poor	Very Poor	Poor	Very Poor	Good	Poor	9	10	No	Yes	Poor
P19	Poor	Very Good	Very Good	Very Good	Not good, Not poor	Not good, Not poor	12	12	Yes	Yes	Poor

Table 3: Converting qualitative criteria into qualitative criteria

Criteria / Project	Cash flow	Profitability percent	Customer (outside of organization)	Cost ratio	Technology and provision dependency	Accessible technical knowledge (considering sanctions)	Creating manufacturing values in short term	Creating manufacturing values for increasing employment of human resources/ numerica	Confirmation of board of directors	Customer's contract with a colleague within a group	Investment for infrastructure to equip and install (calculation or estimation)
P1	7	9	9	9	5	9	1	300	7	9	1
P2	7	1	9	9	7	9	1	150	7	9	1
P3	7	5	3	1	9	3	15	300	7	1	5
P4	5	1	7	1	7	1	3	5	7	9	1
P5	5	7	3	3	5	5	15	50	7	1	3
P6	5	3	7	1	7	7	23	400	3	1	7
P7	3	5	3	1	9	3	9	300	3	1	5
P8	3	3	3	3	3	9	1	65	3	9	3
P9	7	3	3	1	3	9	3	65	3	1	3
P10	7	3	3	7	7	3	2	5	3	1	1
P11	3	3	3	9	1	7	1	5	3	9	1
P12	1	3	9	5	5	9	1	30	7	9	1
P13	3	5	7	1	1	9	1	70	3	1	3
P14	1	3	1	1	7	7	24	200	3	1	9
P15	5	5	3	1	1	9	1	5	3	1	1
P16	5	5	5	1	7	9	12	50	3	1	1
P17	5	9	1	1	7	9	2	5	3	1	1
P18	3	1	3	1	7	3	9	10	3	9	3
P19	3	9	9	9	5	5	12	12	7	9	3

4.3. Criteria normalizing via Euclidean type norm

Every quantitative criterion has its own measurement scale that makes its value comparison impossible. The values should be so measured that they would be compared with no need to any measurement unit. In current research, therefore, Euclidean norm has been used to normalizing criteria on the basis of equation 1. Normalization output is shown in table 4.

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_1^m x_{ij}^2}}$$

4.4. Identification of Wj vector or weight of jth criterion using Shnnon's weight entropy method

In current research, Shnnon's weight entropy method was used for weighting criteria. At first, entropy equation (2) for each criterion, Ej entropy was calculated. In next step, dj was gained by equation (3) which represents how much useful data dj presents to decision makers for making decision. Closer measured values represent less difference in competitor's choice in terms of criterion. Finally, Wj was gained by equation (4).

$$E_j = -K\sum_{i=1}^{m}[P_i . l_n P_i], K = \frac{1}{l_n m}$$

$$d_j = 1 - E_j$$

$$W_j = \frac{d_j}{\sum_{i=1}^{m} d_j}$$

4.5. Making V matrix

To gain V normalized matrix, normalized matrix (table 4) has multiplied into gained weight (table 5). Table 6 represents making V matrix.

4.5.1. Identification of positive and negative ideals

In this step, those choices which are determined by responders as the most and the least important factors should be identified. In other word, for positive criteria, positive ideal is the highest value of V and negative ideal is the lowest one. Also, for negative criteria, positive ideal is the lowest value of V and negative ideal is the highest one. Table 7 shows the results of identifying positive and negative ideals.

(V^+j): Positive ideal solution (vector of the best value of each criterion of V matrix)

(V^-j): Negative ideal solution (vector of the worst value of each criterion of V matrix)

Table 4: Criteria normalization via Euclidean norm

Criteria / Project	Cash flow	Profitability percent	Customer (outside of organization)	Cost ratio	Technology and provision dependency	Accessible technical knowledge (considering sanctions)	Creating manufacturing values in short term	Creating manufacturing values for increasing employment of human resources/ numerical	Confirmation of board of directors	Customer's contract with a colleague within a group	Investment for infrastructure to equip and install (calculation or estimation)
P1	0.33	0.41	0.37	0.44	0.19	0.29	0.02	0.42	0.33	0.35	0.06
P2	0.33	0.05	0.37	0.44	0.27	0.29	0.02	0.21	0.33	0.35	0.06
P3	0.33	0.23	0.12	0.05	0.35	0.10	0.33	0.42	0.33	0.04	0.32
P4	0.24	0.05	0.29	0.05	0.27	0.03	0.07	0.01	0.33	0.35	0.06
P5	0.40	0.32	0.12	0.15	0.19	0.16	0.33	0.07	0.33	0.04	0.19
P6	0.24	0.14	0.29	0.05	0.27	0.23	0.51	0.56	0.14	0.04	0.45
P7	0.14	0.23	0.12	0.05	0.35	0.10	0.20	0.42	0.14	0.04	0.32
P8	0.14	0.14	0.12	0.15	0.12	0.29	0.02	0.09	0.14	0.35	0.19
P9	0.33	0.14	0.12	0.05	0.12	0.29	0.07	0.09	0.14	0.04	0.19
P10	0.33	0.14	0.12	34.00	0.27	0.10	0.04	0.01	0.14	0.04	0.06
P11	0.14	0.14	0.12	0.44	0.04	0.23	0.02	0.01	0.14	0.35	0.06
P12	0.05	0.14	0.37	0.24	0.19	0.29	0.02	0.04	0.33	0.35	0.06
P13	0.14	0.23	0.29	0.05	0.04	0.29	0.02	0.10	0.14	0.04	0.19
P14	0.05	0.14	0.04	0.05	0.27	0.23	0.53	0.28	0.14	0.04	0.58
P15	0.24	0.23	0.12	0.05	0.04	0.29	0.02	0.01	0.14	0.04	0.06
P16	0.24	0.23	0.21	0.05	0.27	0.29	0.27	0.07	0.14	0.04	0.06
P17	0.24	0.41	0.04	0.05	0.27	0.29	0.04	0.01	0.14	0.04	0.06
P18	0.14	0.05	0.12	0.05	0.27	0.10	0.20	0.01	0.14	0.35	0.19
P19	0.14	0.41	0.37	0.04	0.19	0.16	0.27	0.02	0.33	0.35	0.19

Table 5: Weighing criteria using Shnnon's weight entropy method

Priority	Criteria	Weight
1	Creating manufacturing values in short term	0.112
2	Profitability percent	0.111
3	Accessible technical knowledge	0.103
4	Cash flow	0.099
5	Customer's contracts	0.098
6	Cost ratio	0.091
7	Customer	0.08
8	Investment for infrastructure to equip and install	0.078
9	Confirmation of board of directors	0.077
10	Technology and provision dependency	0.076
11	Creating manufacturing values for increasing employment of human resources/ numerical	0.075

Table 6: V matrix

Criteria / Project	Cash flow	Profitability percent	Customer (outside of organization)	Cost ratio	Technology and provision dependency	Accessible technical knowledge (considering sanctions)	Creating manufacturing values in short term	Creating manufacturing values for increasing employment of human resources/ numerical	Confirmation of board of directors	Customer's contract with a colleague within a group	Investment for infrastructure to equip and install (calculation or estimation)
P1	0.032	0.040	0.030	0.030	0.014	0.020	0.002	0.0310	0.025	0.030	0.005
P2	0.320	0.005	0.030	0.030	0.020	0.020	0.002	0.0100	0.025	0.030	0.005
P3	0.032	0.025	0.010	0.004	0.020	0.009	0.030	0.0310	0.025	0.030	0.020
P4	0.230	0.005	0.230	0.004	0.020	0.003	0.007	0.0005	0.025	0.030	0.005
P5	0.023	0.030	0.023	0.013	0.014	0.016	0.030	0.0050	0.025	0.003	0.015
P6	0.023	0.010	0.010	0.004	0.020	0.030	0.050	0.0400	0.025	0.003	0.030
P7	0.130	0.020	0.023	0.004	0.020	0.009	0.020	0.0300	0.010	0.003	0.020
P8	0.130	0.010	0.010	0.013	0.008	0.020	0.002	0.0060	0.010	0.030	0.010
P9	0.320	0.010	0.010	0.004	0.008	0.020	0.007	0.0060	0.010	0.003	0.010
P10	0.032	0.010	0.010	0.030	0.020	0.009	0.004	0.0005	0.010	0.003	0.005
P11	0.013	0.010	0.010	0.022	0.002	0.023	0.002	0.0005	0.010	0.003	0.005
P12	0.004	0.020	0.010	0.004	0.001	2.000	0.002	0.0030	0.020	0.030	0.005
P13	0.013	0.010	0.030	0.004	0.002	0.020	0.050	0.0070	0.010	0.030	0.015
P14	0.004	0.015	0.020	0.004	0.020	0.020	0.050	0.0200	0.010	0.003	0.040
P15	0.023	0.020	0.003	0.004	0.002	0.020	0.002	0.0005	0.010	0.003	0.005
P16	0.023	0.020	0.010	0.004	0.020	0.020	0.020	0.0008	0.010	0.003	0.005
P17	0.023	0.040	0.030	0.004	0.020	0.020	0.004	0.0084	0.010	0.003	0.005
P18	0.013	0.005	0.010	0.004	0.020	0.009	0.022	0.0010	0.010	0.030	0.010
P19	0.013	0.040	0.370	0.030	0.010	0.010	0.020	0.0010	0.020	0.030	0.010

Table 7: Identification of positive and negative ideals

Criteria / Positive and negative ideals	Cash flow	Profitability percent	Customer (outside of organization)	Cost ratio	Technology and provision dependency	Accessible technical knowledge (considering sanctions)	Creating manufacturing values in short term	Creating manufacturing values for increasing employment of human resources/ numerical	Confirmation of board of directors	Customer's contract with a colleague within a group	Investment for infrastructure to equip and install (calculation or estimation)
V+	0.03200	0.04000	0.37000	0.03000	0.00200	0.02900	0.00200	0.04000	0.02000	0.03400	0.00500
V-	0.00400	0.00500	0.00300	0.00400	0.02600	0.00300	0.05900	0.00052	0.01000	0.00300	0.04500

4.6. Calculation of distance of close values to positive and negative ideals

In this step, distance of close values to positive and negative ideals is determined considering equations (5) and (6).

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^+)^2}$$

(Equation 5)

$$d_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2}$$

(Equation 6)

4.7. Calculation of relative close distance to ideals values

In this step, length of distance close to positive and negative ideals values is calculated using equation (7). Table 9 shows the gained results.

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+}$$

(Equation 7)

Table 8: Distance of close values to positive and negative ideals

Project \ Closer choice	D+	D-
P1	0.0344	110
P2	0.347	0.098
P3	0.371	0.05
P4	0.358	0.07
P5	0.37	0.057
P6	0.361	0.055
P7	0.37	0.057
P8	0.368	0.08
P9	0.3704	0.074
P10	0.3702	0.079
P11	0.368	0.09
P12	0.349	0.089
P13	0.356	0.079
P14	0.383	0.03
P15	0.3702	0.083
P16	0.364	0.067
P17	0.376	0.085
P18	0.372	0.058
P19	0.056	0.037

Table 9: Calculation of relative distance close to ideal choice

Project \ Relative close distance	D+
P1	0.242
P2	0.2205
P3	0.1345
P4	0.1803
P5	0.1349
P6	0.13323
P7	0.1343
P8	0.1786
P9	0.1677
P10	0.1761
P11	0.1972
P12	0.2034
P13	0.1823
P14	0.074
P15	0.1832
P16	0.1507
P17	0.1848
P18	0.1357
P19	0.8712

4.8. choosing the best choice

In this step, all choice are graded in the basis of CL value. In other words, the higher Cl gains better grade. Prioritizing of MAPNA Locomotive Engineering Manufacturing Company projects has been graded on the basis of table 10 and the results has been presented.

Table 10: Prioritizing MAPNA Locomotive Engineering Manufacturing Company

Priority	Project	CL
1	P19	0.8712
2	P1	0.242
3	P2	0.2205
4	P12	0.2034
5	P11	0.1972
6	P17	0.1848
7	P15	0.1832
8	P13	0.1823
9	P4	0.1803
10	P8	0.1786
11	P10	0.1761
12	P9	0.1677
13	P16	0.1507
14	P18	0.1357
15	P5	0.1349
16	P3	0.1345
17	P7	0.1343
18	P6	0.13323
19	P14	0.074

5. Discussion and Conclusions

The current research has been conducted aiming at representing a multiple criteria decision making to prioritize and choose of the projects of MAPNA Locomotive Engineering and Manufacturing Company. At first, factors affecting manufacturing investment projects were identified using national and international research literature and also through observing, studying, interview and top managers' brain storm meetings which are divided into four main economic, technical, manufacturing and marketing criteria. Sub-criteria of economic criteria include cash flow, benefit-cost ratio, profitability percent and investment for infrastructure of equipment and install; Sub-criteria of technical criteria include technology and provision dependence and accessible technical knowledge sub-criteria; Sub-criteria of manufacturing criteria include creating manufacturing value in short term and creating manufacturing value for increasing human resource employment- numerical; and Sub-criteria of marketing and contractual criteria include customers' contract and confirmation of the board of directors. Then, the investment projects of MAPNA Locomotive Engineering and Manufacturing Company were prioritized using multiple criteria decision making and compensatory models TOPSIS method of 19 manufacturing projects of MAPNA Locomotive Engineering and Manufacturing Company P19, P1, P2, P12, and P11 are prioritized from 1st to 5th grade, respectively. The output results of current research can help to top managers considerably to invest and focus on projects considering the limited resources on the basis of gained grades, so that organization profit increase through this choosing and allocation. For future researches, study of the effects of human resources on grading is suggested, because TOPSIS method entering is affected by human feelings and factors. So, future researches can be about minimizing the effects of such factors for grading.

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