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Assessment and ranking of automobile manufactures listed on the Tehran Stock Exchange via utilizing ISM and BWM methods

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Abstract

Appraising and evaluating the financial performance of companies as well as the extent to which they achieve their specified objectives are among the important methods for identifying weaknesses, ameliorating them, as well as making financial decisions. However, specialized performance analysis requires the deployment of accurate and comprehensive performance evaluation criteria. In this study, the financial performance of car companies active on the Tehran Stock Exchange shall be reviewed and evaluated. The automotive industry is one of the oldest industries in the country's economy as well as the capital market. Due to its strategic significance as well as creating countless job opportunities and being among the "mother industries", despite multiple problems and obstacles, this industry has always been supported and valued by the government. This support and backing is likely to continue. It is estimated there are approx 60 companies operating in this industry. Hence, for this analysis, upon conferring with relevant experts, 50 financial ratios were utilized (49 ratios were finalized). The ratios were classified into 6 categories: conjunctive, economic, leverage, liquidity, profitability and activity. These ratios were weighted and prioritized by experts. The analysis was conducted utilizing the ***ligo*** software and via the multivariate decision criteria of best/worst and the Aras technique. Ultimately, the companies were ranked. The assessment was performed on companies whose ratios were available. The findings demonstrated that the Mashhad Ring Manufacturing Company, Saipa Azin and Iran Khodro companies were ranked 1 to 3, respectively. Meanwhile, Irandor Foundry Industry Company was ranked in the last place.

Keywords: performance appraisal, financial ratios, best/worst method, tehran stock exchange
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Introduction

Corporations on the stock market collect and gather people's capital and carry out economic activities with it. Hence, optimal utilization of this capital is quite significant for gaining the trust of investors. Moreover, toward this objective, their performance needs be evaluated. In this research, the automotive sector, as a "mother industry", and

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inclusive of 60 companies and where substantial sums of the public's capital, was specifically selected for examination and analysis.

Performance appraisal pertains to a set of measures performed and data obtained toward enhancing the optimal utilization of resources in order to achieve financial aims/goals in an economical manner combined with efficiency and effectiveness. Performance assessment in an organizational dimension usually consists of the effectiveness of activities. Effectiveness refers to the degree to which objectives, plans activities and operations are achieved with efficiency. In general, the performance appraisal system is a process whereby the desired and satisfactory status (as well as method of achievement) of a company is measured [4].

Today's competitive world reminds all companies that have set out their objectives founded on their presence in large domestic and global markets, that in order to attract investors in financial markets and to earn additional profits, they must resort to a variety of methods such as reducing costs and increasing quality, which can be ensued by rising sales [13]. At the same time, a number of companies present and provide favorable, yet often misleading and unrealistic information about themselves in order to maintain their image among the competition as well as to attract investors. Creating value is one of the most essential tasks undertaken by executives/managers in companies. Performance evaluation criteria are used to reveal the success rate of managers/executives in creating and increasing value [10]. In today's competitive world, executives are in an era where they are required to establish a new economic framework within their firms. Hence, identifying an indicator able to describe the company's performance with relatively reasonable confidence is a necessity. A suitable measure of a company's performance is one that pays particular attention to the level of additional wealth the company generates for its shareholders and assists management in value-making decisions. Failure to utilize appropriate metrics to evaluate performance causes a company's value to shrink and not reach or attain its true value, inducing a loss for stockholders, while competitors and their stockholders rake in increasing profits [8].

Representation/agency theory states there may be a conflict of interest between owners and managers of companies. In general, representation/agency theory has been utilized to analyze the relationship between representative/agent and owner in entities whose proprietorship and management are separate. An efficient method to resolve problems between the proprietor and manager is an accurate measurement parameter approved by both parties. Evaluating the performance of companies is one of the most key issues for investors, creditors, executives and governments. In today's competitive world, it is essential to create an appropriate model for evaluating the performance of companies. Traditional accounting metrics have multiple weaknesses for predicting/projecting performance. In the traditional method, because it only focuses on accounting profits and does not take into account the cost of raising capital resources, has been severely criticized and is not considered a desirable or functional method. However, value-based metrics take into account financing, investments, etc [7]. Value-based metrics have two characteristics: First, profits are measured in line with the investment level utilized to achieve that level of earnings. Second, risk is determined via calculating capital costs. Both problems can be overcome by choosing value-based criteria to evaluate the financial performance of companies. As alluded to here above, traditional methods that evaluate based on a single criterion or function can be relied on to assess and analyze only a single aspect. Proper decision-making is composed of the accurate expression of goals/aims, determining various possible solutions, evaluating their feasibility, assessing the consequences/outcome of implementing each solution, and ultimately, choosing and executing it [1].

Hence, the superior criteria should be selected and the redundant criteria should be removed. There more than 50 criteria to choose from. The ISM method (interpretive structure) shall be utilized. This approach was first introduced and developed by Warfield and is now increasingly deployed by various researchers. The ISM approach enables individuals and groups to plot complex relationships between a large number of elements in a complicated decision situation and acts as a tool to regulate and direct the complexity of relationships between variables. This technique commences with identifying variables pertinent to the topic/issue, and then the contextual relationships between the variables are created using the experience and practical knowledge of specific experts, and finally a multilevel structural model is created.

The quality of management is in essence a function of decision-making quality since the quality of plans/programs, the effectiveness and efficiency of strategies and the caliber of the outcomes obtained from their implementation are all contingent on the quality of decisions that managers/executives make. In most instances, decisions are made when the decision maker is satisfied and content with his/her decision grounded on several criteria. In multi-criteria decision making methods focused on by researchers in recent decades, instead of utilizing one measurement optimality, several measurement criteria are used. Among these multi-criteria methods is one recently devised by an Iranian scientist from the Netherlands University of Technology. It is called the BWM method. BWM has more advantages than other multi-criteria methods. In this study, we first utilized the criteria via ISM and then the collected ISM output was utilized as the input of the BWM model to finally devise and design a model able to evaluate the performance of companies.

Therefore, regarding financial and investment performance analysis, the question is which are the best criteria. It can be stated that the top criteria are those that have been assigned more weight in the performance appraisal. In light of these issues and these importance, the present study provides a model for evaluating and predicting performance of automotive companies listed on the Tehran Stock Exchange utilizing ISM and BWM methods.

Performance assessment indicators

Numerous studies have been conducted for extended periods to find appropriate criteria for evaluating the performance of companies and managers in order to ensure the alignment of the company's actions with the interests of actual investors and being the basis for making economic decisions by potential investors and creditors [5]. The findings of these studies are hereby presented as follows, providing five approaches in relation to performance criteria:

***Accounting Approach*:** The figures extracted from financial statements such as earnings/revenues, earnings per share, operating cash flows, return on assets and return on equity are utilized to assess the performance of this approach [11].

***Economic approach*:** In this procedure, economic concepts are analyzed and the performance of the business unit is evaluated by emphasizing the profitability of the company's assets and according to the rate of return and capital costs. Economic value added, adjusted economic value added and market value added are within this category [9].

***Integrated Approach*:** A combination of financial and market data is used to evaluate performance, such as the Tobin S Q ratio and the price-to-earnings ratio P/E.

***Financial Management Approach Or Risk-Based Approach*:** According to this approach, financial management theories and concepts of risk and return are often utilized. The primary emphasis of this approach is on determining the additional return per share.

***New Approaches*:** New liquidity methods such as the comprehensive index of liquidity and the period of cash conversion criteria of each of these approaches include a series of criteria and ratios that are all based on past studies and have theoretical foundations [12]:

Research methodology

These ratios shall be analyzed via the following two methods in order to be utilized for ranking companies:

ISM method (interpretive-structural)

Interpretive Structural Modeling (ISM) is a well-established methodology for identifying relationships between specific elements that define a problem or an issue. However, the direct and indirect relationships between these factors describe the circumstances much more accurately than individual factors [15].Thus, the ISM extends insights toward collective perceptions of these communications. In other words, interpretive-structural modeling is an interactive process in which a set of different and interrelated elements in a comprehensive systematic systematic model. Generally, ISM is a technique examining the complexity and structures of the system in such a manner where it could easily be understood. ISM aids in the diagnosis of internal relationships between variables and is a suitable technique for analyzing the impact of a variable on other variables. ISM can also prioritize the classification and leveling of elements of a system, a great help to managers for better execution. And in terms of meaning, it has three dimensions according to each of the letters [6].

I; Interpretative dimension is grounded on the judgment and opinions of a group of experts to decide whether and how the variables are internally related.

S; Structural dimension is based on the contextual relationship between the variables, it extracts the entire structure out of a series of complex variables.

M; Modeling dimension revealing the specific relationships between the variables and the overall system structure under study. In other words, in the ISM; I is interpretive (byproduct of judgment), S is the structure (findings output of a series of variables), and M is the graph of the particular relationship and the general structure. This analysis is conducted as a step-by-step process [8].

Table 1: Financial and accounting indicators

Row	Ratio	Row	Ratio
1	Cash Value Added (CVA)	26	Ratio Of Operating Cash Flows To Sales
2	Comprehensive Liquidity Index	27	Ratio Of Operating Cash Flows To Total Assets
3	Cash Conversion Period Index	28	Ratio Of Operating Cash Flows To Total Liabilities
4	Net Cash balance Index	29	Ratio Of Operating Cash Flows To Current Liabilities
5	Q Tobin Ratio	30	Ratio Of Total Liabilities To Total Assets
6	Earnings Per Share (EPS)	31	Ratio Of Current Liabilities To Total Liabilities
7	Value Added Market (MVA)	32	Equity To Sum Of Total Debts
8	P/E Ratio	33	Adjusted Economic Value Added (REVA)
9	Economic Value Added (EVA)	34	Return On Assets (ROA)
10	Asset Turnover Ratio	35	Current Assets Turnover Ratio
11	Fixed Asset Turnover Ratio	36	Return On Shareholder Rights (ROE)
12	Cost Of Capital	37	Turnover Ratio Of Long-Term Assets
13	Interest Coverage Ratio	38	Accounts Receivable Turnover Ratio
14	Beta	39	Average Receivables Collection Period
15	Additional Returns	40	Inventory Turnover Ratio
16	Trainer	41	Working Capital Ratio
17	Evaluation ratio	42	Equity Turnover Ratio
18	Sharp	43	Gross Profit To Sales Ratio
19	Current Ratio	44	Profit Ratio Before Tax
20	Fast Ratio	45	Ratio Of Pre-Tax Profit To Equity
21	Cash Ratio	46	The Ratio Of Public & Administrative Expenses To Sales
22	Asset Growth Rate	47	Ratio Of Current Assets To Total Assets
23	Net Profit Growth Rate	48	Ratio of long-term assets to total assets
24	Sales Growth Rate	49	Liquidity To Current Assets Ratio
25	Net Profit Ratio		

Best-Worst Method (BWM)

The best-worst method is for solving multi-criteria decision problem. In a multi-criteria decision situation, a number of alternatives (proposals) are assessed compliant to a number of criteria to select the best alternative [16]. This method was introduced when an article called Best-Worst Multi-Criteria Decision-Making Method was published in 2015 by Dr. Jafar Rezaei from the Delft University of Technology in the Netherlands [14].

The BWM technique is one of the newest and most effective multi-criteria decision making methods utilized to weight decision factors and criteria. Multi-criteria decision-making methods, including the hierarchical analysis of indicators as well as criteria and sub-criteria of decision-making can be ranked via pairwise comparisons and analysis of expert opinions. They are ranked from most preferred (highest priority) and most important to least important [2].

But in the Best-Worst-Method, the best and worst indicators and criteria are determined by the decision maker, and then a pairwise comparison is made between each of these two indicators, and then with other indicators. Then the problem becomes a linear programming issue where the weight of the indicators is obtained in such a manner whereby the absolute differences in weights to be minimized. Compared to other existing MCDM techniques, among the salient features of the BWM method (a rather new multi-criteria decision making technique), the following can be mentioned:

- Fewer pairwise comparisons
- Achieving more consistent pairwise comparisons [3].

List of automotive companies in the stock market

There are approx 60 companies operating in this field. We were able to extract the desired ratios and financial data for only the following 37 companies. Therefore, only the data of these 37 firms were evaluated and ranked.

Table 2: Selected company (whit abbreviation words)

Row	Company Name	Row	Company Name	Row	Company Name
1	KHEPARES	14	KHAMHERKE	26	KHARIKHAT
2	KHODRO	15	KHATSIR	27	KHAMHER
3	KHBHEMEN	16	VERNA	28	KHATRAK
4	KHESAPA	17	KHAHEN	29	KHAZAMYA
5	KHAGESTER	18	KHACHER KHASHEN	30	KHKERMAN
6	KHTOGA	19	KHAFTAVER	31	KHDIZEL
7	KHAZIN	20	KHASHRAG	32	KHMOTOR
8	KHARING	21	KHABTYAN	33	KHAMHOR
9	KHEKAR	22	KHOSAZ	34	KHAKMEK
10	TESHTAD	23	KHALENT	35	KHEKAVEH
11	KHAFTER	24	KHALIL	36	KHAZAR
12	KHATOR	25	KHAPOYESH	37	KHAVER
13	KHASERA				

Research findings

ISM method findings, formation of self-interactive matrix

In the first step, the structural self-interaction matrix of the research is formed via the viewpoints of respondents. To form the structural self-interaction matrix, the experts take into account the criteria in pairs with each other and respond to the pairwise comparisons based on the following spectrum.

V: Row i factor induces the column j factor to be realized. A: Column j factor causes the of i row factor to be realized.

X: Both row and column factors cause each other to be realized O: There is no relationship between factors in rows & columns. The self-interaction matrix is delineated in Table 3.

Table 3: Structural self-interaction matrix

	C1	C2	C3	C4	C5	C6
C1		O	X	O	A	A
C2			A	O	O	A
C3				O	X	O
C4					X	V
C5						X
C6						

Formation of initial achievement matrix

In the second step, the preliminary achievement matrix must be formed by converting the structural self-interaction matrix to the numbers zero and one. The following rule is utilized to accomplish this:

If the symbol of ij cell is the letter V, the number 1 is placed in that cell and the number zero is placed in the symmetrical cell.

If the symbol of ij cell is the letter A, the number zero is placed in that cell and the number 1 is placed in the symmetrical cell.

If the symbol of ij cell is the letter X, the number 1 is placed in that cell and the number 1 is placed in the symmetrical cell.

If the symbol of ij cell is the letter O, the number is zero in that cell and the number zero is placed in the symmetrical cell. The initial achievement matrix is observable in Table 4.

Table 4: Initial achievement matrix

	C1	C2	C3	C4	C5	C6
C1	0	0	1	0	0	0
C2	0	0	0	0	0	0
C3	1	1	0	0	1	0
C4	0	0	0	0	1	1
C5	1	0	1	1	0	1
C6	1	1	0	0	1	0

Formation of compatible initial achievement matrix

Once the initial achievement matrix has been obtained, its internal consistency must be established. For example, if variable 1 leads to variable 2 and variable 2 leads to variable 3, variable 1 must also lead to variable 3. In Table 5, the cells designated with 1^*, are relationships created in the compatible matrix.

Table 5: Compatible initial achievement matrix

	C1	C2	C3	C4	C5	C6	Influence power
C1	1	1^*	1	0	1^*	0	4
C2	0	1	0	0	0	0	1
C3	1	1	1	1^*	1	1^*	6
C4	1^*	1^*	1^*	1	1	1	6
C5	1	1^*	1	1	1	1	6
C6	1	1	1^*	1^*	1	1	6
Degree of dependence	5	6	5	4	5	4	

Determining factor levels

We calculate the set of input (prerequisite) and output (achievement) criteria for each criterion and then determine the common factors. In this step, the criterion is deemed to have the highest level where the output (achievement) is equal to the common set. After identifying this variable/variables, we remove their rows and columns from the table and repeat the operation again on the other criteria. Outputs and inputs are extracted from the matched initial achievement matrix (Table 5). To accomplish this, the number 1 in each row represents the output, and the number 1 in the column is the input. The first level findings can be seen in Table 6.

Table 6: Level 1 criteria

Criteria	Output	Input	Subscription	Level
C1	C1-C2-C3-C5	C1-C3-C4-C5-C6	C1-C3-C5	
C2	C2	C1-C2-C3-C4-C5-C6	C2	1
C3	C1-C2-C3-C4-C5-C6	C1-C3-C4-C5-C6	C1-C3-C4-C5-C6	
C4	C1-C2-C3-C4-C5-C6	C3-C4-C5-C6	C3-C4-C5-C6	
C5	C1-C2-C3-C4-C5-C6	C1-C3-C4-C5-C6	C1-C3-C4-C5-C6	
C6	C1-C2-C3-C4-C5-C6	C3-C4-C5-C6	C3-C4-C5-C6	

In Table 6, the level 1 criteria are extracted, which includes the C2 criterion. Now to determine the second level criteria, it is sufficient to remove the row and column of this criterion from the compatible initial achievement matrix (Table 5) and perform the output and input determination calculations again. The results are stipulated in Table 7.

In Table 6, the level 2 criteria are extracted, which includes the criteria C1, C3 & C5. Next, to determine the third level criteria, the rows and columns of these three criteria must also be removed from the matched initial achievement matrix (Table 4) and the output and input determination calculations performed again. The findings are shown in Table 8.

Table 7: Level 2 criteria

Criteria	Output	Input	Subscription	Level
C1	C1-C3-C5	C1-C3-C4-C5-C6	C1-C3-C5	2
C3	C1-C3-C4-C5-C6	C1-C3-C4-C5-C6	C1-C3-C4-C5-C6	2
C4	C1-C3-C4-C5-C6	C3-C4-C5-C6	C3-C4-C5-C6	
C5	C1-C3-C4-C5-C6	C1-C3-C4-C5-C6	C1-C3-C4-C5-C6	2
C6	C1-C3-C4-C5-C6	C3-C4-C5-C6	C3-C4-C5-C6	

Table 8: Level 3 criteria

Criteria	Output	Input	Subscription	Level
C4	C4-C6	C4-C6	C4-C6	3
C6	C4-C6	C4-C6	C4-C6	3

1 ISM interaction network

In the fifth step, the ISM interaction network is drawn utilizing the levels obtained from the criteria. If there is a relationship between two variables i and j, we indicate it with a directional arrow. The final diagram created, obtained by eliminating the violation modes and also by using the segmentation of the levels, is displayed in the figure below.

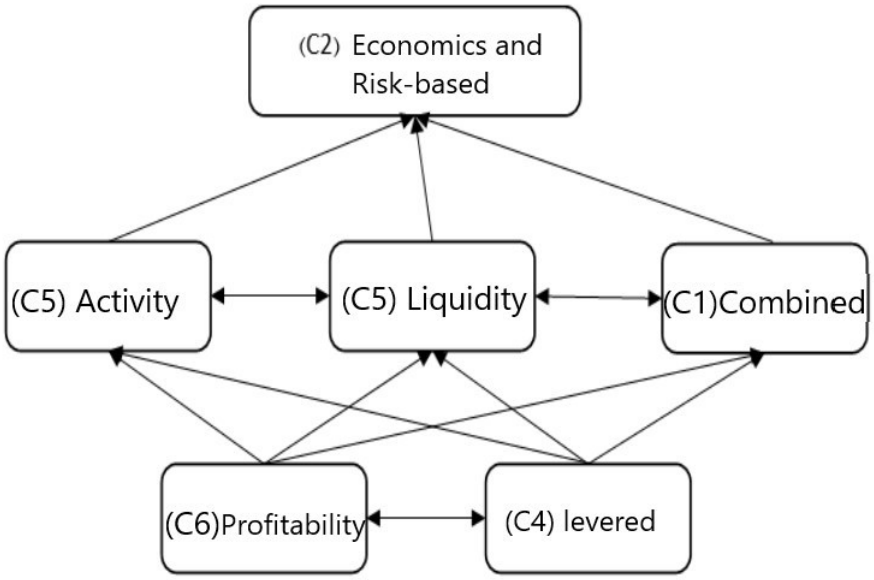

Figure 1: ISM interaction network

Compliant with the figure above, the research model consists of 5 levels. Two of the criteria are S & T in level 5 (the most effective). Level one of this model has three criteria F, G & I (the most effected).

Mick mac analysis

The research model can be displayed in terms of influence power and dependence as follows. Accordingly, only the C2 criterion is of dependent type. These variables have strong dependence and poor conductivity. These variables generally are highly effected and have low impact on the system. The remainder of the criteria are interface/connecting type. These variables have high dependence and high conductivity, in other words, their susceptibility to being effected is very high their impact is also quite high. Any small change on these variables causes fundamental changes in the system.

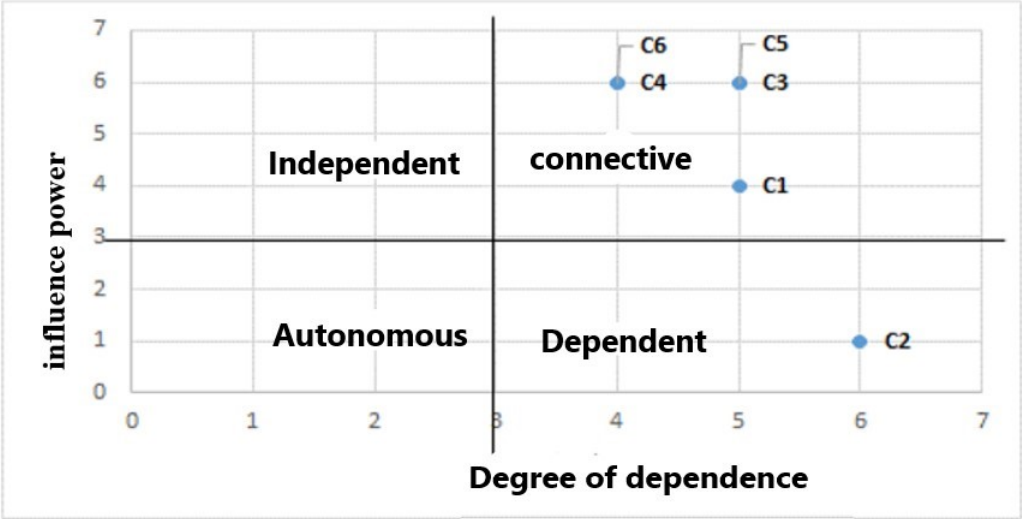

Figure 2: Influence-dependence power matrix

Determining weight & significance of factors

In this section, we determine the weight and significance of research criteria and sub-criteria utilizing the BWM model. Among the first steps within this method is to determine the most & least important criteria and sub-criteria. In this study, using the viewpoints of experts, the most & least significant criteria and sub-criteria were extracted, revealed in Table 9.

Table 9: Most & least significant criteria

Category	Most Important (Best) Criteria	Least Important (Worst) Criteria
Primary Criteria	Profitability	Lever
Combined/Compound	Q Tobin	Net Cash Balance Remaining
Economic & Risk-Based	EVA	Sharp
Liquidity	Current Ratio	Operating Cash Flows To Assets Ratio
Lever	Asset Growth Ratio	Current To Total Debt Ratio
Activity	Inventory Turnover	Fixed Asset Turnover
Profitability	Earnings Per Share	Profit Before Tax On Capital

In the next phase, pairwise comparisons of the best criteria with other criteria (BO) and pairwise comparisons of other criteria with the worst criteria (OW) shall be formed and provided to 6 experts to respond to pairwise comparisons. Upon receiving their response, pairwise comparisons are integrated/combined (via utilizing the geometric mean method) to determine weight & for input into the BWM method algorithm (please see below).

Calculating weight of primary criteria

To calculate the weight of the primary criteria, we first compare the superior criterion (profitability), with other criteria. In addition, in a similar way, paring of other criteria are create with the worst criterion (lever). The findings of the pairwise comparison of the main criteria are provided in Table 10. This table is the geometric average of opinions by 6 experts.

Table 10: Pairwise comparison of primary criteria

BO	**Most Significant: Profitability**	**OW**	**Least Significant: Lever**
Combined/Compound	2.621	Combined/Compound	4.442
Economic & Risk-Based	4.642	Economic & Risk-Based	2.289
Liquidity	3.302	Liquidity	2.884
Lever	9.000	Lever	1.000
Activity	4.610	Activity	2.828
Profitability	1.000	Profitability	9.000

According to Table 10, the BWM linear model of the primary criteria are as follows.

$$
\begin{aligned}
\min \quad & z \\
& |W6 - 2.621 \times w1| \leq z \\
& |W6 - 4.642 \times w2| \leq z \\
& |W6 - 3.302 \times w3| \leq z \\
& |W6 - 9 \times w4| \leq z \\
& |W6 - 4.61 \times w5| \leq z \\
& |w1 - 4.442 \times W4| \leq z \\
& |w2 - 2.289 \times W4| \leq z \\
& |w3 - 2.884 \times W4| \leq z \\
& |w5 - 2.828 \times W4| \leq z \\
& w1 + w2 + w3 + w4 + w5 + w6 = 1
\end{aligned}
$$

The above model is solved in the Lingo software, the output of which was obtained consistent with the following figure.

Table 11: Lingo software output for the BWM model

Variable	Value	Reduced Cost
Z	$0.27722955E-01$	0.000000
W6	0.4363494	0.000000
W1	0.1770618	0.000000
W2	$0.9997392E-01$	0.000000
W3	0.1405448	0.000000
W4	$0.4540220E-01$	0.000000
W5	0.1006679	0.000000

In line with Figure 3, the profitability criterion (weight: 0.436) is ranked first. Combined/conjunctive ranked second (weight: 0.177), liquidity ranked third (weight: 0.141). Moreover, the compatibility rate (Z) of this pairwise comparison was 0.027, indicating high compatibility.

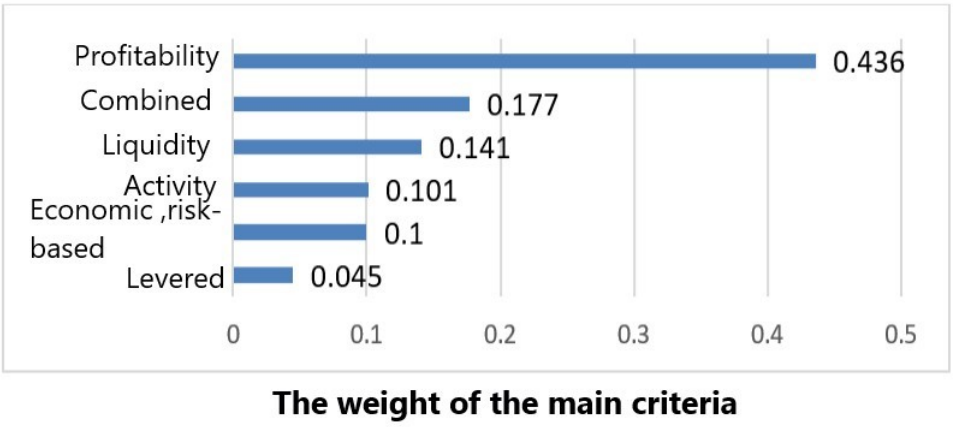

Figure 3: Weight of primary criteria

Final weight of sub-criteria

To calculate the weight of the sub-criteria of each category, we repeat the above calculations and the findings are highlighted in the hereinafter table:
The final weight of the sub-criteria is obtained by multiplying the weight of the criteria by the relative weight of the sub-criteria (delineated in Table 12), pointing out that "focusing on customer requirements" is ranked first among all indicators.

Table 12: Final weight of sub-criteria

Row	Criteria	Criteria Weight	Sub-Criteria	Sub-Criteria Relative Weight	Sub-Criteria Final Weight	Rank
1	Combined/Compound	0.177	Cash Value Added	0.111	0.0196	17
2	Combined/Compound	0.177	Comprehensive Liquidity Index	0.102	0.0181	20
3	Combined/Compound	0.177	Cash Conversion Period	0.104	0.0184	19
4	Combined/Compound	0.177	Net Cash Balance Remaining	0.038	0.0067	43
5	Combined/Compound	0.177	Q Tobin	0.369	0.0653	2
6	Combined/Compound	0.177	P/E	0.151	0.0267	12
7	Combined/Compound	0.177	Cost Of Capital	0.125	0.0221	14
8	Economic & Risk-Based	0.100	EVA	0.252	0.0252	13
9	Economic & Risk-Based	0.100	REVA	0.124	0.0124	28
10	Economic & Risk-Based	0.100	MVA	0.109	0.0109	31
11	Economic & Risk-Based	0.100	Beta	0.099	0.0099	33
12	Economic & Risk-Based	0.100	Capital Asset Pricing	0.099	0.0099	33
13	Economic & Risk-Based	0.100	Additional Returns	0.092	0.0092	36
14	Economic & Risk-Based	0.100	Trainer	0.095	0.0095	35
15	Economic & Risk-Based	0.100	Sharp	0.046	0.0046	48
16	Economic & Risk-Based	0.100	Evaluation Ratio	0.085	0.0085	40
17	Liquidity	0.141	Current Ratio	0.272	0.0384	7
18	Liquidity	0.141	Fast Ratio	0.142	0.0200	15
19	Liquidity	0.141	Cash Ratio	0.142	0.0200	15
20	Liquidity	0.141	Operational Cash Flow To Sales	0.102	0.0144	25
21	Liquidity	0.141	Cash Flow To Assets	0.052	0.0073	42
22	Liquidity	0.141	Cash Flow To Debt	0.107	0.0151	23
23	Liquidity	0.141	Operating Cash Flow To Current Debt	0.080	0.0113	29
24	Liquidity	0.141	Liquidity To Current Assets	0.103	0.0145	24
25	Lever	0.045	Debt To Assets	0.126	0.0057	46
26	Lever	0.045	Current Debt To Total Debt	0.064	0.0029	50
27	Lever	0.045	Capital To Debt	0.200	0.0090	37
28	Lever	0.045	Current Assets To Total Assets	0.132	0.0059	45
29	Lever	0.045	Long-Term Assets To Total Assets	0.115	0.0052	47
30	Lever	0.045	Asset Growth Rate	0.363	0.0163	21
31	Activity	0.101	Asset Turnover	0.086	0.0087	39
32	Activity	0.101	Current Asset Turnover	0.078	0.0079	41
33	Activity	0.101	Fixed Asset Turnover	0.035	0.0035	49
34	Activity	0.101	Long-term asset turnover	0.101	0.0102	32
35	Activity	0.101	HD Circulation	0.132	0.0133	26
36	Activity	0.101	Average Receivables Collection Period	0.123	0.0124	27
37	Activity	0.101	Inventory Turnover	0.184	0.0186	18
38	Activity	0.101	Working Capital Turnover	0.108	0.0109	30
39	Activity	0.101	Equity Turnover	0.066	0.0067	44
40	Activity	0.101	Sales Growth Rate	0.088	0.0089	38
41	Profitability	0.436	Interest Coverage Ratio	0.099	0.0432	5
42	Profitability	0.436	Net Profit To Sales	0.149	0.0650	3
43	Profitability	0.436	Profit Before Tax	0.071	0.0310	11
44	Profitability	0.436	Net Profit Ratio	0.105	0.0458	4
45	Profitability	0.436	Profit Before Tax On Capital	0.037	0.0161	22
46	Profitability	0.436	General Administrative Fee For Sales	0.086	0.0375	8
47	Profitability	0.436	ROA	0.090	0.0392	6
48	Profitability	0.436	Return on equity	0.080	0.0349	9
49	Profitability	0.436	Earnings Per Share	0.205	0.0894	1
50	Profitability	0.436	Net Profit Growth Rate	0.078	0.0340	10

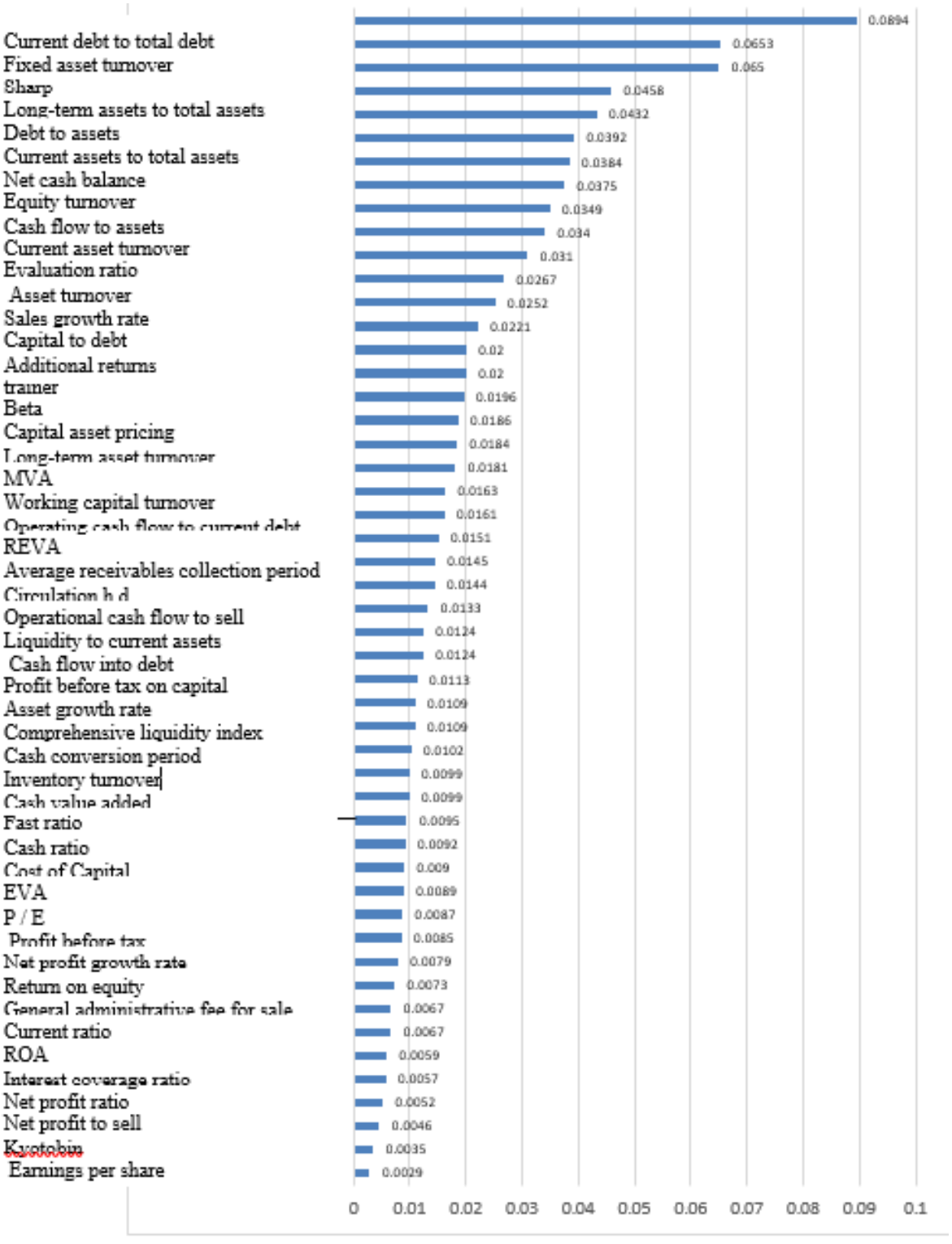

Figure 4: Final weight of sub-criteria

ARAS technique

A clear example of multi-criteria decision-making issue is ranking a finite number of decision-making options, each of which is clearly described in terms of various decision-making criteria that must be assessed simultaneously. The ARAS method determines the value of a utility function as far as relative return (relative efficiency) of a possible

option, directly proportional to the relative effect of the values and weights of the primary criteria proposed in a project.

The ARAS method is among the multi-criteria decision making methods introduced in 2010 by Mr. Zavadskas and Mr. Turksis. ARAS is the abbreviation of Additive Ratio Assessment. The ARAS method is similar to TOPSIS, VICOR & ELECTRE methods in the sense that its decision matrix is criterion-option. This method requires the criteria's weight in order to perform, hence, the weight of the criteria should first be calculated via methods such as Shannon entropy, AHP or like this research (BWM method). Thereafter, the options are rank by this method. The ARAS method questionnaire is quite similar to the TOPSIS method questionnaire.

The ARAS method is founded on the argument that complex relative world phenomena can be understood utilizing relatively simple comparisons. It is argued that the ratio of the sum of the normal values and the weight of the criteria (describing the desired alternative), to the sum of the normalized and weighted values of the criteria (describing the optimal alternative), is the optimal degree. By reaching the alternative option according to the ARAS method, a value of the utility function to determine the complex relative efficiency of a suitable alternative is directly proportional to the relative effect of the values and weights of the main criteria considered in a project.

Formation of a decision matrix

This method's decision matrix is criterion-option, specifically, criteria are placed in columns and options in rows, and each cell is the score of each option relative to each criterion.

Determining Hypothetical Ideal Value

In this stage, a hypothetical ideal option called A0 is created. Its values for positive criteria are the maximum value of the benchmark column and for negative criteria are equal to the minimum value.

$$x_{0j}=\max_i x_{ij}, \quad \text{forbeneficialcriteria} \tag{1.1}$$

$$x_{0j}=\min_i x_{ij}, \quad \text{fornon-beneficialcriteria} \tag{1.2}$$

Converting Negative Criteria To Positive

In this step, the negative criteria must be reversed to positive criteria. This process turns the decision matrix into a positive decision matrix.

$$x_{ij}=\frac{1}{x^*_{ij}}. \tag{1.3}$$

Normalization of Decision Matrix

In this step, via the following equation we normalize the decision matrix.

$$x^*_{ij}=\frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}}. \tag{1.4}$$

Weighing Normal Decision Matrix

In this step, we multiply normal matrix values to the weight of the criteria to obtain the weighted matrix.

$$\hat{x}_{ij}=x^*_{ij}*w_j. \tag{1.5}$$

Calculating ARAS Index (S) & Desirability Level Of Options

In this step, via the following relationships, we calculate the ARAS index and the degree of desirability of options. Henceforth, the final ranking is undertaken.

$$S_i=\sum_{j=1}^{n} \hat{x}_{ij} \tag{1.6}$$

$$k_i=\frac{S_i}{S_0} \tag{1.7}$$

ARAS method findings

The objective of the ARAS technique is to rank research options (104 companies). The first step is to form a decision matrix. The ARAS method decision matrix consists of 49 research indicators and 104 companies. Each cell is the evaluation matrix of each company in relation to each index.

In the second step, a hypothetical ideal value should be created based on Equations (1.5) and (1.6). If the criterion has a positive aspect, the ideal value is the highest score of that criterion, and if the criterion has a negative aspect, it is the smallest score of that criterion. However, in this study, a number of criteria had a base value or numerical value as ideal. The type of indicators are stipulated in Table 13.

Table 13: Type of indicators

Indicator Name	Indicator Type
Cash Value Added	Positive
Comprehensive Liquidity Index	Positive
Cash Conversion Period	Positive
Net Cash Balance Remaining	Positive
Q Tobin	Positive
P/E	$0 < X$ Smaller Better
Cost Of Capital	$0 < X$ Close To Zero
EVA	Positive
REVA	Positive
MVA	Positive
Beta	$0 < X < 1$ Close To One
Additional Returns	Positive
Trainer	Positive
Sharp	Positive
Evaluation Ratio	$0 < X$ Close To Two
Current Ratio	$0 < X$ Close To One
Fast Ratio	$0 < X$ Close To One
Cash Ratio	Positive
Operational Cash Flow To Sales	Positive
Cash Flow To Assets	Positive
Cash Flow To Debt	Positive
Operating Cash Flow To Current Debt	Positive
Liquidity To Current Assets	$0 < X < 1$ Close To Zero
Debt To Assets	$0 < X < 1$ Close To Half
Current Debt To Total Debt	Positive
Capital To Debt	Positive
Current Assets To Total Assets	$0 < X < 1$ Close To Half
Long-Term Assets To Total Assets	$0 < X < 1$ Close To Zero
Asset Growth Rate	Positive
Asset Turnover	Positive
Current Asset Turnover	Positive
Fixed Asset Turnover	Positive
Long-Term Asset Turnover	Positive
HD Circulation	Positive
Average Receivables Collection Period	Close To Zero Better
Inventory Turnover	Positive
Working Capital Turnover	Positive
Equity/Shareholder Turnover	Positive
Sales Growth Rate	Positive

ARAS method's third step is to convert negative criteria to positive based on Equation (1.7). In other words, to convert negative criteria to positive, their scores must be reversed. Hence, we normalize the decision matrix using relation 8. To normalize, it is enough to divide each element by the sum of the elements of that column. The normalized

matrix is stated in Table 6.

In the fifth step, a normal weighted matrix should be created. It is requisite to multiply the weights of the criteria calculated by the entropy method by the normal matrix to obtain a normal weighted matrix (described in Table 7).

In the sixth step, utilizing the relations existing between 10 and 11, we calculate the ARS index and the degree of desirability of the options, and consistent with that, the options are ranked (arranged in ascending order in Table 14).

Table 14: ARAS index & ranking of options

Company Name	SI	Final Score	Rank
A0	0.0767	-	-
KHKAR	0.0249	0.108	19
KHKMAK	0.015	0.066	30
KHBHEMAN	0.0396	0.172	4
TESHTAD	0.0186	0.081	28
KHGESTER	0.0132	0.057	31
KHTOFA	0.0204	0.088	26
KHFTER	0.0264	0.115	17
KHAHEN	0.0093	0.040	34
KHPARES	0.0348	0.152	9
KHAZIN	0.0489	0.212	2
KJSHERG	0.0231	0.101	57
KHTOR	0.0117	0.050	32
KHAMRA	0.0222	0.097	25
KHMOHEREKE	0.0243	0.106	20
KHNASIR	0.0234	0.102	22
VERNA	0.0006	0.002	36
KHRING	0.0492	0.215	1
KHCHERKHESH	0.0192	0.084	27
KHFENAVER	0.0309	0.134	13
KHSAIPA	0.0297	0.129	14
KHBONYAN	0.0258	0.112	18
KHOSAZ	0.0369	0.160	24
KHLENT	0.0228	0.099	24
KHLIBL	0.0237	0.103	21
KHRIKHT	-0.0324	-0.141	37
KHPOYESH	0.0276	0.119	16
KHMEHR	0.0105	0.046	33
KHTRAK	0.0084	0.037	35
KHZAMYA	0.0336	0.146	11
KHKERMAN	0.0366	0.159	7
KHDIZEL	0.0294	0.127	15
KHMOTOR	0.0342	0.148	10
KHMEHVER	0.0384	0.167	5
KHODRO	0.0456	0.199	3
KHKAVEH	0.0333	0.145	12
KHAZER	0.0183	0.080	29
KHAVER	0.0357	0.120	8

Discussion and conclusion

The findings (ranking of 37 companies) that were studied are presented in the above table. By comparing this ranking with previous studies such as the survey of this industry by Shokrallah Khajavi et al., [9], we find that on average, the findings of this research are substantially similar same (73%) to the results and rankings of previous studies.

Finally, it can be stated that this ranking can be the criterion for a variety of decisions by small, large, potential and actual investors.

Furthermore, it can be declared that these criteria are a credible foundation for the financial evaluation of companies, and of course, other criteria can be added to these and the findings can be re-examined to achieve more accurate and superior results.

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