

Designing a Model for Three-Dimensional Robustness Analysis: A Case Study of Iran Khodro Machine Tools Industries Company

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Abstract

Background/Objectives: Today, to help decision-makers in the decision-making process, researchers have been increasingly inclined to using soft operational research techniques to create an atmosphere of participation. **Methods/Statistical Analysis:** One technique for making the decision-making process simpler and more flexible is the robustness analysis. Considering robustness analysis as a two-dimensional analysis of the desired and acceptable results and unacceptable and disastrous results to achieve more flexibility and also stronger decision, this paper presents a three-dimensional model in which the third dimension is the lack of making an initial decision or lack of entering into a decision area. **Results:** The results of this analysis, which is a case study conducted in Iran, show that the introduction of the third dimension in the robustness analysis can change the results obtained by the two-dimensional robustness analysis. **Conclusion/Application:** The results of this study may provide comprehensive insight into the conditions and dimensions affecting the outcomes of making a decision.

Keywords: Decision Making, Flexibility, Robustness Analysis, Soft Operational Research

1. Introduction

Complexity of and rapid changes in the environment, increased global competition, striving to survive and other similar terms have been seen and heard frequently in papers, scientific conferences, etc. in the past decades. These are phenomena of modern human life which demonstrate the need for proper management, proper use of limited resources and equipping managers with effective and efficient tools and techniques. It is clear that on the one hand, managers have always tried to control their environment and adapt the organization to the environmental changes by such tools as planning, prediction, decision-making, organization and so on and on the other hand, researchers in the field of management

have attempted to enhance the effectiveness and efficiency of these tools and the result of this collaboration can be seen in large advances made in management in the past decades.

Clearly, one of the most important and major tools of management is decision-making and planning resulting from it. Planning is nothing more than applying the scientific although crude method for policy-making¹ and this is the same definition which has been presented by² for operational research. But what must be considered are the changing conditions of today's environment in organizations which lead research in the field of management in order to improve methods and tools. Fitness of traditional methodologies in conditions with high complexity and uncertainty has been widely

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questioned³. The traditional methodologies often include applications of the hard techniques of operational research which look for optimization. In the past, 40% of research has been conducted in the field of mathematical methods which, if the current trends continue, may lose their identity as a distinct activity and therefore efforts at using a versatile approach should be re-directed⁴. A flexible program that can respond to the current situation should not necessarily look for optimization, but should be able to introduce a range of possible solutions⁵. Following the conditions alluded to about planning, the decision-making system needs also to learn and be adapted effectively to the optimization system. Analytical problem-solving paradigm has internal contradictions and should be replaced by the synthesizing planning paradigm (such as designing the desired future)⁶.

One of the relatively emerging methods to help managers indecision-making, which includes making decisions in successive stages, is the method of robustness analysis. This method was proposed for the first time in 1968 for the issue of location⁷ and subsequently applied in the field of chemical products⁸, education⁹ and health services¹⁰. In robustness analysis, the uncertainty of the future has been considered and it has been attempted to keep various options open, with attempts made to facilitate participation. This method allows the analysis of the strategic planning that can maintain the benefits of different options for future decisions. This method has many advantages when uncertainty of assets is at high levels^{11,12}. The important issue in the robustness analysis is to planning scenarios for the future, which may release decision makers from the wonderment in the face of environmental changes and may increase coordination, communications, flexibility, etc¹³. Strategic design based on scenarios enables organizations to more effectively confront strategic uncertainty and to look creatively at possible futures and to be ready to deal with them¹⁴.

A scenario is not the reality of the future, but it is a way to represent it aiming to clarify the current action in the light of possible and desirable future¹⁵. A scenario is a valuable tool for thinking about the future of the organization which helps us to act as flexibly as possible by testing the future under different conditions¹⁶.

In robustness analysis, once possible scenarios for the future are identified, in addition to calculating the robustness of any decision (one side of the coin) and the inability of the decision (the other side of the coin), other decisions are also discussed and then the information is

provided to decision makers. Therefore, it can be said that robustness analysis is a two-dimensional analysis, where desirability and acceptability of decisions (robustness matrix) constitute one dimension and undesirability or catastrophe of decisions (disability matrix) from the other dimension. This study aims to show that considering the importance of planning and decision-making under complex and ambiguous conditions, decisions should be widely linked with other dimensions to make more robust decisions.

The authors of the paper believe that one way to achieve this goal is adding a third dimension to the model of robustness analysis, which is the lack of selection of a particular decision or the lack of entering into a particular domain in decision-making. The proposed model was implemented in Iran Khodro Machine Tools Industries Company in Iran as a case study the results of which, according to the managers of the organization, were satisfying. In recent years, due to management problems, the managers of this organization which has served for many years as a supplier in the field of automobile, railway etc. have been trying to improve the situation. Firstly, among the three decisions of continuing cooperation with Iran Khodro Company or with the Mapna Group Company or with other companies (such as home appliances) and other subsequent decisions that will be introduced in detail in the next section, they had to make a decision which should be a robust decision. To clarify the issue, the two-dimensional robustness analysis will be explained in the following section and the third dimension is introduced in the model in the next section and the changes this dimension has brought about will then be discussed and finally the results will be discussed.

2. Two-Dimensional Robustness Analysis

Although some believe that robustness analysis is a kind of non-empirical confirmation and thus not acceptable in the scientific practice¹⁷, the results of hard robustness models which have been reported in various fields such as finance¹⁸, non-linear optimization¹⁹, risk management²⁰, inventory²¹ etc. and the successful application of soft robustness analysis in such studies as health service¹⁰, balanced scorecard model²² and sustainable community development²³ show this analysis can lead to maintaining maximum flexibility due to its principles²⁴.

Table 1. Description of decisions and practices

Conf.	Description	Conf.	Description
2	Continuing cooperation with Iran Khodro	12	Use of robot approved by the Iran Khodro Co
3	Cooperation with Mapna group	13	Chancellorship with managers of the national taxi services
4	Cooperation with other companies such as the producers of home appliances	14	Recruitment of specialist human resources
5	Productseries of Samand and 405	15	Retraining human resources
6	Productseries of Rana and 206	16	Signing a contract for sectional outsourcing
7	Rail transport system	17	Establishment of new product line
8	Urban fleet projects		
9	Entering into industries related to home appliances		
10	Entering into the road construction industry		
11	Improvement of existing production lines		

Figure 1 represents the chart of subsequent decisions in the organization under investigation. It should be noted that the model was simplified for ease of understanding, which was approved by the senior managers of the organization. As Figure 1 indicates, the given planning contains three stages and seventeen decisions as shown in Table 1.

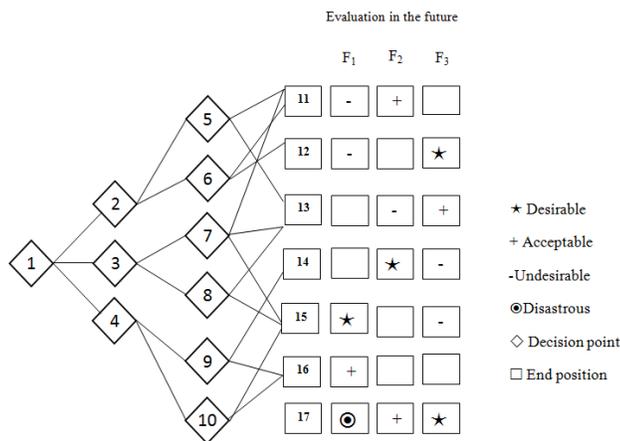


Figure 1. Three-stage planning.

Table 2 shows future scenarios with three variables: change in the rate of exchange, the situation of competitors and market conditions.

Table 2. Future scenarios

Future scenario	Change in rate of exchange	Situation of competitors	Market conditions
F1	Increase	Current situation	Good
F2	Stability	Improvement	Bad
F3	Decrease	Improvement	Moderate

According to the valuations of three scenarios in

Figure 1, Table 3 shows the possibility of the selection of desirable and undesirable options using different decisions. Also robustness and disability matrix have been obtained as follows, in which, for example, the initial decision 2 leads to the decisions 5 and 6, the decision 5 leads to the decisions 11 and 13 and the decision 6 leads to the decisions 11 and 13, which result in a desirable situation for the decision 12 in the future F_3 , two acceptable situations for the decisions 11 and 13 in the futures F_2 and F_3 , and three undesirable situations for the decisions 11, 12 and 13 in the futures F_1 and F_2 .

Table 3. Selected options

Initial decision	Desirable	Acceptable	Undesirable	Disastrous
2	1	2	3	-
3	1	3	3	-
4	2	2	1	1

Robustness Matrix based on the desirable and acceptable.

Disability Matrix based on the undesirable and disastrous.

2.1 Preliminary Conclusion

Two-dimensional analysis, conducted in this section, shows that the initial decisions 3 and 4 are more robust than the initial decision 2 and that if the initial decisions are to be prioritized, it seems that making the initial decision 4, then the initial decision 3 and finally the initial decision 2 is more logical. However, it will be shown in the next section how entering the third dimension into the model could change the results.

Table 4. Selected options of the three-dimensional model

Initial decision	Desirable	Acceptable	Undesirable	Disastrous	Third dimension
2	1	2	3	-	O
3	1	3	3	-	L
4	2	2	1	1	I

3. The Three-Dimensional Robustness Analysis

If the first dimension of robustness analysis is considered as the desirable and acceptable results of any decision and the second dimension is considered as undesirable and disastrous results, it could be said that the third dimension is the result of not making any decision or not entering into the given field, which can have three outcomes:

- **Obliteration:** In this situation, the organization suffers considerable damage and completely loses its margin of safety which can lead to its obliteration.
- **Loss:** in this situation, as in the previous case, the organization will face loss, but the loss is not lethal enough to lead to destruction or obliteration. However, its negative consequences should be considered.
- **Indifferent:** In this situation, not making any decision or not entering into the given field does not have any effect on profit and loss, where we can say that the organization will be indifferent.

For a better understanding, you can see in Table 4 the effect of introducing the third dimension in the robustness analysis of the given case study:

As it was mentioned previously in the section of preliminary conclusion, a proposed combination of decision options can be as follows: firstly decision 4, then decision 3 and finally, decision 2 can be made where as it is clear the initial decision 2 has very little chance to be selected. However, it can be inferred from Table 4 that not making decision 2 means the breakup of cooperation with Iran Khodro Company, which can lead to the obliteration of the organization and as a result, the given organization is obliged to enter into the field and regardless of the desirable or undesirable consequences of the decision, it has to make it. Softer results appear with the introduction of the third dimension in the selection between initial decisions 3 and 4; these two decisions have almost equal desirable and undesirable privileges in the two-dimensional analysis which lead to some problems in decision making. But as shown in Table 4, the initial

decision 3 has the status L in the third dimension and the initial decision 4 has the status I showing that the initial decision 3 certainly has a much higher priority than the initial decision 4. While not entering into field 3 can lead to loss in the organization, field 4 does not have such a feature.

4. Discussion and Results

Robustness analysis, when decisions have to be made consecutively, can greatly help decision makers because it specifies desirable and undesirable results of each decision and accordingly a decision which is more robust can be made. But since the decision maker needs more robust decisions to maintain flexibility in confronting a complex environment and high uncertainty, it also seems necessary to explore the results of decisions from other angles and dimensions. For this purpose, what has been considered by the authors in this paper has been the third dimension, which is the lack of making a decision or lack of entering into a field. The results of the study show that introducing a third dimension in the robustness analysis can change decision-making leading to high robustness. Just as in this case, while the results of the two-dimensional robustness analysis showed that initial decision 2 should be abandoned, three-dimensional analysis indicates high priority of the initial decision 2 than the initial decisions 3 and 4. Other results are related to the analysis of the selection between the initial decisions 3 and 4. While the two-dimensional robustness analysis showed no significant difference between the two decisions, three-dimensional analysis indicated high priority of the initial decision 3 than the initial decisions 4. Yet, still it can be said that more research can be done on the robustness analysis to achieve greater flexibility, some of which are as follows: in the present study, the third dimension has been added generally in one phase to the model, which can be added separately to each of the scenarios and the results can be studied. Also the third dimension can be

introduced quantitatively in the model and the results can be provided quantitatively for the decision makers. Introducing financial and temporal dimensions in the analysis can be another recommendation. Clearly, this is why more research is warranted on the robustness analysis to reach better results.

5. References

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