

# EVALUATING THE RISK OF PROJECTS IMPLEMENTATION IN VARIOUS SITUATIONS USING GENERALIZED TOPSIS MODEL AND BUSINESS PLAN

**Gholamreza JANDAGHI**

Professor, University of Tehran, Farabi College, Iran

**E-mail:** jandaghi@ut.ac.ir

**Mahbube HOSSEINI**

MBA Student, University of Tehran, Farabi College, Iran

**E-mail:** m\_hosseini88@ut.ac.ir

## Abstract

*Due to the growing acceptance of project management, the application of appropriate knowledge, processes, skills, tools and updated and new techniques can affect the success of project. Risk of project implementation has always been discussed in prosperity or not reaching the desired goal, and due to complex world, the updated techniques and tools must be used for measuring of this kind of risk. So the purpose of this paper is to evaluate this risk in various situations with the new models that its name is generalized TOPSIS and also used BP that it is one of the important tools before the implementation of the project. In this method the new concept is used; as peril, hazard and risk. A case study of the proposed model will be introduced in the MATLAB that the end method is modeled in it. The sensitivity analysis of the proposed method are discussed in the next and will be measured by using the Microsoft Excel.*

**Keywords:** *Project management, Peril, Hazard, Implementation risk, Business plan, Generalized TOPSIS model, Sensitivity analysis*

## 1. Introduction

Innovation is the origin and driving force of economic growth in the post-industrial era. The competitiveness of the national economy is stably provided Only by new products and improving existing products. In today's dynamic world innovation is accelerating and goods quickly are copied.[15] But should we act hastily? Business executives in years ago have tried using techniques such as total quality management to restrain implications of changes in their business processes. Approach such as total quality management allows administrators to minimize the risk of changes with the scientific methods and run their business management step-by-step. Bur developments in the economies that are take place re-

cently, need the new requirements in its business scope. In the new economic situation, different firms and organizations need more agility and flexibility to accept the changes that have been inevitable.[13] Therefore many managers want to know how they can beget greatest change in the business process in the shortest time and at the same time minimize the risk of changes. Sometimes the change is necessary because without it business is highly declined and can not compete with other actors in the economy. However, if changes are not made intelligently, the risks will be created for the business that they may undermine the philosophy of all actions and efforts. [7]

## **2. What is Business Plan?**

James Short and Davenport in 1990 in an article define the idea of designing business plan in this way: " Analysis and design of cycles and new business processes." Design of business processes means analyzed delicately business and designed the existing processes to achieve significant improvements in business efficiency. In the TQM improvement process and more modification are based on statistical control of the business situation, while the process of innovation and change in the design of business processes is based more on the role of information technology. So from this point to discuss IT is come in the change management and business process. In the methodology of designing business process the issue is to make rapid changes that the tools of these changes are IT. Sometimes these changes are to create environmental sustainability that beget IT-based tools and systems and sometimes IT is used to implement changes in business processes. [17]

### **2.1 Why do you need BP?**

According to the definition business plan is a plan that determines the future and develops a business and and often takes a period of several years. [24] Indeed it is a document that expresses company actions is in a specified period and typically includes a detailed list of the risks and uncertainty and analyzes them. [25] Consequently, it is a tool for predicting and managing better of existing businesses or new ones. These works can be accomplished through focus on priorities, monitoring and evaluating progress and contributing to achieve the predetermined objectives. Such a plan would enable individuals to gain necessary preparation for promotion programs in various stages of businesses. [4] In fact, the plan is to respond such question as; why? What thing? How to? Who? What time? How much? And One of the stages of preparation of it is the assessment of the business risk. [25]

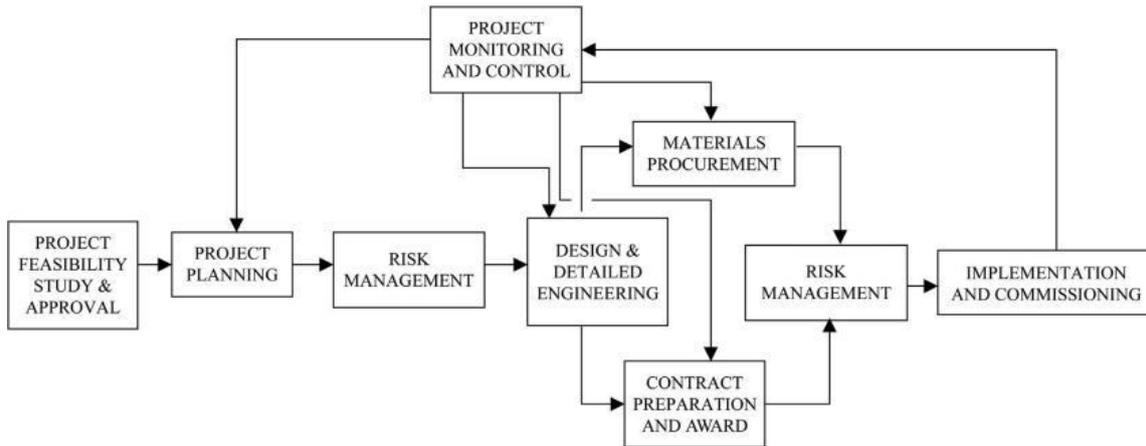
## **3. Risk and its management**

Risk in general is probability of incurring losses, and project risk is an uncertain and plausible event and if it occurs, it affects on the positive impact of the project results and objectives (opportunities) or negative impact (threats). [18] Consequently, it is essential in today's world, the risks should be identified and also controlled. So discussion of risk management is important too. Risk management is the systematic process that develops and implements to increase the positive risks (opportunities) and reduce the negative risks (threats).[23] For management policy the Risk Management is one of the good tools in any organization that he can reduce them by checking and evaluating of existing risks in the system. This tool is widely used in investment, project management, etc. [21]

**4. The position of risk management in project management**

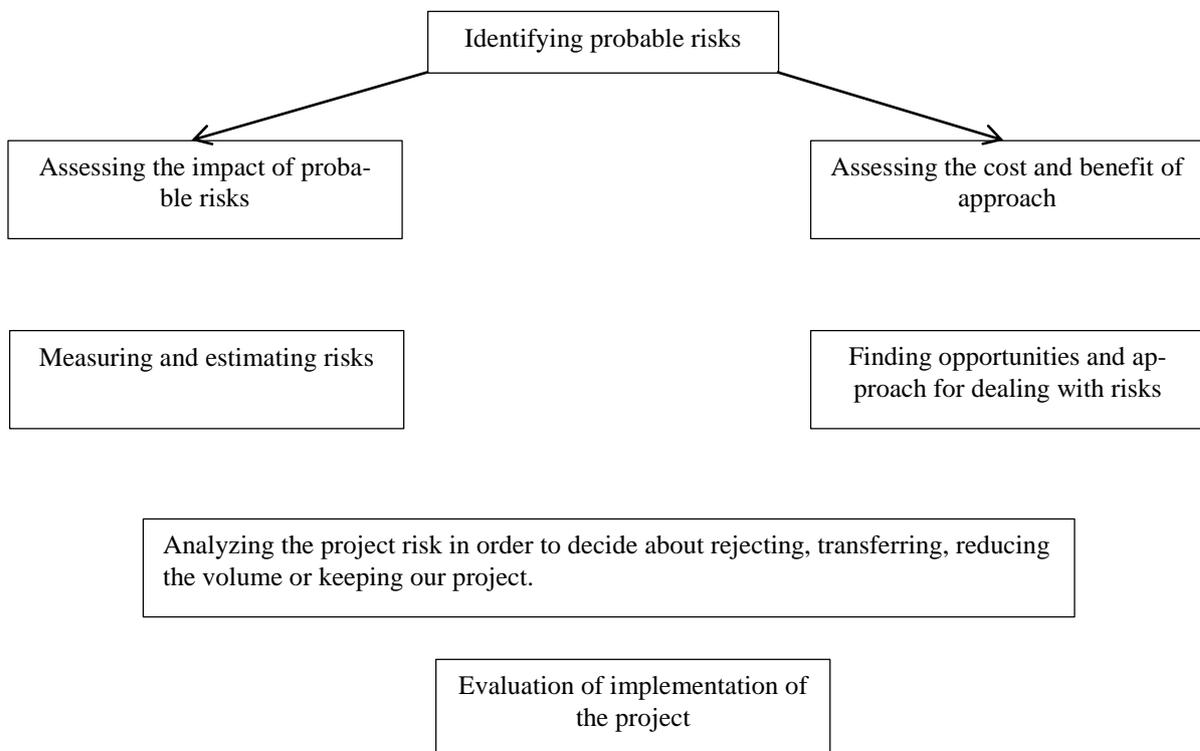
Project management is a process that plans, organizes, directs and controls the context of project implementation by the possible ways to achieve the desired objectives. In other words, it is a process that coordinates all components of a project. [14] The risk management process is continuously carried out in the project life cycle. [8]

In figure 1 the project management has been modeling and the position of RM is showed in it. [22]



**Figure 1.** Project management model

**5. The main steps in the implementation of risk management [6]**



**Figure 2.** Implementation of risk management

## 6. Benefit of RM in the project

RM has produced criteria and procedures that persons, financial institutions (commercial and industrial) and non-profit organizations and governments can use it in evaluating prospective of job and controlling and also financing hazard. Accordingly risk management manage the risks by systematic approach. Therefore always in working it is important to respond to two basic questions about probable future events: The first question is "what will happen?" The second one is that "what should we do?" Risk management planes to deal with possible future events. [11] Also it provides the ability for project manager to reduce the risk of failing in achieving the specified benefits by creating the efficient rating system in the process of project implementation, re-sourcing allocation and activities implementation and phases of project. [2]

## 7. The relationship between risk management and business plan:

By definition that has been presented can see that the risk management and business plan are closely related. To be able to face the peril before it individuals must be prepared to deal with it. As a result, the business plan can be identified risks.

But it should be noted that the business plan is based on a number of assumptions stated. Regardless of whether you have considered assumptions carefully, The probability that everything goes exactly according to your plan is too low. So if you plan for probable outcome, you're ready to run. It is very important that know areas of your business plan as fragile and vulnerable. [16]

Due to follow the business plan can be used to manage and control project risks:

- 1- It can help manager or entrepreneur to specify, focus and examine the aspects and development of their project.
- 2- Creates logical and accepted framework in which a work can be developed and measures related to the profession will follow in the next few years.
- 3- Offers criteria for the assessing the situation of a real business to what it should be. [24]

## 8. Research issue

The purpose of this article is to measure the risk of project implementation in different situations. In following mathematical model offers for reaching to the aim.

Some assumption in this model must be considered:

- 1- The main objective of the model is to optimize the locating of project and measure the risk of project implementation in different places.
- 2- It is assumed that by changing the location of the project the ratio of cost and income is constant. [10]

$$\frac{C_1}{I_1} = \frac{C_2}{I_2} = \dots \quad (1)$$

$C_i$ = the cost made by project in the  $i$  location

$I_i$ = income of project in the  $i$  location

- 3- In this model risk is created only as a threat and do not consider the positive aspects of it. Indeed ,for example, the rate is 0.9 implies that if the probable or unlikely event occurs , probability of threat in that location is equal to 0.9. And it does not mean that 90% can be converted to an opportunity or a threat. [19]

## 9. Methodology

1- Obtain an indicator that during the project create risk if the amount of them change.

2- Rank the locations of project with the TOPSIS model. This method is based on  $CL_i$  criterion and projects will be ranked by this criterion.  $CL_i$  of alternative that is higher than ones is in priority. [12] But then you will see that what is important to choose the project is probability of peril.

Before continuing some definition need to determine:

**Peril:** It is a situation that can lead to an accident or incident.

**Risk:** It is a chance of peril detonating to an accident or incident.

**Hazard:** Personal injury arising out of an accident, direct or indirect financial loss caused by incident or accident is known hazard.

**Consequences:** It is a condition that occurs as a result of actual peril.

$$\text{Peril} = \text{Financial hazard} * \text{Risk} \quad [8]$$

$$\text{Probability (peril)} = \text{probability (financial hazard)} * \text{probability (risk)}$$

$$\text{Probability of peril} = \text{probability of financial hazard causing} * \text{probability of risk}$$

$$P_{p_i} = P_{fh_i} * P_{r_i} \quad (2)$$

So for choosing project not only the risk is important, but also financial hazard is important, too. In fact, what it is important to choose the project is probability of peril.

3- Calculate the probability of the risk

$$1 - CL_i = P_{r_i} \quad (3)$$

$CL_i$ : index ranking of TOPSIS method

$P_{r_i}$  = risk probability in i-th location

4- Calculate the probability of financial hazard

For calculating this parameter at first it is required to calculate the financial hazard for each of the locations in each of the indicators.

### 4.1 Method of calculating the financial hazard for each of the indicators

Financial hazard for any indicator per unit loss should be estimated for each location.

$$fh_{ij} = P_{ij}(\text{create loss}) * COI_{ij} \quad (4)$$

$$i = 1, 2, \dots, n$$

$$j = 1, 2, \dots, m$$

$fh_{ij}$  = financial hazard for i location in the j indicator

$COI_j$  (cost or income) = For j indicator when threat is created in the project the amount of cost become high or the amount of income become low

#### 4.1.1 Calculate $COI_j$

COI amount depends on the type of index that any of its damage to which part of the plan. It may be changed the cost or income. Cost may increase or income may decrease. Depending on the nature of index by the business plan the amount of costs or incomes that the index are influences them consider as amount of COI for that index. For example, consider the supply of raw materials indicator for the construction of the sugar production factory. If the cost of material become high, it's influence the cost. So the cost change. As a result, this index COI is equal to the amount of cost.

#### 4.1.2 Method of calculating the $P_{ij}$ (create loss)

Depending of the type of index that is quantitative or qualitative, calculating the probability of losses is different.

##### 4.1.2.1 Probability of losses by the qualitative index

Weighted index for the  $j$ -th criterion ( $w_j$ ) in the TOPSIS model indicates that the this criterion affects the project with the amount of  $w_j\%$ . As a result, when the level of criterions become low probability of the creating loss for the project is  $w_j$ .

$$P_{ij}(\text{create loss}) = w_j \quad (5)$$

##### 4.1.2.2 Probability of losses by the quantitative index

$$P_{ij}(\text{create loss per unit reduction}) = \binom{x_{ij}}{1} w_j (1 - w_j)^{(x_{ij}-1)} \quad (6)$$

If the probability of creating failure or loss is  $w_j$ , the probability that  $x_{ij}$  (amount of  $j$ -th index for the  $i$ -th location in the TOPSIS model) reduces per unit, defines by the binomial distribution with  $(x_{ij}, w_j)$  parameters.

Exception: positive and negative indicators that are at their lowest levels they will not cause harm for the project. Therefore, the probability of loss for these index will be zero.

#### 4.2. Calculate the probability of financial hazard to the entire project

To calculate the peril probability it should be considered that all the parameters are not gone up or down at the same time to cause harm for the project.

$$P_i(\text{hazard from the } i - \text{th project}) = \frac{fh_i}{fh_T} \quad (7)$$

$$fh_i = \sum_{j=1}^m fh_{ij} \quad (8)$$

$$fh_T = \sum_{i=1}^n fh_i \quad (9)$$

$FH_i$ = financial hazard for the  $i$ -th location

$FH_{ij}$ = financial hazard for  $i$  location in the  $j$  indicator

$FH_T$ = all project financial hazard for total locations

It must estimate the probability that at least one of the  $m$  index create financial hazard to the project. This probability is equal to:

$$p_{fh_i} = \sum_{j=1}^m \binom{m}{j} p_i^j (1 - p_i)^{m-j} \quad (10)$$

$p_{fh_i}$  = probability of financial hazard creation

$m$ = amount of indicators

$p_i$ = probability of fh from the  $i$ -th location

##### 5- Calculate the peril probability

$$P_{p_i} = P_{fh_i} * P_{r_i} \quad (11)$$

$P_{p_i}$  = peril probability of  $i$ -th location

$p_{fh_i}$  = probability of financial hazard creation

$P_{r_i}$  = risk probability in  $i$ -th location

$P_{p_i}$  represents the parameter that in this article known as risk of the project implementation in different situations. The more peril probability ( $P_{p_i}$ ) is less, the more project is ideal.

## 10. Case Study: appropriate location for Municipal solid waste landfills using geographic information system (GIS) and Analytical Hierarchy Process (AHP) (Case study of Iran (city: Ilam))

In this paper we introduce 12 indexes that their weights of each index were determined according to the AHP method. Based on geographic information systems and indicators top priority (location 1) have been selected from 3 locations.

Some assumptions are considered for comparison:

- 1- Impact indicators and weights of them is intended according to the thesis.
- 2- Decision matrix according to the definitions in the thesis, is prepared by an expert.
- 3- COI matrix is expressed with respect to the business plan of the project.

### 10.1. Decision matrix and indicators weights

**Table 1.** Decision matrix and indicators weights

Indicators	Type of indicators	Weights	Location	Location	Location
			1	2	3
Far from city	Quantitative	0.212	6	7	4
Far from airport	Qualitative	0.167	6	7	6
Stay away from the blue zone	Qualitative	0.13	8	6	8
Stay away from the main roads	Quantitative	0.104	6	4	8
Slope	Quantitative	0.09	8	6	4
Stay away from protected areas	Qualitative	0.068	7	7	7
Geology	Quantitative	0.06	5	8	7
Land use	Qualitative	0.048	8	6	8
Stay away from the village	Qualitative	0.041	7	7	7
Fault	Qualitative	0.033	7	7	7
Height	Quantitative	0.026	8	6	4
Precipitation	Qualitative	0.021	6	6	6

### 10.2. Calculate the relative proximity index and risk probability

**Table 2.** Relative proximity index and risk probability

	Location 1	Location 2	Location 3
CL	0.633	0.592	0.381
Pr	0.367	0.408	0.619

### 10.3. COI matrix

**Table 3.** COI index

Indicators	COI (dollars per ton)
Far from city	0.51
Far from airport	0.51
Stay away from the blue zone	0.51
Stay away from the main roads	0.51
Slope	93.75
Stay away from protected areas	0.51
Geology	93.75
Land use	93.75
Stay away from the village	0.51
Fault	973.75
Height	973.75
Precipitation	973.75

**10.4. Calculate the probability of financial hazard**

**Table 4.** Probability of financial hazard

	<b>Location 1</b>	<b>Location 2</b>	<b>Location 3</b>
$P_{fh}$	0.99998997436	0.999997555	0.9999980368

**10.5. Measuring risk of the project implementations**

**Table 5.** Risk of the project implementation

	<b>Location 1</b>	<b>Location 2</b>	<b>Location 3</b>
$P_p$	0.366561994	0.407779	0.6194821

Location 1 with the lowest risk (36.66%) is selected as the preferred location. Risk of the project implementation in location 2 is 40.78% and in location 3 is 61.94%. This ranking is consistent with the end priorities of the thesis. But this method shows risk and also ranking.

In any decision method risk has not been investigated and values obtained from the models are used to rank the options. For this reason, this method is distinct from other methods. Furthermore in the next section another distinctive feature of this method will be specified.

**11. Sensitivity analysis of the proposed method (as used in this case) using a stability index**

Sensitivity analysis (SA) is the study of how the uncertainty in the output of a model (numerical or otherwise) can be apportioned to different sources of uncertainty in the model input. The SA is hence considered by some as a prerequisite for model building in any setting, be it diagnostic or prognostic, and in any field where models are used. Kolb (quoted in Rabitz, 1989) noted that theoretical methods are sufficiently advanced, so that it is intellectually dishonest to perform modeling without SA. [3]

In fact, it checks the relationship between input and output of information and discuss the modifications that affect the output of the model. [20] There are different ways for sensitivity analysis that Campolongo (2001) and Saltelli and Chan (2000) fully reviewed these methods.

One of these methods is changing the index weights. But it should be noted that the output of this proposed model are two different things:

- 1- Ranking the project locations
- 2- Calculating the risk of project implementation in the site chosen

Therefore, it is necessary to do sensitivity analysis on both output per changing the index weights. To change the weights of indicators it is used an index that called instability index and its sensitive will be discussed in those two output. [1]

**11.1. sensitivity analysis of first section**

This part is focused on changing of the final ranking of project per changing of the indicator weights.

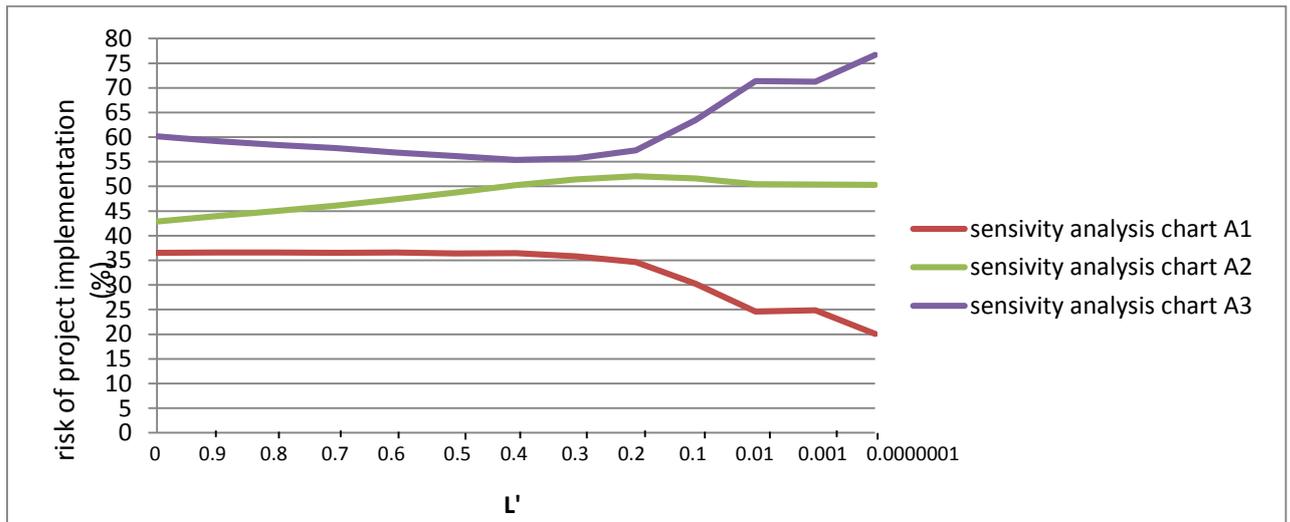
Since the thesis is used AHP method and paired comparisons for weighting the indicators, for analyzing the sensitivity the instability index (L') will be used. This index indicates that in which extent decision maker judging can be such that the final ranking does not change. Therefore in the AHP matrix elements above the main diagonal should be multiplied

on  $L'$  and the elements below the main diagonal should be divided on  $L'$  ( $0 < L' < 1$ ). The  $L'$  gradually reduced from the unit until the final ranking does not change. As soon as ranking changing causes, the decreasing of  $L'$  must be stopped and the instability index is obtained. Stability index ( $L$ ) is defined as followed:

$$L = \frac{1}{L'} \quad (12)$$

The lower the instability index is, the less sensitive model is to changes in weights. [5]

Figure 1 shows the trend of changes in the instability index and the final result for the case study. According to the entries expressed first part of curves that intersect will be presented as an instability indicator.



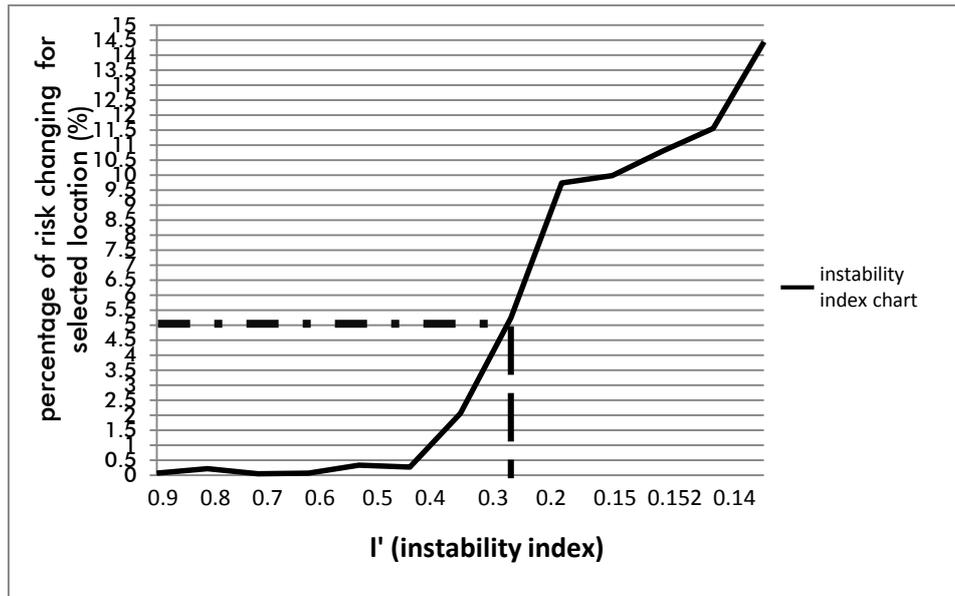
**Chart 1:** sensitivity analysis based on the instability index for the first section

Decreasing  $L'$  has continued until  $10^{-7}$  but as the chart shows none of the graphs intersect. So we can say that the final ranking model is not sensitive of weights changing or it's almost zero. This case seems reasonable. Because the ultimate goal of the model is measuring the locations risk and final ranking should not be changed by changing the weights. For accurate investigation, this claim will be examined in future research.

**11.2. Sensitivity analysis for second section**

The previous section outlined that model ranking sensitivity is very few by changing in the weights. In this part the sensitivity analysis will be done based on the risk of implementing the project in location 1 in case study by changing the weights of indicators.

In this section we will use the instability index, too. But the difference is that amount of  $L'$  will decrease until the amount of deviation in risk has arrived to 5%. Chart 2 shows decreasing of  $L'$  and percentage of changing in the amount of risk. [5.]



**Chart 2:** sensitivity analysis based on the instability index for the second section

According to the figure 1 when the  $L=0.2$ , Percentage of risk changing for location 1 is equal to 5%. As a result  $L=5$ . Since the instability index is low, so the amount of risk is less sensitive to changes in weight.

## 12. Discussion and conclusion

At the management level, a clear vision that is created by the use of risk management system is to facilitate and improve the quality of decision making in the project. To create a clear vision should always combine qualitative and quantitative approaches to decide better. [9] In this paper, new model called generalized TOPSIS method has been presented by integrating the business plan as a basis for the start of a project and TOPSIS method as a quantitative method for ranking decision problems. In this method three elements have defined: peril, financial hazard and risk and with these elements risk of project implementation measures and the best options is selected in the terms of the lowest risk.

One of the attributes of this model that differentiate it from other forms of multi-criteria decision making is that in addition to ranking options this model measures the peril probability and Final numbers obtained will be not applications only for ranking.

Sensitivity analysis is also examined in this article in a particular case and has been identified that final ranking of the model is not sensitive relative to the weights changing and the method for analyzing the sensitivity is stability index and model sensitivity from this index is 5 relative to the 5% changing in the amount of the project implementation risk in the best location. Since the stability index for the peril probability of the project implementation is very high, the model has very few sensitivity.

## 13. Suggestion

To develop more and better the model the following items will be studied in future research, included:

- 1- According to the first assumption in this model risk is considered as its negative aspect. In the future research this one can be developed and the positive aspect of it can be considered, too. One the way that can remove this problem is that after measuring the risk of project implementation this factor can again come to the model as a indicator and with the one of the multi-criteria decision making model such as TOPSIS resolved the issue. The name of this indicator can be "unforeseen options".
- 2- One of the factors influencing the decision-making model and also this model is to explain the impact indicators. On the other hand the PMBOK standard is a complete guide for Project Management. So with Combining this standard by business plan and fuzzy expert system can explain effective indicators on these issues and define the scientific basis for the indicators. [19]
- 3- About the sensitivity analysis in future article can speak better and more. Also can analyze sensitivity of the model with the others one.

## References

1. Alfredo del Cañó, P.E., M.ASCE, and M. Pilar de la Cruz, P.E , "**Integrated Methodology for Project Risk Management**", Journal of construction engineering and management, Nov. Dec 2002.
2. Alison Mobey, David Parker, "**Risk evaluation and its importance to project implementation**", International Journal of Productivity and Performance Management, 2002.
3. Andrea Saltelli, "**Sensitivity Analysis for Importance Assessment**", Risk Analysis, Vol. 22, No. 3, 2002.
4. Benson Honig, Tomas Karlsson, "**Institutional forces and the written business plan**", Journal of Management vol. 30 no. 1, February 2004, 29-48,.
5. Che-Wei Chang, Cheng-Ru Wu, Chin-Tsai Lin, Huang-Chu Chen, "**An application of AHP and sensitivity analysis for selecting the best slicing machine**", journal of Computers & Industrial Engineering Volume 52, Issue 2, March 2007, Pages 296–307.
6. Crouhy, M., Dangalaj, R, "**The essentials of risk management**", chapter 1, Risk Management, 2000.
7. David L. Cleland, "**Project Manager's Handbook**", University Of Pittsburgh-Pittsburgh, and Lewis R. Ireland, 2008.
8. FAA, "**The system safety handbook**", Dec. 2000.
9. Fiona D. Patterson, Kevin Neailey, "**A Risk Register Database System to aid the management of project risk**", International Journal of Project Management 20 (2002), 365–374.
10. Frank T. Anbari, "**Earned value project management method and extensions**", Project Management Journal; Dec 2003.
12. Gary Stoneburner, Alice Goguen, and Alexis Feringa, "**Risk Management Guide for Information Technology Systems**", Recommendations of the National Institute of Standards and Technology, July 2002.

13. G.R. Jahanshahloo, F. Hosseinzadeh Lotfi, M. Izadikhah, "**An algorithmic method to extend TOPSIS For decision-making problems with interval data**", Applied Mathematics and Computation 175, 2006.
14. J. Rodney Turner, "**The handbook of project-based management**", 3rd Edition, 2009.
15. Jack R. Meredith, Samuel J. Mantel. JR, "**Project management, a managerial approach**", 2011.
16. James M. Lyneis, David N. Ford, "**System dynamics applied to project management: a survey, assessment, and directions for future research**", System Dynamics Review, Summer/Fall 2007.
17. John Rafter, "**Risk analysis in project management**", 1994.
18. Linda Pinson, "**Anatomy of a business plan: the step-by-step guide to building a business and securing your company's future**", 2008.
19. Lionel Galway, "**Working paper: Quantitative Risk Analysis for Project Management ; A Critical Review**", WR-112-RC, February 2004.
20. Kalle Kähkönen, "**Integration Of Risk And Opportunity Thinking In Projects**", Presented at the Fourth European Project Management Conference, PMI Europe 2001, London UK, 6-7/ June 2001
21. M. Saisana, A. Saltelli and S. Tarantola, "**Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators**" J. R. Statist. Soc.A, 2005.
22. Paul Hopkin, "**Fundamental of risk management**", third edition, 2014.
23. Prasanta Kumar Dey, "**Decision support system for risk management: a case study**", Management Decision, 2001.
24. Project Management Institute, Inc, "**A Guide to the Project Management Body of Knowledge**", chapter 11, Risk Management, 2004.
25. Tomas Karlsson, Benson Honig, "**Judging a business by its cover: An institutional perspective on new ventures and the business plan**", Journal of Business Venturing, Pages 27–45, January 2009.
26. <http://www.entrepreneur.com/article/38290>