

## Research Article

# **Prioritizing most important effective factors on contractors' claims in three-factor contracts using phase multi-criteria decision-making methods**

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## **ABSTRACT**

The growing complexity of construction as well as its rapid progress and uncertainties and shortcomings of legal terms governing civil works and lack of confidence of the commitments and the rules in parties are the most important reasons of disagreements in domestic projects which have made facing with disagreements inevitable so that truly made contracts are not even excepted from any disagreement. Construction contracts disagreements are costly, time consuming and unpleasant and affect quality and increase in contracts price.

In most of the projects with different systems of project accomplishment there may be claims made by agents specially contractors and on the other hand since project accomplishment by design and construction method has a limited background in our country and contracting parties know a little about it, claims and disagreements among these agents and specially in civil projects with three-factor contracts are inevitable. So in this paper, reasons of making claims in civil projects accomplished with three-factor contracts method in country have been considered. Naturally making decision in projects is essential and complex regarding type and quality of contractors' claims and here there are many factors which could be prioritized by decision-making methods in this research after identifying main reasons of claims in civil contracts by contractors. On this basis criteria and sub-criteria are determined and ranked by different decision-making methods.

**Key words:** claim management, contractors, three-factor contract, multi-criteria decision making method contract

## **1. INTRODUCTION**

One of the economic development specifications for each country is its civil plans which are considered as main criterion in economic growth of that country. So Progress, welfare and prosperity of a nation depend on their country civil plans and success in civil plans accomplishment requires mechanisms and factors in order to desirably organize and finalize affairs cycle with minimal cost and maximum profit. These three factors are similar to the sides of a triangle so defect and deficiency of each side affects other sides. These three indices are considered as main criteria and limitations of

project. Ambiguity, tense work, project duration and the number of components involved in projects could act as a ground for various disagreements between the various parties of the contract (Shakeri 2013).

In a study by Caroline Maria et al. using multiple-criteria decision making method (MCDM) in project management and achieving its targets was dealt with and a model was presented based on which managers can focus on main duties and prevent risks and negative claims to a great extent (Caroline Maria et.al 2014). Eckert et al. made an investigation in

which by using MCDM method they dealt with true selection of contractor and indentifying their claims. In their paper attempts have been made to use MCDM method and they have known their method effective in civil plans (Eckert et.al 2011). In another study by Gholipour et.al phase AHP method was dealt with in order to determine contractor. That article states that contractor selection is one of the most important issues in project because the majority of the budget is related to it and can be a part of MCDM method. Analytic Hierarchy Process (AHP) and other methods are of high importance in this selection and prioritization (Gholipour et.al 2014).

Ghorbani et al. conducted a study on management of contractors' claims in buildings' repair and maintenance projects using standard PMBOK and 4-stage analytic method to study construction projects characteristics and conditions, then identified causing factors of financial claims and their basic causes including change, delay, rapid stop, delayed payment and price fluctuations and stated suitable techniques in analysis of causes impact, created costs in case of claims, and quantification methods for contractors' financial claims in construction projects and while introducing effective analytical method to evaluate financial claims, in order to suitably manage claims they presented suggestions concerning the need for proportionality between the characteristics and conditions of construction projects, preparation of contract documents with the approach of claim management and necessity of projects risk management to prevent disagreements (Ghorbani Salahshoor 2014).

In this study efforts will be made to firstly conduct field studies in construction projects of the country and having interview and consultation with experts and scholars as well, the most important causes of contractors' claims in these projects be identified and evaluated.

Then by using MCDM methods the above mentioned reasons be prioritized and in this way a model be represented to prioritize contract contractors' claims reasons in three-factor contracts in the country.

## **2. Three-factor projects**

In contracts made with three-factor method, the employer implements the project through distinct contracts with the designer or consultant and manufacturer or contractor. In this method design is completed at first and then is outsourced to one or more companies through tender. Also coordination, lack of coordination risk between design and construction and commissioning of the project is the responsibility of the employer (Ghorbani and Salahshoor 2014). Three-factor construction method is one of project accomplishment systems based on which design (whole or a part of basic design and detailed desing), equipment and material and their relevant services supply, manufacturing, installation, commissioning, performance tests and other extra services related to them are simultaneously done by single contruction contractor (State Management and Planning Organization 2004) . in these projects employer reduces his responsibilities and increases contractor's responsibilities by outsourcing a great deal of responsibilities and risks of project to the contractor (Shakeri and Sajjadi 2013). Although three-factor construction method has advantages than traditional method mentioned in the third column of the following table condition for achieving these advantages in the first stage is the full understanding of the three-factor design and construction method and in the second stage is using it in projects which have primary essential criteria and principles to suit this method.

So in the following table the essential principles to accomplish projects with three-factor design and construction method is presented (Emam Jome Zadeh 2004).

**Table1.** Principles, indice and advantages in three-factor construction system based on priority

Row	Essential principles in project accomplishment with three-factor construction method	Success indice of project accomplishment
1	<b>Project complete definition</b>	According predicted budget
2	Bidirectional agreement in project scope and target	According Beneficiary expectations
3	<b>Employer capability of project management</b>	
4	Employer capability in defining project	According time schedule
5	<b>Supplied budget and credit</b>	According technical characteristics
6	Final deadline of project completion	
7	<b>Designer-Manufacturer capability</b>	High quality of project accomplishment
8	Employer avoidance of risk	Employer Minimum involvement
9	<b>Standard technical characteristics</b>	

### 3. Main factors of forming contractors claims in three-factor contracts

Generally the trend of forming claim and disagreement is supposed as below:

- ✓ A. disagreement on the basic claim
- ✓ B. Accepting the claim by the other party, but the amount of compensation and implementation of claim is not agreed here.

Based on contract definition, contractor is committed to accomplish the issue with determined quality over a certain period and with the specific price.

So on this basis it could be concluded that if one of the main factors of contract differs, can lead to

contractor's claim. In other words, change in time, change in terms of contract subject and finally changes in prices agreed in the contract themselves will be the cause of claims. Important point here is considering that these claims may themselves be acceptable, unacceptable, correct or incorrect. The main cause for these claims can be summarized in two factors as delay and change which depend on and impact each other (Nieto et al. 2012).

These two factors finally lead to increase in time and cost and increase in cost causes financial claim. Usually time of project completion is an important aspect of project contract. Overall, employer has specific need for project and may have arranged special agreements in order to use completed facilities in specific time (Ebrahimi et al. 2011).

### 4. Claims and their causes

As earlier mentioned consequences of these claims in most of the cases results in breakup the relationships, referring to the judgment of the trial court with all its delays and costs (Shakeri and Mansoori 2013). Claims in contractor contracts may form due to different causes. Kumaraswamy divided causes of claims formation into two direct (claim formation) and basic (claim origin) causes and defined claim formation causes as those which appear immediately and separated them from basic causes.

Changes made by employer are examples of claim formation cause and lack of enough information for employer to make suitable decisions is an example of basic claim cause. Origine of claim has been defined different from claim formation cause and origine is known as prerequisite for claim formation cause, so in the table below differences between claims origine and formation causes are shown (Mardi Pilerood 2010).

**Table2.** Differences between claim origin and cause

Row	Origin of claim	Causes of claim
1	Pre-requisite causes of claim -----	Post-requisite of origine and pre-requisite cause of claim
2	Before or during project life cycle	During project life cycle (specially over project accomplishment)
3	Estimating the amount of claim is not possible	Estimating the amount of claim is possible

## 5. METHODOLOGY

In this section for ranking most important factors affecting claims and their management in three-factor contracts presenting a model is considered. Due to time limitation, dispersion and complexity of construction projects need for an effective project management system considering required processes to suitably manage claims for increasing project quality, decreasing project time and cost is expected.

Naturally making decision in projects is essential and complex regarding type and quality of contractors' claims and here there are many factors which could be prioritized by decision-making methods in this research after identifying main reasons of claims in civil contracts by contractors.

On this basis criteria and sub-criteria are determined and ranked by different decision making methods.

One of recently considered issues in Management sector is MCDM method.

In such decision makings several indice or targets that sometimes seem to be contradictory are considered.

In case of organizational issues: in selection of organization strategy criteria like organization

incomes over a period, organization stock price, market share, organization image in community ...

if in MCDM, criterion is interpreted as index this method is called Multiple Attribute Decision Making (MADM) and if multiple objectives are addressed this method is called Multiple-Objective Decision Making (MODM).

## 6. Data Analysis

In this section contractors' claims reasons in three-factor projects have been studied and their sub-criteria will be analyzed.

This will be done in two parts and two multi-criteria decision making methods and finally comparison between their results will be done. The first method is TOPSIS and the second is AHP. Ranking of criteria and sub-criteria has been done by 30 authorities and specialists of this field and attempts have been made to introduce the most effective methods for most matching ranking with state local conditions.

### 6-1- Prioritizing based on TOPSIS

At first factors and sub-factors are determined then using authorities' idea and taking steps and obtaining results, TOPSIS analysis will be done.

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**Table3.** Primary secondary factors of contractors' claims in three-factor projects and acronyms in TOPSIS

Row	Factor	Criterion
1	Change in contract agreements (A1)	Changes in provisions and working level (C1)
		Request of overtime/ work reduction (C2)
		Change in project schedule (C3)
		Change in project accomplishment price (C4)
2	Change of employer delays in implementing commitments (A2)	Making contract effective (C5)
		Removing probable obstacles and opponents (C6)
		Taking needed permissions from authorities (C7)
		Lack of enough attention to social and local issues in area of project accomplishment (C8)
3	Major drawbacks in contract (A3)	Ambiguity, contradiction and deficiency of information in contract provisions (C9)
		Climate conditions (C10)
		Suspension in affairs (C11)
		Major Drawbacks and failures in design (C12)
		Equipment quality and conditions (C13)
		Level of accessibility to place (C14)
		Change in development policies and rules of country (C15)
		force majeure project (C16)
Difficulty/ complexity of project (C17)		

**Table4. Unscaled**

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17
A1	0.667	0.545	0.518	0.489	0.551	0.59	0.526	0.604	0.429	0.494	0.497	0.507	0.596	0.529	0.559	0.541	0.51
A2	0.593	0.654	0.644	0.567	0.657	0.626	0.641	0.654	0.544	0.509	0.524	0.498	0.548	0.596	0.552	0.489	0.609
A3	0.451	0.524	0.567	0.663	0.515	0.509	0.559	0.455	0.724	0.709	0.688	0.707	0.587	0.604	0.619	0.697	0.607

(N<sub>1</sub>)

**Table 5. Positive ideal and negative ideal for each index**

critierion	Positive ideal	Negative ideal
C1	0.039	0.027
C2	0.038	0.03
C3	0.038	0.031
C4	0.039	0.029
C5	0.039	0.03
C6	0.037	0.03
C7	0.038	0.031
C8	0.038	0.026
C9	0.043	0.025
C10	0.042	0.029
C11	0.041	0.029
C12	0.042	0.029
C13	0.035	0.032
C14	0.036	0.031
C15	0.037	0.033
C16	0.041	0.028
C17	0.036	0.03

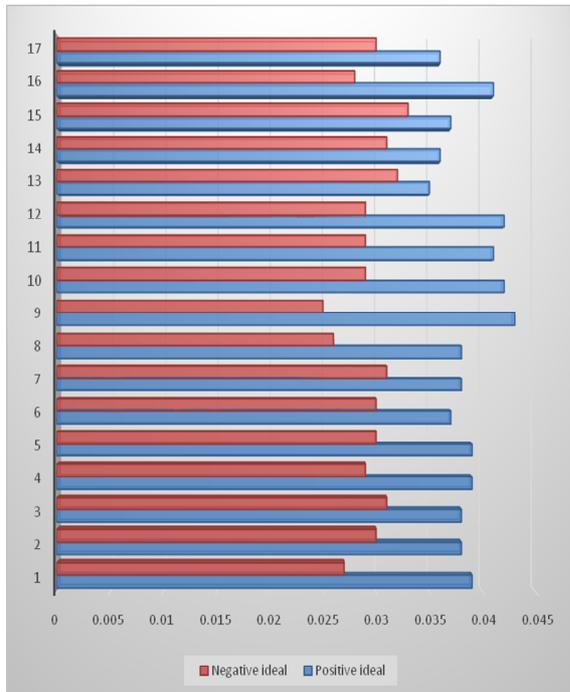
According results it's obvious that criterion "Ambiguity, contradiction and deficiency of information in contract provisions" and "quality and conditions of equipment" respectively have

the maximum and minimum positive ideal. Subsequently negative ideals in criterion "Ambiguity, contradiction and deficiency of information in contract provisions" have

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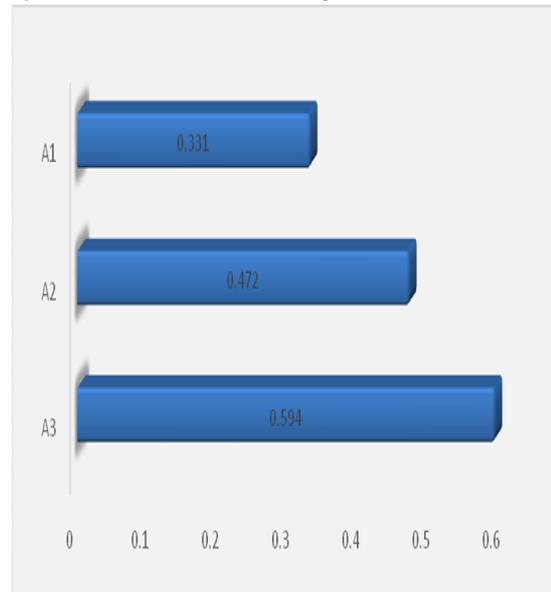
achieved the lowest position and in criterion “Suspension in affairs” have achieved the lowest and the highest position.

**Figure1.** Positive and negative ideal for studied criteria



Results achieved from ranking items by Topsis show that item “Major drawbacks in contract” has the upper priority than other items. The chart below shows items ranking.

**Figure2.** Chart of items ranking



**Table6.** Items ranking

Row	Items	Distance to the positive ideal	Distance to the negative ideal	CL	Rank
1	A1	0.034	0.017	0.331	3
2	A2	0.027	0.024	0.472	2
3	A3	0.023	0.033	0.594	1

**6-2-Prioritizing based on AHP**

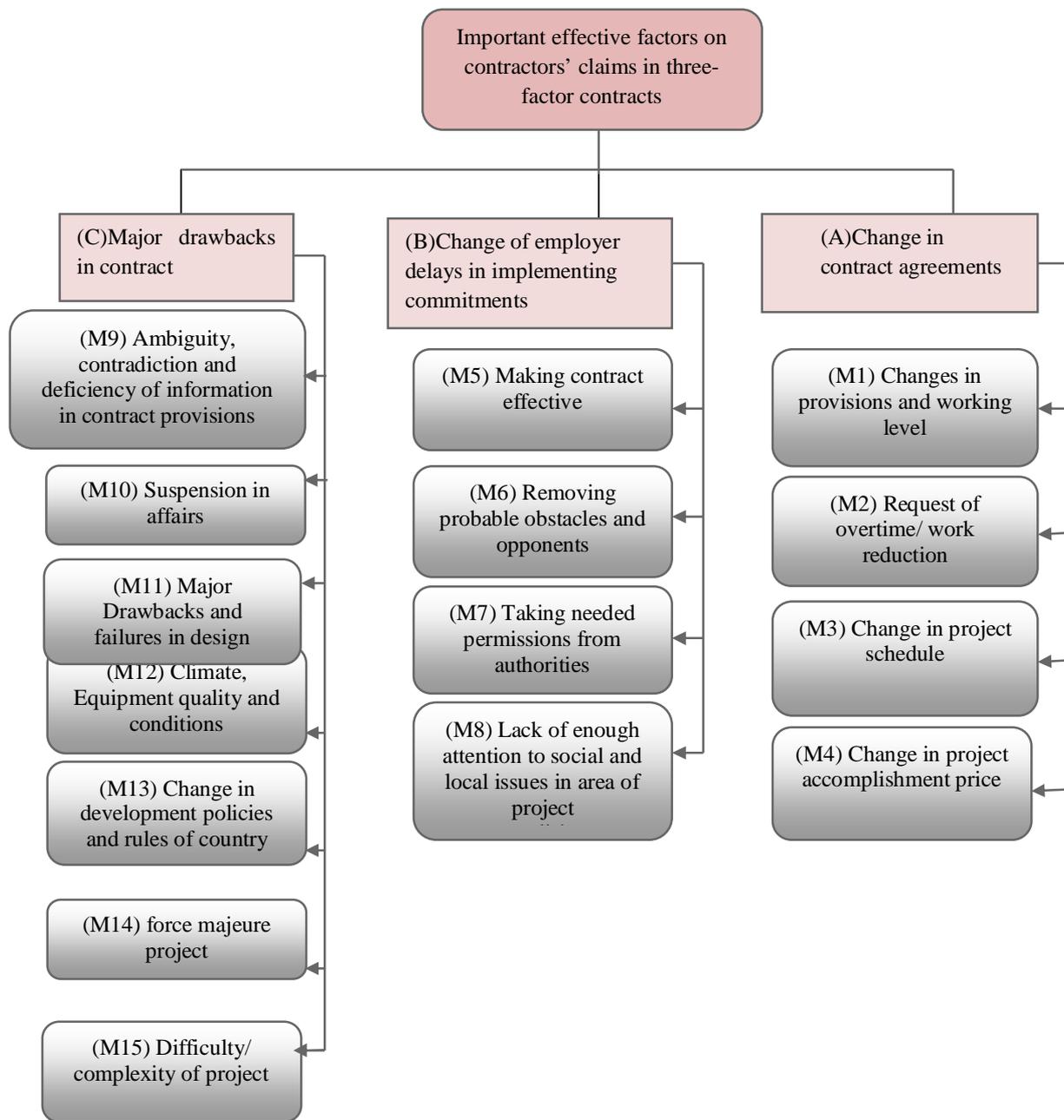
First steps in AHP is making a graphical representation of the problem that in this study, this graphical representation is made with 3 factors and 15 sub-factors and in three forms. 17 criteria existing in Topsis are merged in other 15 important criteria due to special limitation of AHP software used here.

The degree of importance and their priority from specialists' viewpoint is indicated in table 7 and its chart in figure 4.

**Table 7.** Importance of sub-criteria in three main criteria

Criterion	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
A	0,2906	0,6795	0,6144	0,6795	0,5842	0,1365	0,2385	0,1265	0,1947	0,1130	0,1721	0,1104	0,5278	0,1243	0,1571
B	0,1048	0,1093	0,2684	0,1093	0,1350	0,2385	0,1365	0,1865	0,0881	0,6519	0,1020	0,5666	0,1396	0,5171	0,5936
C	0,6046	0,2111	0,1172	0,2111	0,2808	0,6250	0,6250	0,6870	0,7172	0,2351	0,7258	0,3230	0,3325	0,3586	0,2493

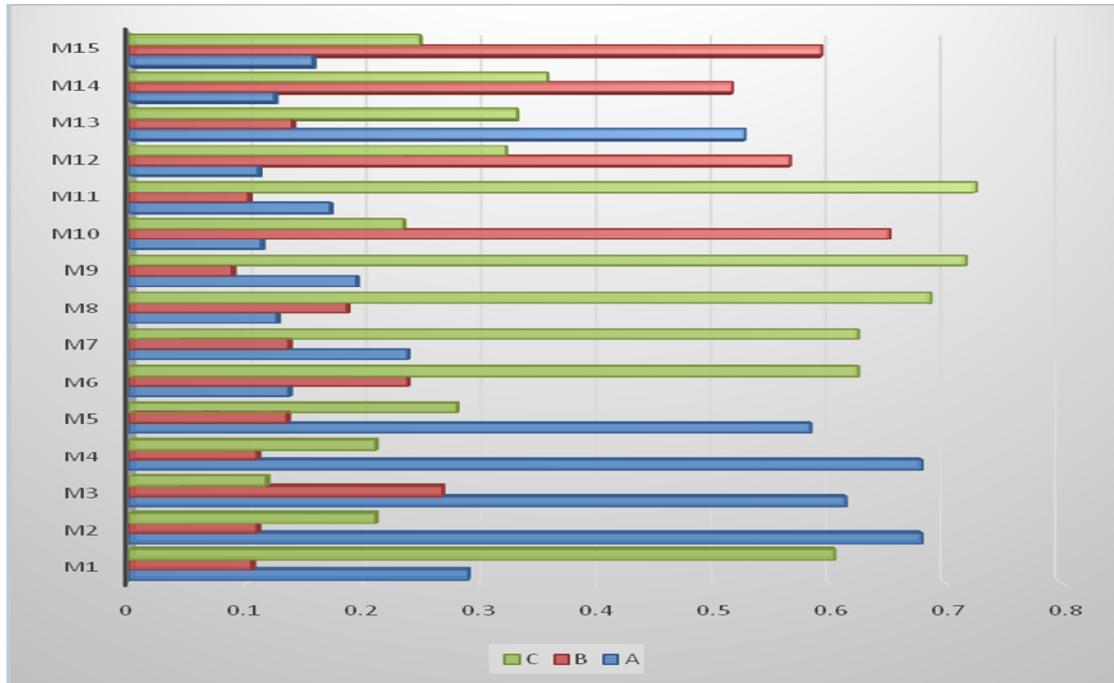
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**Figure3.** Criteria and sub-criteria in AHP of contractors claims

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**Figure 4.** Chart of relative weights of each sub-criteria in three main criteria



According table results and after summing up criteria for each reason, the following results are achieved:

- For the first factor (change in contract agreements(A)) sum of criteria weight is equal to 2.264.
- For the second factor (employer delays in implementing commitments(B)) sum of criteria weight is equal to 0.6965.
- For the third factor (major drawbacks in contract(C)) sum of criteria weight is equal to 2.941.

Referring these results, the third factor is placed in the first level of importance.

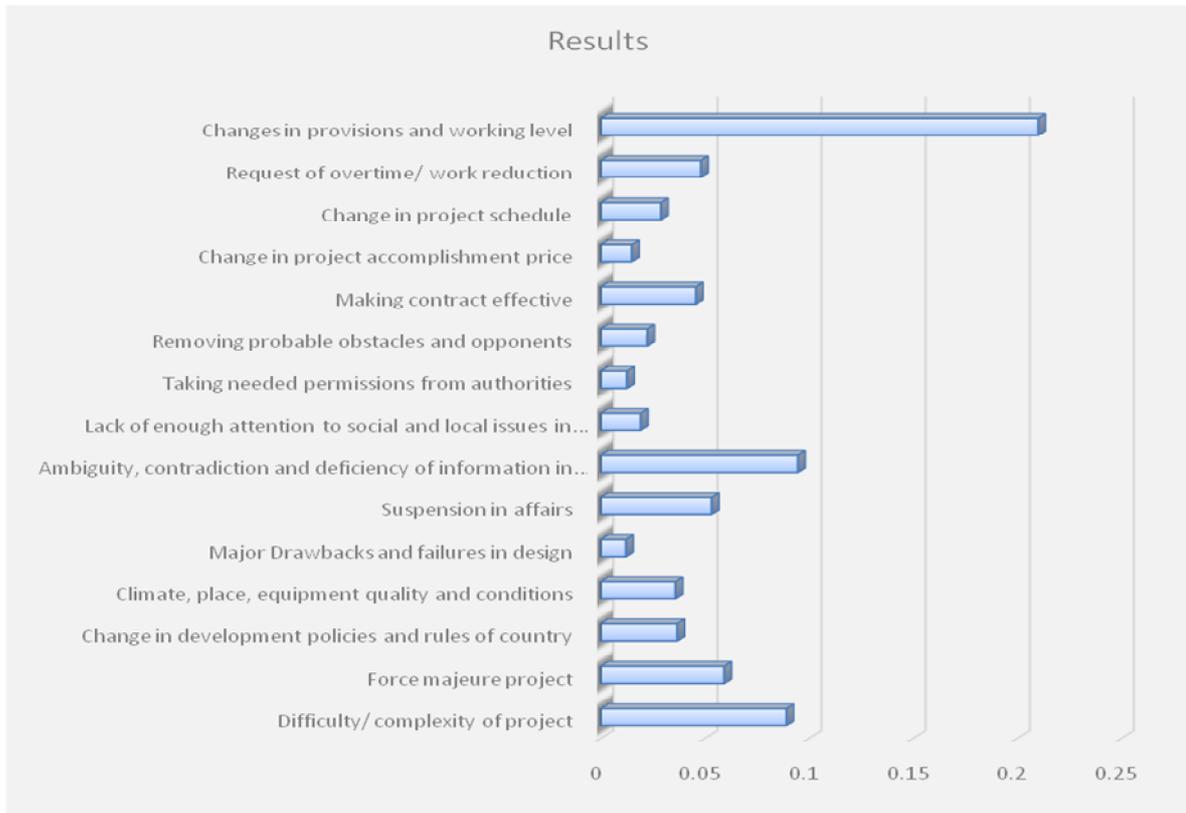
In order to rank criteria the following table and chart have been designed. As could be seen criteria: “Changes in provisions and working level”, “Taking needed permissions from authorities”, “Major Drawbacks and failures” and “Ambiguity, contradiction and deficiency of information in contract provisions” have achieved the first to fourth position from specialists’ viewpoint. Consistency Ratio

(CR)of Relative Weights in this method is 0.097 and this perfectly suits answers consistency.

**Table 8.** Final weight of sub-criteria

Criterion	Results
Changes in provisions and working level	0.2099
Request of overtime/ work reduction	0.0479
Change in project schedule	0.0287
Change in project accomplishment price	0.0148
Making contract effective	0.0455
Removing probable obstacles and opponents	0.0222
Taking needed permissions from authorities	0.1245
Lack of enough attention to social and local issues in area of project accomplishment	0.019
Ambiguity, contradiction and deficiency of information in contract provisions	0.0945
Suspension in affairs	0.0531
Major Drawbacks and failures in design	0.1197
Climate, Equipment quality and place conditions	0.0357
Change in development policies and rules of country	0.0366
force majeure project	0.0591
Difficulty/ complexity of project	0.089

**Figure 5.** Final weights of sub-criteria



## 7. CONCLUSION

Civil projects have special complexities and regarding their specific operational role their complexity increases. In these projects a great deal of financial and human resources are involved so project success means its accomplishment in a specific time with predicted cost and desired quality by all issues involved in project. Certainly prevention of claim formation is much simpler and cheaper than its solution. Sometimes removing a claim takes a long time and due to passing time and aging problems, other aspects are added to them and complexity increases, hence they impose more costs on the project. By knowing factors in making claims it can be said that prevention ways will be understood as well and in most of the cases by taking simple measures, a considerable amount

of claims could be prevented. In this study efforts were made to identify and evaluate the most important claim causes of contractors in civil and construction projects by firstly doing field studies in these projects and interviewing and consulting with specialists and authorities in this field. Then the mentioned causes were prioritized using MCDM methods and in this way a model was presented to prioritize contractors' claims reasons in three-factor contracts in the country. Outstanding results were achieved coming as follows. After analysis of these causes and reasons and their criteria using TOPSIS and AHP the outcomes below were obtained:

### - In Topsis method

- Criterion of work increase and decrease and change in project schedule affects delay factor

more.

- Ambiguity, contradiction and deficiency of information in contract major drawbacks factor has gained the most importance.

- Criteria "Ambiguity, contradiction and deficiency of information in contract provisions" and "equipment quality and conditions" are respectively of the most and the least positive ideal.

- Consequently negative ideals in criterion "Ambiguity, contradiction and deficiency of information in contract provisions" have achieved the lowest position and in criterion "Suspension in affairs" have achieved the lowest and the highest positions.

- Results from ranking main causes with Topsis indicate that item "major drawbacks in contract" is of upper priority than others.

#### - In AHP

- In all matrixes inconsistency rate was smaller than 0.1 indicating that matrixes don't need review in

Judgements done by individuals.

- Factor "major drawbacks" is placed in the first degree of importance.

- Criteria: "Changes in provisions and working level", "Taking needed permissions from authorities",

"Major Drawbacks and failures" and "Ambiguity, contradiction and deficiency of information in contract

Provisions" have achieved the first to forth position from specialists' viewpoint.

Reviewing results obtained from these two methods it should be stated that AHP is based on three principles of analysis, pair comparison, items summation and prioritization. In this method criteria with higher importance are placed in upper rows of this hierarchical structure. Despite Topsis which is mostly based on mathematical calculations since the base of all calculations in AHP is experts' idea, results are flexible and this is a point of strength of this

method. Also using AHP empowers decision making so that in experts' view those more important factors which more affect positioning be studied with their own degree of importance in the problem.

It should be noted that both studied methods are applicable methods in MCDM and in both methods, quantitative and qualitative criteria are simultaneously involved in evaluation. In Topsis system operation is acceptable. In this method input data could be changed and based on these changes system answering could be studied. Relations used for normalization of information and calculation of distances are optional and adjustable with the type of information available in the problem. Output can quantitatively show priorities and in fact these quantities are the final weight of items in prioritization. If limitations exist for the problem, with problem solving of linear programming selection among options can be done. However it is recommended that Topsis be used when number of indices and available information is limited and this method is not recommended when the number of parameters is high. Results obtained from AHP seem to be of higher accuracy and reliability as weight and importance of each criterion in each problem is determined in relation with other criteria. So in the present study AHP is more practical and is suggested as the optimum method.

#### REFERENCES

1. Ebrahimi N, Farahani M, Sheikh MJ 2011. Pathology and roots of Claim management process and disagreements solution in design and construction contracts, case study of Oil Ministry contracts. 6<sup>th</sup> international conference of project management.
2. Aboutalebi R, Shakeri A 2013. Identifying factors of contractors' claims resulted from notification of contract termination in three-factor contracts. 7<sup>th</sup> national congress of

- civil engineering.
3. Asgharpour J 2008. Multiple-criteria decision making. Tehran university publication.
  4. Emam Jome zadeh M 2004. Comparative study of some researches done in project accomplishment systems. 1<sup>st</sup> international conference of project management.
  5. Talkhabi H 2013. Study on causes of contractors' claims and its impact on project costs in country design and construction projects. Master's thesis. School of Architecture. Tehran university.
  6. Plan and budget organization of Iran Islamic republic 1999. Letter of agreement, general and private terms of contracts and their regulations, circular No. 54.842
  7. Shakeri A, Ghorbani A 2006. Study on contract origin of contractors' claims in civil projects. 1<sup>st</sup> national conference of Contracting system development in country industrial structure. Tehran. Sharif industrial university. The Headquarters of The Islamic Summit.
  8. Shakeri A, Sajjadi S 2013. Comparative study among three general terms of three-factor, local design and construction and industrial design and construction in changes range in projects. 7<sup>th</sup> international conference of project management.
  9. Ghorbani M, Salahshoor J 2014. Effective method of evaluation of contractors' financial claims in construction projects of government buildings. 1<sup>st</sup> National Conference on Architecture, civil engineering and environment, Hamedan, society of Hegmataneh environment evaluators.
  10. Fathi Z 2008. Effective reasons in claims formation in civil projects contracts. Master's thesis, school of civil engineering. University of Science and Technology
  11. Maria. Caroline de Miranda Mota, Adiel Teixeira de Almeida \*, Luciana Hazin Alencar (2010) " A multiple criteria decision model for assigning priorities to activities in project management" International Journal of Project Management 27 (2010) 175–181
  12. Eckert ., C . Zolghadri M., Zouggar S., & Girard P. (2011). Power-based Supplier Selection in product development projects. Computers in Industry, 62(5), 487-500.
  13. Gholipour, Rahmatollah , Jandaghi, Gholamreza (2014) " Contractor selection in MCDM context using fuzzy AHP " Iranian Journal of Management Studies (IJMS) Vol. 7, No. 1, January 2014 pp. 151-173.
  14. Moura H, Teixeira J C. 2007. Types of construction claims: a Portuguese survey. Procs 23rd Annual ARCOM Conference. Belfast, UK.
  15. Nieto Morote, Ana , RuzVILA, Francisco (2012) " A fuzzy multi-criteria decision-making model for construction contractor prequalification" 2012 Elsevier B.V.