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Prioritizing Financing Methods for Dam and Power Plant Projects Using Hierarchical Analysis Process (AHP) Model (Case Study of Dam and Power Plant Projects in Iranian Water and Power Resources Development Company)

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ABSTRACT: Today there are many methods of financing in the world and every country selects its convenient financing methods according to its economic and political relations and technological and technical conditions and management skills. Due to the many constraints, developing countries must act with greater sensitivity, so that projects can be completed in the desired time and with optimal and economical cost. This paper aims to briefly review the theories, methods and concepts of financing to take a step toward understanding the financial situation and choosing the best and most useful techniques. For this reason, Hierarchical Analysis Process (AHP) Model was used which is one the most comprehensive systems designed for multiple criteria decision-making. After forming a tree structure of the factors affecting the financing of projects, using Expert choice Software, the weights of criteria were specified. And after ranking the alternatives, appropriate methods for financing the dam and power plant construction projects were prioritized. The research findings showed that among the seventeen major methods proposed for financing dams and power plant projects in Iranian Water and Power Resources Development Co., according to experts, the "financing" factor has the first priority by earning the most points. Also factors like "compensatory transactions", "foreign investment", "sales of assets", "usance", and "BOT contracts" are the next factors in the ranking of project financing methods, respectively.

Keywords: Finance, Financial resources, Financing of project, Project Financing Techniques, Analytical Hierarchy Process (AHP)

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INTRODUCTION

Financing is a branch of economics for providing funds for individuals, businesses and governments (FiruzZare and Borji, 2011). Financial funding is providing the necessary capital for the acquisition of different resources and production factors needed to produce goods or provide the services. In other words, funding means providing the required capital for investment in economic projects (Ershadmanesh et al, 2007). Methods and financial resources of energy projects in developing countries have changed significantly in the past two decades and due to these improvements, financing methods have become very diverse (Razavi, 2011). And with regard to Developing countries special situation and financial crises, it is hard to find financial resources for implementing mega projects. So applying another method that is outdoor capital resources would be considered in these countries (Park, 2003). In an overall classification, financing tools and methods can be classified into either funded domestically or foreign financing. This type of financing is classified according to the location of financing (FiruzZare and Borji, 2011). It is evident that financing is possible through various means including external debt, using domestic savings, attracting foreign investments and so on (Danning, 1998). If we accept that domestic savings in developing countries are not able to cover the gap between investment and savings, and their investment and stocks are also in their infancy and without complete stability, then one must use the technique for attracting foreign investments (Talebi et al, 2008).

In Iran, the study of legal history for promoting the financing of projects with the goal of their timely completion shows that the rules in support of investment in general and some parts of the rules of investment in large and infrastructure projects have been specifically developed and some of them have been approved; Also, as mentioned in the laws of the Fifth Plan of Development and the annual budget laws, using the methods of financing (borrowing and non- borrowing method) have also been the focus of attention. Therefore the in explanations for the performing (financing) of major and infrastructure projects, it is necessary to use financial resources other than the approved budget lines such as the following. Here comes the question "What is the most appropriate procedure of financing dam projects?" The main objective of the present study is identifying the optimal methods of financing with the approach of dam projects using Analytic Hierarchy Process (AHP) method.

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Literature

About the methods of financing a variety of construction projects and the techniques to prioritize them, some research has been carried out by Iranian and non-Iranian researchers. Among the most important projects outside Iran and the methods of financing, we can refer to be "NAM THEUN 2 dam and power plant in Laos". This hydroelectric power plant was constructed in (2005). The project sponsors were mostly the Asian or European investment banks; contracting companies and also financial institutions were from the European countries. Resources to finance the project were funded 69% through loan and the remaining should be provided by the Lao government and this share should be provided in various ways (Robinson, 2009).

Construction of the dam in Iran began in 1950. Fourteen large dams in Iran were constructed with the help of foreign engineers and consultants during the two decades before the revolution. In the post-Islamic revolution (1979), in Iran, there was a substantial power and capacity in dam building, and by strengthening some companies under the contract, 200 contractor companies, 70 consultant companies and 30 large companies have emerged. Also during this period, hundreds of hydroelectric power generating units has been established in Iran within less than three decades. In Table 1, the number of dams in Iran after the Islamic Revolution can be seen province by province.

Table 1. shows statistics on the number of dams separated by the administration system in various stages of sources (Http://Daminfo.wrm.ir).

Executive Organization	Feasibility Study	Executive	Utilization	Total	Executive Organization	Feasibility Study	Executive	Utilization	Total
Ab-Mantaghei Azerbaijan, East	46	12	60	118	Ab-Mantaghei Kurdistan	19	6	6	31
Ab-Mantaghei Azerbaijan, West	31	9	22	62	Ab-Mantaghei Kerman	9	2	5	16
Ab-Mantaghei Ardabil	24	7	24	55	Ab-Mantaghei Kermanshah	21	9	6	36
Ab-Mantaghei Isfahan	24	2	18	44	Ab-MantagheiKohgiluyeh and Boyer-Ahmad	20	2	2	24
Ab-MantagheiIlam	8	5	2	15	Ab-MantagheiGolestan	8	1	14	23
Ab-MantagheiBushehr	6	1	1	8	Ab-MantagheiGilan	8	4	1	13
Ab-Mantaghei Tehran	5	3	7	15	Ab-MantagheiLorestan	28	9	3	40
Ab-MantagheiChaharMahaal and Bakhtiari	12	4	5	21	Ab-MantagheiMazandaran	10	2	10	22
Ab-MantagheiKhorasan, South	8	3	13	24	Ab-MantagheiMarkazi	13	1	16	30
Ab-MantagheiKhorasan, Razavi	29	3	41	73	Ab-MantagheiHormozgān	6	1	10	17
Ab-MantagheiKhorasan, North	10	5	7	22	Ab-Mantaghei Hamadan	8	5	5	18
Ab-MantagheiZanjan	30	5	16	51	Ab-Mantaghei Yazd	1	1	2	4
Ab-MantagheiSemnan	3	1	6	10	Ab-Mantaghei Khuzestan	20	5	7	32
Ab-MantagheiSistan and Baluchestan	22	4	21	47	Sistan Water and Soil Development	0	0	1	1
Ab-Mantaghei Fars	8	7	8	23	Iranian Water and Power Resources Development Company	26	11	7	44
Ab-Mantaghei Qazvin	9	2	0	11	JahadeKeshavarzi	58	6	298	362
Ab-Mantaghei Qom	14	0	3	17	OmranRafsanjanInstituion	1	0	0	1
Total						545	138	647	1330

Also the dams under study are: Roodbar dam, Aligoodarz dam, Bakhtiari dam, Karun 4 dam, Siahbisheh dam, Seymare dam and Upper Gotvand dam. Review of the dam funding related to Azad dam during 2004 to 2012 indicates that about 47 percent of the financing of the dam has been supplied through bonds and 53% was supplied through public resources. In Bakhtiari Dam also 47.95 percent of financing was provided through public sector, 10.4% was provided by the domestic sector and 41.65% was funded by bonds. In Darian dam, (41.44) percent of financing was provided through public sector, 0.2% was provided by the domestic sector and 58.36% was funded by bonds. In Khersan Dam, 83 percent of funding of project was provided through the public sector and 17 % was supplied through internal resources. Financing of Lorestan dam was provided through public sector (27.7%), domestic resources (6.23%), financing (40.3%) and bonds (25.77%). About Zhaveh dam also 57.27 percent of financing was provided through public sector and 42.73% was provided by bonds. About Sardasht dam 47.59 percent of financing was provided through public sector and 0.3% was provided by the domestic sector and 52.1% was funded through bonds. In Siahbishe dam, 15.16 percent of financing was provided through public sector, 73.14% was provided by the domestic sector and 5.3% was provided by foreign exchange reserves, 5.02% was finance and 1.35% was funded through long-term bank loan.

MATERIAL AND METHODS

In terms of the objective, the present research is an applied one and in terms of its nature, it is analytical - descriptive. Statistical population in this study consists of deputies, senior managers, financial managers and generally the experts in the field of finance in dam

projects being constructed by Iranian Water and Power Resources Development Company which are 38 subjects. Because the study statistical population has not a homogeneous composition and features different and uncommon (level of experience, education, etc.) characteristics; therefore inappropriate random stratified sampling technique was selected. But in this research, in order to ensure a greater certainty and the proximity of the sample to the statistical population, the entire statistical population was considered as the sample size. The general practices related to financing in this research were divided into four general categories and the limiting factors related to the projects financing were compared to and ranked according to these four general criteria. Also, 17 more operational procedures associated with funding the projects were compared with the six limiting factors in a pair-wise manner and then were ranked. Detailed explanation of the criteria and variables of the study can be found in the following.

Table 2. Classification of general and operational methods of financing (source: author's studies)

No.	Methods	General and operational methods of financing
1	Domestic Short-Term Methods	Trade Credits، Short-Term Bank Loans ، Issuing Commercial Documents, Financed through collateralization of accounts receivable
2	Domestic Long-Term Methods	Long-Term Bank Loans ، Long-Term Lease , Common Stocks , Preferred Stocks ، Bonds، Calls،Credit Instituions Loan، Converting Assets into Securities
3	Foreign Debt Methods	Finance Foreign Financial Institutions and Banking , Facilities ، Usance، Credit Lions
4	Foreign non-Debt Methods	Compensating Transactions , BOT Contracts Foreign Direct Investment (FDI) , Foreign Portfolio Investment (FPI)

All the factors, criteria and methods have been set up and structured in three levels (based on the overall objectives of the study) and in the form of a tree structure; thereby the required conditions and context have been prepared for pair-wise comparisons and therefore the calculation of the final weights and they were ranked. The study data collection resources were library-based, documentation, technical reports, essays and dissertations that can be derived by means of field observations for necessary items. Also, in the course of completing field studies, a questionnaire was used besides the observation tool.

In order to prioritize and rank the factors and methods of financing the projects, AHP model was used. Hierarchical Analysis Process or AHP is one of the most comprehensive systems designed for aware and multi-criteria decision-making (Moosakhani et al, 2009), because the technique provides the possibility of formulating the problem as a hierarchy (Sameti et al, 2003). And moreover, it has the possibility of considering different quantitative and qualitative criteria in the problem. The process involves different options in decision-making has the possibility of sensitivity analysis on the criteria and sub- criteria. Additionally, this method is based on pair-wise comparison which facilitates the judgment and calculations. Final weights of the factors and criteria in this model are based on hourly points (points ranging from 1 to 9) (Saaty and Vargas, 1994). And shows the incompatibility and inconsistency of the decision that are the privileged benefits of this technique in multi-criteria decision-makings (Ghodsipour, 2006).

RESULTS

Analysis of the general characteristics of the respondents

In the present study, (31) respondents to the questionnaire were male and three were female. In terms of literacy rate, 38 percent of the subjects had bachelor degree and 62 percent had a master's degree. In terms of work experience, 1 individual had an experience record of less than 5 years, 2 individuals had (6-10) years, and 8 individuals and 23 individuals had (11-15 years) and (+15 years) work experience, respectively.

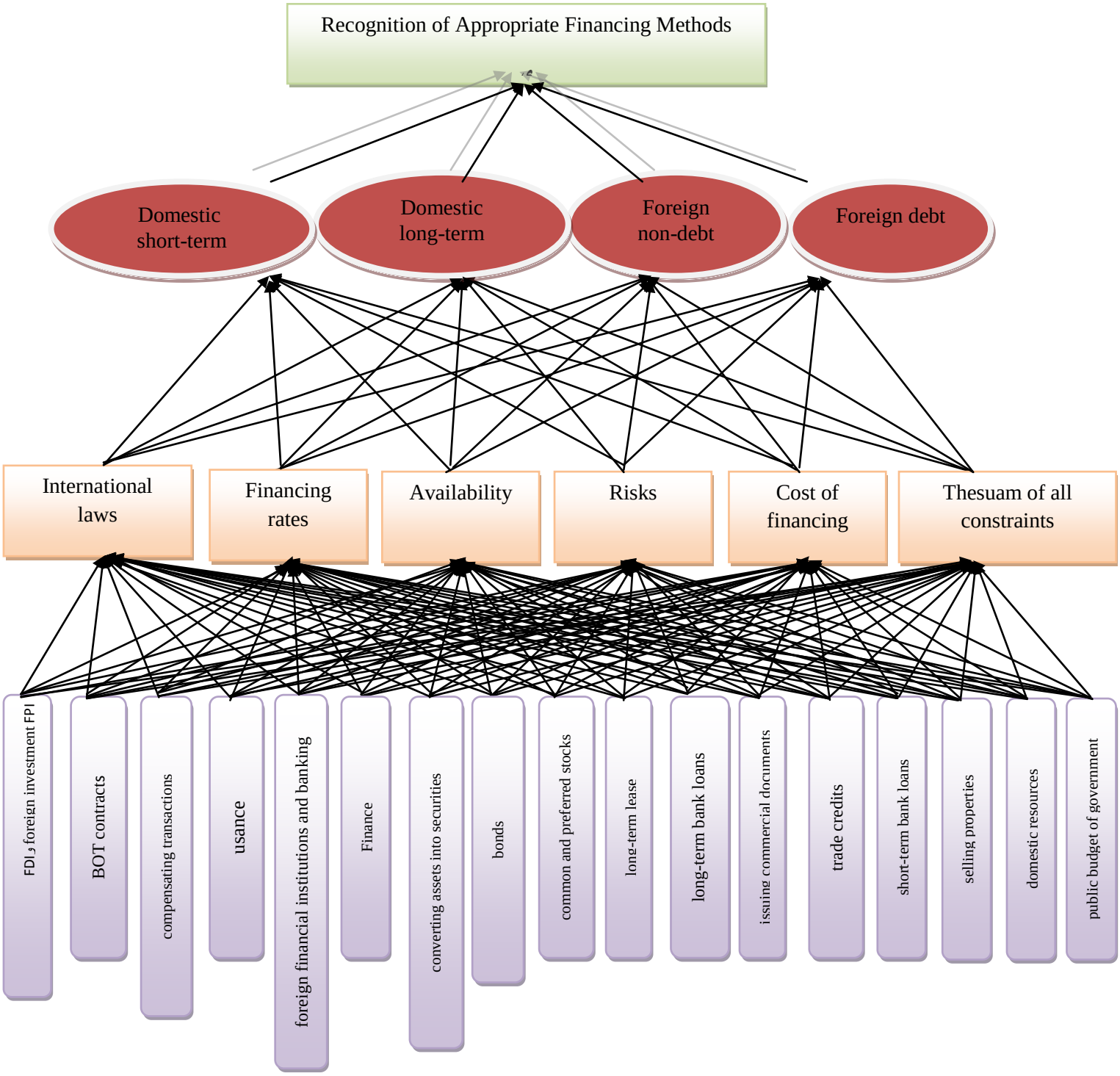
Also in terms of age, (2.94) % of the subjects were aged less than 30 years. Also (23.52) percent of respondents were in the age range of 30-39 years, (55.88%) were in the age range of 40 -49 years and finally (17.64 percent) of the subjects had ages of 50 and older.

Ranking the factors, constraints and the methods of financing in dam and power plant projects of Iranian Water and Power Resources Development Co.

After analyzing the factors influencing financing in dam and power plant projects of Iranian Water and Power Resources Development Co. by asking the viewpoints of professionals and technical experts, using Analytical Hierarchy Process (AHP), we proceed to prioritize these factors. Therefore, after identifying the factors affecting the financing of construction projects, the first step was to design a tree structure. As can be seen in the schematic diagram 1, the tree structure of the current study was designed in order to respond to its questions in four levels and the points related to the factors and sub-factors were determined (Schematic diagram 1).

Based on the tree structure of the study model, the major affecting sources and funding the construction projects are divided into four categories (foreign debt, foreign non-debt, domestic short-term, domestic long-term), so that each of the main methods has their own applications. Each of these general factors is affected by six sub-factors affecting on financial resources and these six sub-factors constitute the third level of the tree structure. Finally, each of these six factors is also influenced by seventeen sub-factors which is the fourth level of the research tree structure.

Figure 1. Research tree structure



In the present study, using the analytic hierarchy process (AHP) model and using the standards of the first level (foreign debt, foreign non-debt, domestic long-term, domestic short-term) and the second-level factors(cost of financing, risks, availability, financing rates, international laws, the sum of all constraints) and also the affective third-level factors related to access to the second level factors(public budget of government, domestic resources, selling properties, short-term bank loans, trade credits, issuing commercial documents, long-term bank loans, long-term lease, common and preferred stocks, bonds, converting assets into securities, finance, foreign financial institutions and banking facilities, usance, compensating transactions, BOT contracts , foreign investment), we proceeded with prioritization of influencing factors and resources in financing dam and power plant projects of Iranian Water and Power Resources Development Co. First, using pair-wise comparisons questionnaire, the ideas of experts was determined about the importance and priority of each criterion and sub-criterion in comparison to the higher levels and pair-wise comparisons. Then, using hierarchical analysis process (AHP) technique and in the medium of Expert Choice software, the coefficient of each of the methods of financing project was determined (Diagram 1) and then we proceeded to rank and prioritize the factors affecting on the financing of dam

and power plant construction projects of Iranian Water and Power Resources Development Company.

As shown in Table 3, based on hierarchical analysis model output, the final weights of each of the seventeen practices and procedures of financing the projects of dam and power plant projects of Iranian Water and Power Resources Development Co. are visible (based on the six influential comparative criteria in funding the projects).

Table 3. The final weights of the Financing Methods of funding construction projects based on the (AHP) model

Comparison of the measured / The final weights of the Financing Methods the projects of dam and power plant projects of Iranian Water and Power Resources Development Co.

No.	*Methods*	Cost of Financing	Risks	Availability	Financing rates	International laws	The sum of all Constraints
1	Public Budget of Government	0.07905	0.08787	0.04054	0.03109	0.01587	0.04828
2	Domestic Resources	0.07905	0.08612	0.02703	0.02073	0.01587	0.04253
3	Selling Properties	0.07115	0.07909	0.01351	0.01036	0.01587	0.03448
4	Short-Term Bank Loans	0.03162	0.02636	0.12162	0.05181	0.01587	0.05172
5	Trade Credits	0.05929	0.07909	0.06757	0.06218	0.01587	0.05977
6	Issuing Commercial Documents	0.03953	0.04394	0.01351	0.01036	0.01587	0.02299
7	Long-Term Bank Loans	0.06719	0.03954	0.13514	0.06218	0.01587	0.06207
8	Long-Term Lease	0.05929	0.04833	0.08108	0.04663	0.01587	0.04943
9	Common and Preferred Stocks	0.05138	0.08260	0.09459	0.05181	0.01587	0.06437
10	Bonds	0.07510	0.07469	0.09459	0.07772	0.01587	0.06897
11	Converting Assets into Securities	0.03162	0.06591	0.05405	0.04145	0.01587	0.04713
12	Finance	0.05534	0.00879	0.06757	0.09326	0.14286	0.06897
13	Foreign Financial Institutions and Banking Facilities	0.04743	0.01757	0.05405	0.08808	0.13492	0.06667
14	Usance	0.03953	0.02636	0.05405	0.07254	0.11905	0.06207
15	Compensating Transactions	0.07115	0.08436	0.04054	0.09326	0.14286	0.08851
16	BOT Contracts	0.07905	0.07909	0.02703	0.10363	0.12698	0.08391
17	Foreign Investment	0.06324	0.07030	0.01351	0.08290	0.15873	0.07816
Random index(RI)		0.0205	0.0587	0.0389	0.0247	0.0302	0.0484

Histogram 1. Ref: Base on Specialists opinion and Analytic Hierarchy Process results

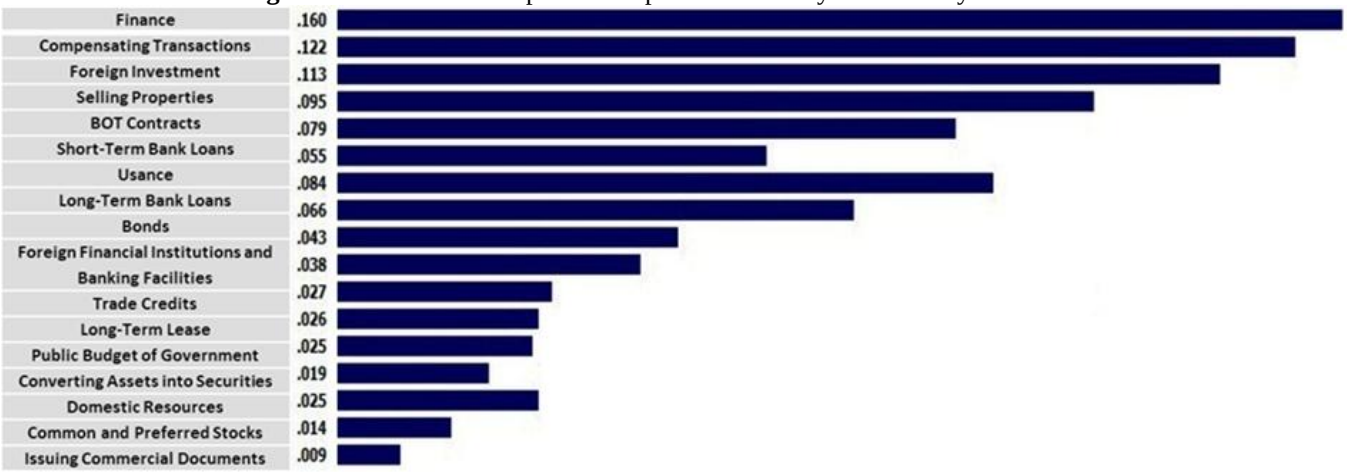


Table 4. The final weights of the factors and constraints of funding construction projects based on the (AHP) model

No.	Control indexes/ factors & restrictions	Foreign debt	Foreign non-debt	Domestic long-term	Domestic short-term	Total scores
1	The sum of all Constraints	0.394	0.153	0.385	0.311	1.243
2	Financing Rates	0.265	0.378	0.101	0.096	0.84
3	Cost of Financing	0.030	0.084	0.236	0.228	0.578
4	Availability	0.103	0.102	0.104	0.229	0.538
5	Risks	0.154	0.246	0.042	0.042	0.484
6	International laws	0.054	0.037	0.131	0.110	0.332
Random index(RI)		0.0307	0.0506	0.0102	0.0204	

Source: author's calculations based on experts' opinions and the output of AHP model

Based on the output of the hierarchical model, the main proposed method for financing dam and power plant projects of Iranian Water and Power Resources Development Co. is the "Finance" factor with the final point of (0.160) which was ranked in the first priority based on the viewpoints of the experts. Also, the factors of "compensating transactions", "foreign investments", "sale of assets","Usance ","BOT contracts" and " Long-Term

Bank Loans"Were ranked after the mentioned factor with the final scores of (0.122), (0.113), (0.095), (0.084), (0.079) and (0.066), respectively. Finally, based on the output of the combined model of the research, in terms of the viewpoint of the associated experts and specialists, among the financing methods of dam and power plant projects of Iranian Water and Power Resources Development Co. the factors of "issuing commercial papers", "common and preferred stocks" and "domestic resources" had the lowest final score of 0.009, 0.014 and 0.025, respectively and therefore had the least importance in financing of projects.

Also based on four control measures (which constitute the major sources of financing construction projects), the final weights of factors affecting the financing of dam and power plant projects of Iranian Water and Power Resources Development Co. were also determined based on the experts and specialists opinions.
As, it is visible from the ranking Table 4, it can be stated that among the six factors limiting the major sources of financing in dam and power plant projects of Iranian Water and Power Resources Development Co., the factor of (sum of all constraints) or in other words, the combination of all limiting factors and considering them as a whole according to the concerned experts and specialists is regarded as the most important factor limiting the financial resources of projects. In this way, the factors of "the level of financing", "financing costs" , "availability" and "risk" are the next factors in the ranking of constraints and limitations of financial resources dam and power plant projects of Iranian Water and Power Resources Development Co. with the scores of 0.84, 0.578, 0.538 and 0.484, respectively. Finally it can be stated that among the factors and limitations of financial resources of projects, the factor of "international laws", by earning 0.332 points has the minimal impact.

CONCLUSION

Based on the experiences of different countries and also the executive experiences in managing construction projects in Iran, this research primarily tried to identify and classify the general criteria affecting the financing of projects.

Therefore, based on their endogenous or exogenous origin, financial resources of construction projects are categorized into four general categories. With regard to infrastructural and development programs of developing countries and the shortage of resource in these countries, it is infeasible to provide the required capital to perform big construction projects easily. Therefore, selecting the appropriate financing method for foundational plans and projects is of utmost importance. In some projects, the required funds can be provided by the governmental credits and support, but in important and infrastructural projects, it is not possible for the government to fund all the required funds. In addition, it should be noted that the structure used for financing the projects in a country may not be effective due to differences in its rules and conditions, while it may be used effectively in another country. The important point is selecting the correct procedure of financing according to the conditions of each project and also the conditions of the host country of the project. Foreign investment is one of the methods of financing and countries like China, India, U.S.A., Russia and Brazil are the countries with a better context to attract foreign investments, respectively. Therefore, more investment will happen in these countries. Then the main limiting, encouraging or affecting factors in financing dam projects were identified and classified into seven categories. And finally, after the identification and classification of operational-executive practices and procedures of financing projects in seventeen approaches, we proceeded to rank them. The results of the calculations and the final output of the Hierarchical Analysis Process model on the limiting ranking of projects financial resources suggested that according to the opinions of experts, technicians and skilled people, the factor of "composite index", in other words a combination of limiting factors and considering them as a whole according to experts, is the most important limiting factor among the six major factors limiting the financing of dam and power plant projects of Iranian Water and Power Resources Development Co. After the composite index, the financial resources of projects are the main limiting factors; therefore, the factors of "The amount of Finance", "financing costs", "availability" and "risk" are in the next ranks of factors and financial constraints for dam and power plant projects of Iranian Water and Power Resources Development Co. The "International law" has the minimal impact on the projects financial resources limits.

Also in the ranking of the 17 methods, the model output (Diagram 1) showed that based on experts' and specialists' opinions, the "finance" factor has the first priority with a final score of (0.160)Followed by that are the factors of "Compensative Transactions", "Foreign Investment", "Sales of assets" , "Usance", "BOT Contracts" and " Long-Term Bank Loans "in the ranking of practices of financing dam and power plant projects of Iranian Water and Power Resources Development Co.

In this study, using comparison with other countries, an appropriate model has been provided for financing dam and power plant projects of Iranian Water and Power Resources Development Co. For large and medium scale construction projects the infrastructure of which is still under the ownership of Iranian government, some methods should be used the ownership of should be for the government, so finally the risks may become lower. Based on the experiences of foreign countries as well as other projects in Iran, what was more common was that, for the development and exploiting construction projects, one method that can be introduced is using the model of arranged credit lines by the government with governmental ownership. In order to supply equipment and facilities of public services, the government can also act based on general participation (selling bonds or other policies).

Of course, it is noteworthy that due to current political and economic problems in Iran, such as international sanctions, inflation, etc., implementation of some new financing methods in Iran would be difficult and first the appropriate context should be prepared. Appropriate political and commercial relations should be established in Iran, so that the methods implemented in other countries which have brought about the development of construction projects, can become applicable in Iran. Although the amendment and changes of the fifth development programs, Principle 44, includes some rules to promote investment in construction projects in Iran, some plans and policies have been carried out to implement the increased investment, but it is not enough to make the modern methods, efficient. It is obvious that policies, programs and strategies taken for financing of various projects are influenced by two general attitude and basic approaches to the issues of economic development. Therefore if the preferred aspect is inclined toward a contrast/ interaction between an exogenous and endogenous nature in the economic development, we will observe profound changes in the method of funding the construction projects as well. Improving the political and commercial relations of Iran with an emphasis on friendly politics (in contrast to oppositional policies) and attracting foreign financial resources (both borrowing and non-borrowing) considering the national interests, is a view that is more outward looking and relies on using the capabilities, abilities and the experiences of foreign countries. Another aspect of economic development that can have a dramatic effect on the funding of projects is concentration on endogenous development and relying on domestic capabilities and potentials. Interpretation of factors and practices will be also different with respect to this approach.

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