

Development of Comprehensive Water Resources Management Plan using SWOT Model

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Abstract

In strategic management it is necessary to step forward with a strategic approach. One of the important steps in using water resources strategies is to determine and formulate them; there are different methods and models for this purpose, each of which has a specific concept and insight, and the technique and instructions specially follows. Among them, the SWOT matrix that evaluates the strengths, weaknesses, opportunities and system threats is more common and popular. Therefore, in the present study, for the purpose of strategic management of water resources, using the SWOT strategy development method, we will develop appropriate strategies. In this regard, the use of Hurricane method, which is one of the group decision making methods, has been used to extract SWOT matrix factors and then, by examining the importance factor and rank of these factors, using the quantitative strategy planning matrix of the well-known superior strategies group and its strategies will be extracted. In this research, in order to extract strategies for water resources management, a SWOT strategy has been used. Using a quantitative strategy planning matrix, the best group of strategies is selected by examining the internal and external factors affecting the four groups of watersheds. Slowly To this end, at first weaknesses, strengths, opportunities and threats have been extracted by experts and experts in the water area, as well as a review of the studies in that area, the method of storm and group decision making, and then the coefficient of importance and rank of each One of the factors was determined in the assessment matrix. According to the results, the weaknesses overcome the strengths and also water resources are more threatened than opportunities. Hence, strategies of the WT group (defensive strategies) were identified as selected strategies in this way, which allows them to achieve the goals and prospects of water resources.

Keywords : Water resources management, strategic analysis, SWOT matrix, and brainstorming

I. Introduction

Water is a fundamental natural resource that influences social progress and economic development [I, II]. Today, one of the major challenges facing developing countries in the world is to focus on preserving water resources and protecting and optimizing their exploitation, while addressing development infrastructure in these countries. Management and planning have a variety of levels that are

the highest-level strategy and have a long-term role in resource expertise and decision making. Strategic approach to water resource management, based on the sum of perspectives, policies, structures and systems in this field, will prevent future sudden events and the occurrence of critical situations and will lead to sustainable development of resources. In strategic management it is necessary to step forward with a strategic approach. One of the important steps in using water resources strategies is to determine and formulate them. There are various methods and models for this purpose, each of which has a specific concept and insight and follows a special technique and instructions [III]. In recent years, reduction of water losses has been considered as one of the most strategic and economical ways of dealing with water deficit in Iran. One of the most important reasons for this would be the heavy costs of constructing and maintaining structures for controlling and maintaining surface water such as dams and gutters or facilities for extracting water from underground resources such as pumps and water transmission lines or the cost of water purification and sanitation. The other issues that cause the conservation and maintenance of water in the network as one of the low-cost solutions in water projects to be taken into consideration by water and wastewater companies. Iran is located in the dry and semi-arid climates of the world due to low rainfall and inappropriate distribution of its temporal and spatial distribution. In this context, demand for water is increasing day by day due to population growth, urbanization and the development of agricultural and agricultural sectors [IV, V]. One of the important steps in using water resources strategies is to determine and formulate them; there are different methods and models for this purpose, each of which has a specific concept and insight, and the technique and instructions specially follows. Among them, the SWOT matrix evaluating the strengths, weaknesses, opportunities, and system threats is more common and popular [VI]. Management and planning have a variety of levels that are the highest-level strategy and have a long-term role in resource expertise and decision making. Strategic approach to water resource management, based on the sum of perspectives, policies, structures and systems in this field, will prevent future sudden events and the occurrence of critical situations and will lead to sustainable development of resources. In strategic management it is necessary to step forward with a strategic approach. A strategic approach in its own sense is to rely on positive factors in order to be able to face negative factors and overcome them [VII]. Today, the SWOT approach is used as a tool for the analysis of functions and the formulation of a water resource strategy by designers and strategy assessors [VIII]. Also, Ebonzo et al (2013) acknowledged that strategic planning should consider all effective factors as part of strategic planning within the framework of the SWOT analysis methodology. The SWOT approach examines all internal and external factors affecting water resource strategies that lead to sustainable water resource development [IX]. Due to the application of SWOT strategy formulation in water resources management can provide acceptable results, in this research the strategic management of water resources Bushehr province that always faces a shortage of water resources, using this method to derive strategies is proportional to the area. In this regard, the method of brainstorming is a group decision-making procedure and to achieve the vision of the area has been derived factors SWOT matrix and then index and rank the importance of these factors. Quantitative Strategic Planning Matrix strategies using the best-known group and strategies will be extracted [X].

Among the applications of this technique in the field of water resources management can be done by Galkv - Ayala et al (2011) noted which utilizes the SWOT method to derive strategies in integrated management of water resources in Mozambique has the results of this study indicate the need for strategic management by a combination of factors is involved in the opportunities and threats SWOT group [XI].

II. Research background

Nejadirani et al (2014) in a study entitled "investigating value engineering impact on organizational performance" a case study from the Department of ater and Wastewater West Azerbaijan province, review value engineering and its impact on organizational performance in West Azerbaijan province have addressed the General Directorate of Water and Wastewater in West Azerbaijan province. This research based on SR operational model of value engineering and operational model of organizational performance Kaplan and Norton has been done. The results of this study show variable value engineering as the independent and organization performance with function variable with normal distribution is not significantly different and has normal distribution [XII].

It can be said that one of the main problems of water management in country is failure in decision-making and water management decision-making process, especially in the field of non-compliance prioritize projects for study and especially the lack of terms and conditions of selecting projects for various purposes, including financing plans, water allocation and other things like that [XIII].

Zhao et al. [14] modeled a comprehensive evaluation index considering water quality, water quantity, population density, and GDP standards to obtain water resources risk levels. Gong et al. [XIV] established a fuzzy comprehensive evaluation model to evaluate water resources capacity and related dynamic trends, providing insights for scientific water management policies. Khalifipour et al (2012) had done SWOT analysis regarding the urban management approach for Isfahan City in Iran. Based on our findings the location of city in country, rich cultural history and civilization, various historical attractions, The presence of Zayanderood river in Isfahan are the most strengths factors which can make great opportunities for tourist attractions, however the high rate of urban expansion and industrial development, increasing water demands and degrading Zyandehroud water quality, air pollution and heavy traffic, high rates of immigration to the city, Landuse/cover change and natural habitats fragmentation should be considered as weaknesses and threats for strategic environmental planning [XV].

Mousavizadeh et al (2015) to derive strategies in management of water resources, SWOT strategy formulation technique which is used by internal and external factors affecting watershed groups, mining strategy and quantitative Strategic Planning Matrix using the group selects strategies. According to the results, the strengths and overcome their weaknesses and water resources with more threats than opportunities facing. The Strategies Group WT (defensive strategy) selected in this way were identified as strategies to implement them, possibility of achieving the goals and vision of providing water [XVI].

Damani and Hashmi (2017) perform strategic analysis on water resource management in Iranshahr city using SWOT approach. Based on results of the study, the final score of internal factors is 2.65 that reflects the relative strength across the region and final score of external factors is 2.18 that indicates the relative threat across the region. As a result, water resource management in Iranshahr city is in a competitive strategy state [XVII].

Therefore, in the present study, SWOT strategy development method used for strategic management of water resources. In this regard, the SWOT matrix factors are extracted using the brainstorming method, which is one of the group decision making methods. Then, by examining the importance factor and rank of these factors, using the strategy of quantitative strategy matrix, a group of well-known strategies will be identified and its strategies will be extracted.

III. Methodology

This research method and the analytic field are done by using SWOT. A questionnaire survey of experts and professionals has been used in the water sector that their number is 40. The questionnaire consists of five sections, the first section of information respondents and in other four parts of a total of 26 items, including 11 weaknesses, 5 strengths, 5 opportunities and 5 threats. Identified the strengths, weaknesses, opportunities and threats in the study area during the field study was conducted in two stages. The first stage of the interview strengths and weaknesses, opportunities and threats were identified with the help of experts. In second stage, based on data collected from a questionnaire in order to determine the coefficients and setting out internal and external factors assess sample analyzes. At the end of the relevant questionnaire to collect, collate and conclusions were based on this information and analysis to help develop appropriate strategies and SWOT, David was presented.

SWOT analysis

1. Gather the required information
2. Collect a group of experts for water as a group decision
3. A report to learn more about the band and explain the objectives and prospects for regional development
4. Brainstorm to identify internal factors (strengths and weaknesses) and external factors (opportunities and threats)

Input stage: In this stage the main factors required information from inside and outside the organization to develop strategies identified and characterized. This phase includes the evaluation matrix of internal factors and external factors evaluation matrix.

Matching stage: In this stage the main internal factors (the swan and weaknesses) and external main factors (opportunities and threats); using tools such as SWOT matrix (SWOT) and internal and external matrix (EI) are adapted to identify strategies that are related to the internal and external factors.

Decision-making stage: In this stage using Quantitative Strategic Planning Matrix (QSPM) different options strategies identified in the implementation phase, evaluated and judged and determined their relative attractiveness.

The input stage

A) Internal factor evaluation matrix (IFE)

Internal factor evaluation matrix is the result of a strategic review of internal factors. The matrix formulation and evaluation is the strengths and weaknesses of the original.

Table 1. Analysis results of internal factors (strengths and weaknesses)

No	Strengths	Significant coefficient	Rank	Weighted score
S ₁	The development of artificial aquifer feeding plans and the existence of wells and aqueducts by creating the necessary substrates	0.043	3.4	0.132
S ₂	Developing industries, mines and ecotourism by creating the necessary platforms	0.036	3.2	0.121
S ₃	Study, technical and executive capacities and the possibility of developing new methods	0.040	3.3	0.129

S ₄	Use of high waste water	0.044	3.6	0.148
S ₅	Use alternative water sources based on old traditions	0.043	3.5	0.154
No	Weaknesses	Significant coefficient	Rank	Weighted score
W1	Lack of proper management of the urban rehabilitation system	0.039	1.1	0.055
W2	Lack of proper culture of water consumption	0.038	1.2	0.050
W3	Lack of irrigation system suitable for agriculture	0.042	1.6	0.060
W4	Lack of local partnership	0.044	1.3	0.061
W5	The excessive use of fertilizers and pesticides by farmers	0.040	1.5	0.060
W6	Lack of incentive system for employees	0.041	1.6	0.049
W7	Lack of studies in the water and soil	0.043	1.5	0.061
W8	Absence of research institutes in the water sector	0.039	1.3	0.065
W9	Lack of knowledge of water sector problems	0.040	1.4	0.051
W10	Significant growth in the digging of unauthorized wells	0.042	1.5	0.069
W11	Increase illegal use of groundwater resources	0.043	1.5	0.062
Total		2.114		

According to Table 1, if the sum of the final score of the internal factors to be 1.5 to 2.5, it indicates weakness and, if to be 2.5 to 3.5, it means strength. Therefore, the 2.114 number in the table means relative strength.

B) External factor evaluation matrix (EFE)

Evaluation Matrix external factors, external factors are the result of a strategic review. The matrix formulation and evaluation of opportunities and threats is external environment.

Table 2. Analysis results of external factors (opportunities and threats)

No	Opportunity	Significant coefficient	Rank	Weighted score
O1	Ability to use the resources of the watersheds in the vicinity of the catchment area	0.078	3.3	0.242
O2	Access to the market due to the existence of appropriate communication	0.045	3.8	0.211

	networks			
O3	There are laws and regulations on water management	0.121	3.7	0.232
O4	Possibility to use loans and facilities	0.110	3.7	0.301
O5	Increase and improve agricultural practices	0.080	3.1	0.293
No	Threats	Significant coefficient	Rank	Weighted score
T1	Economic fluctuations based on actual water prices	0.056	1.2	0.087
T2	Lack of expert report based on development principles	0.083	1.3	0.099
T3	Lack of resources for water resources development	0.067	1.4	0.078
T4	Lack of an untapped harvesting of water resources	0.087	1.2	0.082
T5	Absence of macro-optimization in optimal water consumption	0.105	1.7	0.095
Total		2.642		

According to Table 2, if the sum of the final score of the internal factors to be 1.5 to 2.5, it indicates threats and, if to be 2.5 to 3.5, it means opportunity. Therefore, the 2.642 number in the table means relative opportunity.

V Results

SWOT matrix

Another use of the SWOT model is that external opportunities and threats are systematically compared with weaknesses and internal strengths in a structured approach. The purpose of this comparison is to identify one of four specific patterns for internal and external position adaptation. It needs to be explained that the strategy of SO strategies is aggressive, WO conservative strategies, competitive ST, and ultimately WT are defensive strategies.

Table 3. Matrix of strengths, weaknesses, opportunities and threats (SWOT)

SWOT	Strengths		Weaknesses	
	S ₁		W ₁	
	S ₂		W ₂	
	S ₃		W ₃	
	S ₄		W ₄	
	S		W	

		S ₅	W5
Opportunity		SO Strategies	WO strategies
O	O ₁	1- Use of science and technology and research in the water industry.	1- Take advantage of the strengths of the opportunities. Prevent unnecessary withdrawal of drinkers
	O ₂	2- Deploys utilization plans for surface water resources, underground.	2- Reducing leakage and losses in the abstraction networks by implementing rules
	O ₃	3- Increase water productivity in agriculture through efficient methods	3- Increasing modern irrigation systems and culture making using it with stakeholder training
	O ₄	4- Stable exploitation of historic blue structures.	4- To prepare a comprehensive plan to prevent the introduction of contaminated water into the natural cycle
	O ₅	5- Reconstruction of the worn water networks	5- Change the irrigation method from the traditional to the new.
			Using the opportunities, weaknesses will be eliminated.
Threats		ST strategies	WT Strategies
T	T ₁	1- Prevention of waste water in water transmission lines and water distribution networks	1- Change water resource management from authoritarian to participatory management
	T ₂	2- Use of water consumption pattern in agricultural sector	2- Increased billing mechanisms (quantitative and qualitative)
	T ₃	3- Determine the environmental environment for drinking water supplies	3- Approval of relevant rules and regulations regarding water resources management
	T ₄	4- Using risk management methods to deal with drought and flood	4- Public awareness for the quantitative and qualitative protection of water and the optimal utilization of water resources
	T ₅	5. Establishing water pricing system based on the cost spent with the productivity enhancing approach	5- Training, deploying and empowering management and human resources in the water sector
	T ₆	Use the strengths to avoid threats.	Reduce your weaknesses and avoid threats
	T ₇		
	T ₈		
	T ₉		
	T ₁₀		
	T ₁₁		

Internal and external matrix

For the simultaneous analysis of the matrix of the same name is used internally and externally. For this purpose the sum obtained from the evaluation of internal and external factors in the horizontal and vertical axes of the matrix can be placed. Typically used as a matrix grid matrix is close correspondence. Score obtained on the basis of internal and external factors, strategies are selected in one of four positions. The priority level determines the type of strategy. Generally, internal and external evaluation matrix is shown in Fig 1.

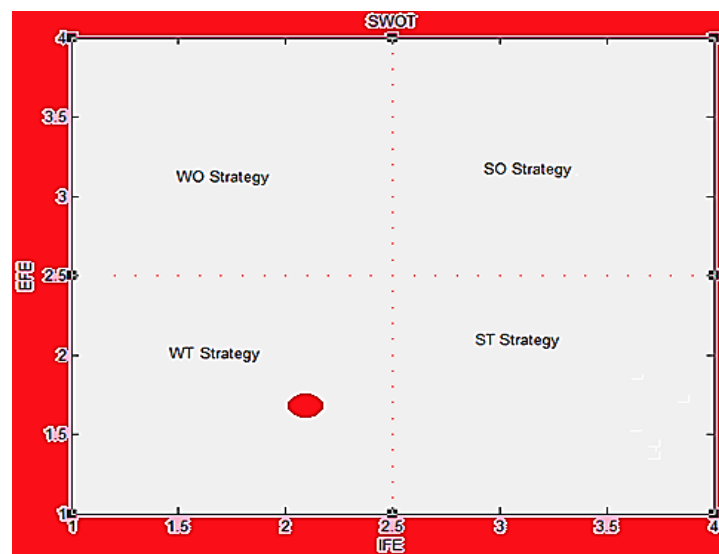


Fig 1. Internal and external matrix (IE)

Based on Figure 1, strategies derived from the combination of weaknesses and threats that form the defensive strategies (WT group) are obtained using the matrix indicated in the figure. These strategies aim at reducing internal weaknesses and avoiding threats from the external environment. In fact, the overall purpose of the strategy, defense (minimum), minimum (which can also be called "survival strategy", is to reduce system weaknesses in order to reduce and neutralize threats, and its defensive state is an organization that has internal weaknesses and faces a lot of threats in the external environment, in a risky position. In fact, such an organization will fight for its survival.

Stages of decision making

Quantitative Strategic Planning Matrix (QSPM)

A quantitative strategic planning matrix is one of the tools or methods that allow strategists to do this. Considering the successful internal and external factors of the organization that have already been recognized, they objectively evaluate the types of possible strategies.

Table 4. Quantitative Strategic Planning Matrix

The main strategic elements	Significant efficient	a variety of applicable strategies (defensive strategy WT)									
		Strategy 1		Strategy 2		Strategy 3		Strategy 4		Strategy 5	
		Interest rate	Score	Interest rate	Score	Interest rate	Score	Interest rate	Score	Interest rate	Score
Strengths											
S ₁	0.043	2	0.09	2	0.09	3	0.13	2	0.09	2	0.09
S ₂	0.036	2	0.07	2	0.07	3	0.11	1	0.04	2	0.07
S ₃	0.040	4	0.16	3	0.12	4	0.16	3	0.12	3	0.12
S ₄	0.044	2	0.09	4	0.17	3	0.13	3	0.13	2	0.09
S ₅	0.043	2	0.09	4	0.17	4	0.17	2	0.09	2	0.09
Weakness											
W ₁	0.041	2	0.08	2	0.08	3	0.12	3	0.12	3	0.12
W ₂	0.041	2	0.08	3	0.12	4	0.17	3	0.12	3	0.12
W ₃	0.048	1	0.5	4	0.19	3	0.15	2	0.1	2	0.1
W ₄	0.037	4	0.15	1	0.04	3	0.11	2	0.07	2	0.07
W ₅	0.030	4	0.12	1	0.03	2	0.06	3	0.09	3	0.09
W ₆	0.038	4	0.15	1	0.04	3	0.11	3	0.11	4	0.15
W ₇	0.050	1	0.05	4	0.2	3	0.13	3	0.13	3	0.13

W_8	0.044	4	0.17	2	0.09	3	0.13	4	0.17	4	0.17
W_9	0.042	2	0.08	3	0.13	4	0.17	4	0.17	4	0.17
W_{10}	0.049	2	0.1	4	0.2	4	0.2	3	0.15	2	0.15
W_{11}	0.041	2	0.08	4	0.17	3	0.12	3	0.12	2	0.08
Total internal score			2.8		2.71		3.05		2.45		2.4
Opportunities											
O_1	0.082	1	0.08	3	0.24	3	0.24	2	0.16	2	0.16
O_2	0.062	2	0.12	1	0.06	3	0.19	2	0.12	2	0.12
O_3	0.081	2	0.16	2	0.16	4	0.32	3	0.24	3	0.24
O_4	0.079	4	0.32	2	0.16	3	0.24	3	0.24	4	0.32
O_5	0.091	2	0.18	3	0.27	3	0.27	3	0.27	3	0.27
Threats											
T_1	0.076	2	0.15	4	0.3	4	0.3	3	0.23	3	0.23
T_2	0.082	4	0.3	3	0.2	4	0.3	4	0.3	4	0.3
T_3	0.073	3	0.22	2	0.15	3	0.22	3	0.22	3	0.22
T_4	0.091	2	0.18	4	0.36	3	0.27	3	0.27	4	0.36
T_5	0.053	2	0.11	2	0.11	4	0.21	3	0.16	3	0.16
total external score	100%		2.49		2.45		3.29		2.86		3.03

Total strategy score		6.32	6.12	7.23	6.56	6.36
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According to Table 4, using the QSPM matrix, the prioritization of strategies that are appropriate to the organization's position (defensive strategies) takes place. There are strategies in the defensive that the organization needs to implement in order to achieve the goals, but the answer to the question of which of these strategies has a higher priority is the opinion of the organization's experts based on the QSPM matrix. In this matrix all the opportunities, threats, strengths and weaknesses of the organization, together with their weight, are of great importance and the decision group attempts to allocate scores from 1 to 4 to each of these factors in the implementation of each strategy. In other words, in this table the decision group determines that the implementation of each strategy up to how much is it to take advantage of strengths and opportunities and to avoid threats and cover weaknesses. Based on the assessment of the defensive strategy scores in the quantitative strategic planning matrix, the strategy for amending and approving the relevant water resource management regulations and regulations was selected as the best strategy. According to the results of this study, the following strategies are recommended as desirable strategies in order of priority:

Table 5. Prioritizing Strategies

Strategy	The interest score of internal factors	The interest score of external factors	Mean Scores
Training, deploying and empowering management and human resources in the water sector	4.12	4.30	8.42
Public awareness for the quantitative and qualitative protection of water and the optimal utilization of water resources	3.40	4.03	7.43
Approval of relevant rules and regulations regarding water resources management	3.45	3.86	7.31
Change water resource management from authoritarian to participatory management	3.80	3.49	7.29
Increased billing mechanisms (quantitative and qualitative)	2.32	2.45	4.77

VI. Discussion and Conclusion

In this study, SWOT matrix was used to formulate strategies for water resource management. To this end, the strategic conditions of water resources are identified and after determining the boundary to distinguish between effective internal and external factors, strengths, weaknesses, opportunities and threats were extracted using group decision making. By using this method and by forming a storm session, 5 strength points, 5 weaknesses, 5 opportunities and 11 threats were identified and extracted. Then, the coefficient of importance and rank of each of these factors were determined in the evaluation matrix. According to the results, the total score obtained from the internal factors estimator matrix is 2.642 and as a result, strengths overcome the weaknesses. Also, the total score obtained from the external factors assessment matrix is 2.114, resulting in less threats compared to the opportunities ahead. By entering the results from the evaluation matrices into the internal and external analysis matrix, WT strategies (defensive strategies) were identified as selected strategies in this method. These strategies include the approval of relevant rules and regulations regarding water resources management, training, deploying and empowering management and human resources in the water sector, public awareness for the quantitative and qualitative protection of water and the optimal utilization of water resources, change water resource management from authoritarian to participatory management, increased billing mechanisms (quantitative and qualitative). Achieving integrated water management with direct participation of economic, cultural, social, infrastructure and services in the watershed of each climatic and environmental zone in order to optimize the utilization of water resources, balance between resources and water consumption, quantitative and qualitative conservation of water resources, observing the rights of all stakeholders (natural and human) and equitable access for everyone to safe and adequate water based on the proper pattern of consumption and value of water in line with national interests and sustainable development of the country.

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