

8- United State Department of Interior Bureau of Reclamation.
“Design of Small Dams”, New York, 1988.

9- Awed Adel. "Dam Impact on Violating the Environmental Balance," Science and Technology Journal, Beirut, Issue No. 17 – 18, 1989. (Arabic).

10-Al-Gunaid, Ahmed Mohamed" Fundamental Criteria for Selection Suitable Dam Sites in Yemen", PhD, Baghdad,2001.

11-Erns, Christian. "Management Expert System", Addition Wesley Publishing Company ,Inc, Workinghom, 1988.

(2) The social factors that affect the selection of dam site are, Citizen desire to accept the project, Establishment of people and preventing migration, right of water distributions in the region and improving the standard living for the individual income.

(3) The computer program that provides the management system with data bases will be extremely useful especially in cases when experts are not available.

(4) Most of the site engineers have a lack of knowledge about the factors that affect the selection of dam site.

consolation is too expensive. This situation is very common in Yemen construction projects.

References

1-Khaudair, Thuban Kadim. *Water Control Engineering*, Dar Al-Shurook, Amman, 1998.

2-Varshney, R.S. and Gupta S.C. "Theory and Design of Irrigation Structure", Vol. II, RoorIndia, 1992.

3- Grishen et al. *Hydraulic Structures*, Moscow,1988. (Arabic Translation).

4- Al-Junied, A.F. "Key Requirements for Dam Construction and their Best Management", NWRA, 2000.

5- Al-Junied Ezzaldin. "Environmental Impacts of Dam Construction, MAI, Dec. 1999.

6- Al-Jailani, Jawid:"Dams Importance for Yemen," Paper presented in the Regional Conference on Dams and Agricultural Development, Sana'a, 25-28 May 1997.

7- Harvey, M. R. *Guide to Site and Environmental Planning*. New York, 1984.

Table 3. program evaluation answers.

Res. no	Experience (year)	Running program	Consider all. factors	Program applicability	Saving in Time & Cost
1	20	Simple/easy	Yes	Very good	Yes
2	15	==	==	==	==
3	13	==	==	==	==
4	12	==	==	==	==
5	10	==	==	==	==
6	10	==	==	==	==
7	10	==	==	Good	==
8	8	==	==	==	==
9	6	==	==	==	==
10	5	==	==	==	==

4. CONCLUSION

Based on the results obtained in this study, the following conclusions are drawn:

(1) The important factors that affect the selection of dam site are: Social factors, Physical factors, Political factors, Economic factors, Environmental and Human factors.

project.	6.45	24.5
Right of water distributions in the region.	7.32	8.8
* Physical Factor, such as:	6.86	8.24
Topographic Factors	6.83	8.22
Hydrologic Factors	6.62	7.95
Geological Factors		
Availability of materials	6.08	26
* Political Factor, such as:	5.59	24
Population social stability		
Providing national security	7.1	19.5
* Economic Factor	6.54	18
Cost of the dam.	5.78	16
Availability of water resources.	5.75	15.8
Cost of operation and maintenance.		
Availability of local labors.		
* Environmental Factors, such as:	6.00	37
	5.13	31.6
	5.08	31.4
Flood mitigation.		
Health improvement.		
Environment recreation.		
*		

$$M = NX100 / \sum N$$

Table (1) percentage of the mean of frequency for collecting data**(Main factors)**

Main Factors	Mean of frequency answers (N)	%of mean of frequency answer (W*)
1- Social Factors	6.94	21
2- Physical Factors	6.76	20.5
3- Political Factor	6.46	19.6
4- Economic Factor	6.43	19.5
5- Environmental Factors	6.35	19.3

$$W^* = N \times 100 / \sum N$$

**Table 2. percentage of the mean of frequency for collecting data
(Secondary factors)**

Secondary Factors	Frequency answers(N)	%Mean of Frequency (M)
* So Social Factors Citizen desired to accept the	7	26.5

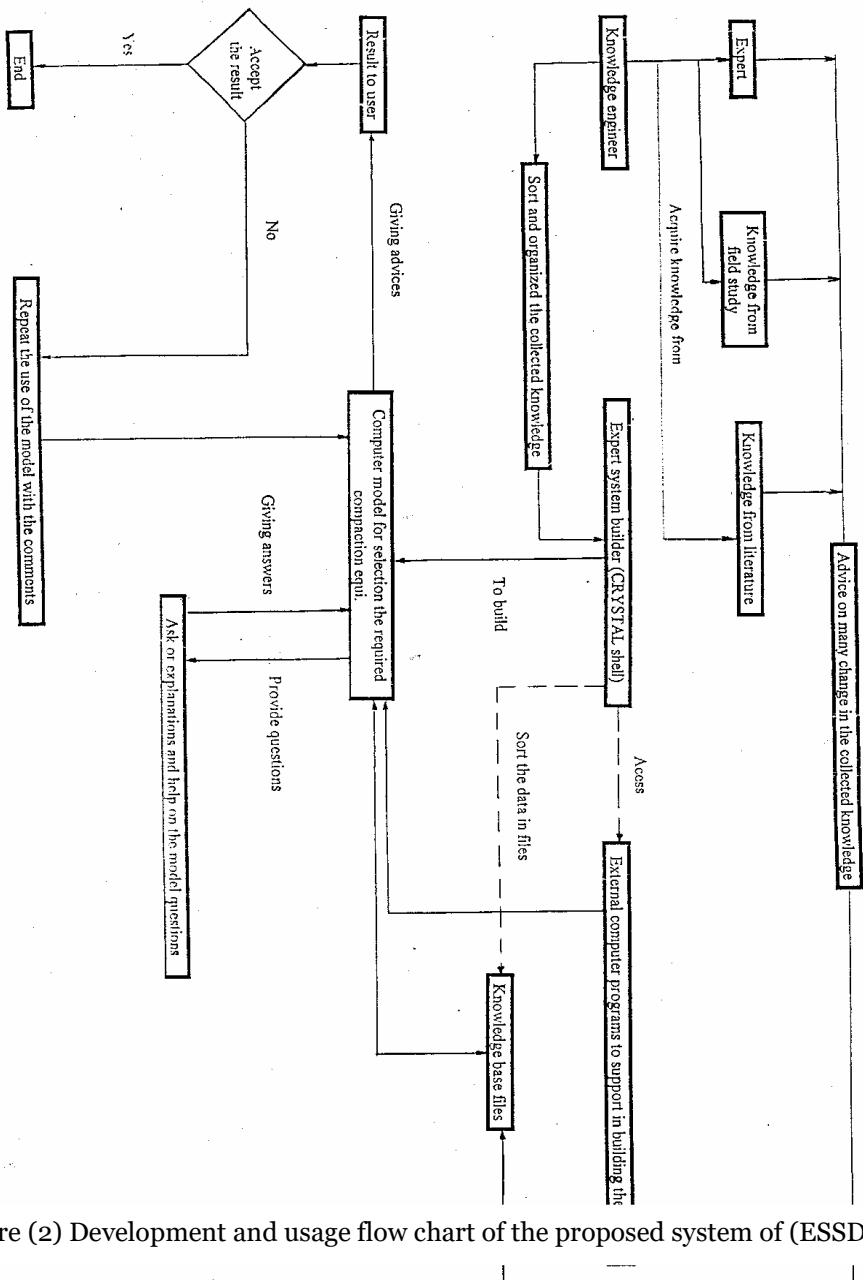


Figure (2) Development and usage flow chart of the proposed system of (ESSDS).

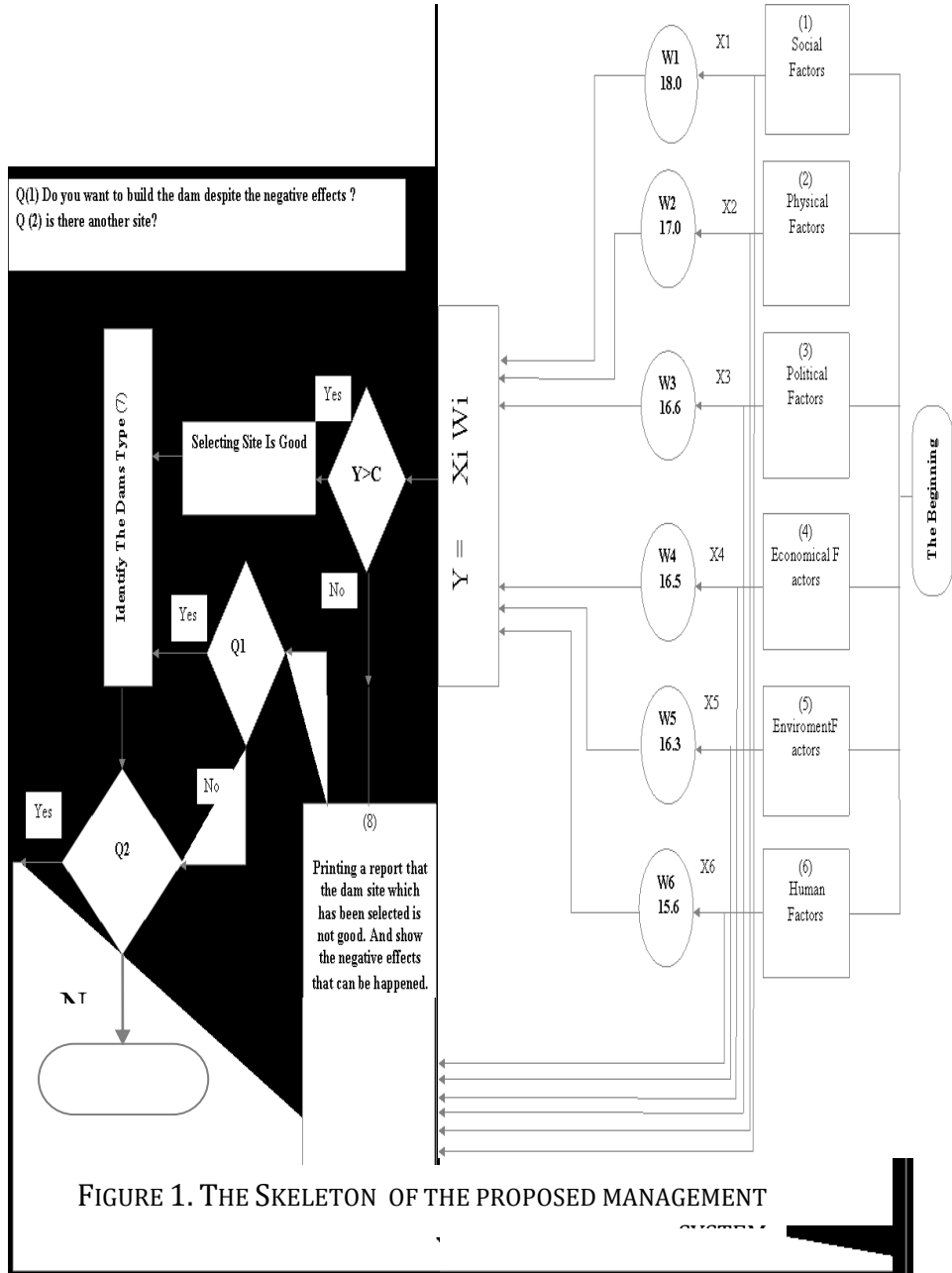


FIGURE 1. THE SKELETON OF THE PROPOSED MANAGEMENT SYSTEM

(c) The economic factors that affect the selection of dam site according to their importance are as follows: cost of the dam, availability of water resources, cost of operation and maintenance, availability of local hand and cost of temporary constructions.

Depending upon the previous factors and the results shown in table (1) and table (2), The researcher concluded with building a management system which can be used to select the suitable dam site as shown on Fig. (1). The evaluation of the system was achieved by presenting the facilities of the developed system to the respondents and then asking them to answer a questionnaire form.

The years of experience of those selected personnel ranged from (5-20) years of experience as represented in table (3). The results show:

(a) All the answers show that the running system can be used in selecting suitable dam site.

(b) All the answers show that the running system is simple and easy to use.

(c) Regarding the question about the program included all the factors that affect the selection of dam sites, all the users answered (Yes).

(d) With reference to the question on the efficiency of the program in providing suitable selection of dam sites, six of the users answered that the program was very good, and four of them answered that the program was good.

(e) Regarding the question about if the program can save time and cost, all the users answered that the program would have a good saving of time and cost that is usually spent on the selection of suitable dam sites.

f- Site specifications.

By using this information, the developed Expert System (ESSDS) gives the result which may clarify the following:

- a- The suitable dam site.
- b- The type of the dam.
- c- The negative impacts of selecting unsuitable dam site.

2.5 Evaluating the System

An evaluation study has been prepared to show the system efficiency in selecting the suitable dam site. This was made by selecting a group of engineers to evaluate the suggested management system.

3. RESULTS

Based on the analysis of the answers in table (1):

All the answers consider the following factors which are arranged according to their importance in selecting dam sites in Yemen: social factors, physical factors, political factors, economic factors, and environmental and health factors. Table (2) shows that:

(a) The orders of the importance of the social factors that affect the selection of dam site are as follows: citizen desire to accept the project, establishment of people and preventing migration, right of water distributions in the region and improving the standard living for the individual income.

(b) The orders of the importance of the physical factors which affect the selection of dam site are as follows: topographic factors, hydrologic factors, geological factors, and availability of materials.

extracted from the literature and the field survey which both include the factors that influence building the system structure. It is considered as a knowledge base for developing an expert system for selecting suitable dam sites. The system has been developed by using six stages as illustrated in figure (1) and figure (2). These six stages reflect the analysis procedures that progress from broad generalization to the specified selection of dam sites. These stages are:

- 1- Identifying the effective factors of dam site selection.
- 2- Identifying the effective factors of dam type selection.
- 3- Identifying the order of the effective factors of selecting dam site and its type according to their importance.
- 4- Identifying the percentage of the mean frequency answers for each factor importance.
- 5- Selecting the suitable dam site.
- 6- Selecting the type of the dam.

2.4 Running the Developed System

To execute the developed system and realize the selection of dam site and its type, firstly this system must be provided with the following pieces of information:

- a- Social factors specifications.
- b- Physical factors specifications.
- c- Political factors specifications.
- d- Economic factors specifications.
- e- Environmental factors specifications.

(a) Field survey for the most dams which have been constructed and the dams which are still under construction.

(b) Field questionnaire was made for:

- Collecting data from the experienced engineers on the construction dam projects and the selection of dam sites.

- Selecting a study sample from the engineers who have no less than five-year experience in executing dam projects. The length of their experience is ranged from (5-20) years.

- Developing questionnaire forms based on the results of the literature survey. The questionnaires include the following sections: the importance of dam construction, the construction methods, and the factors that affect the selection of dam site in Yemen. These factors have been further used as a basis to build a management system for selecting suitable dam site in Yemen.

(c) Interviews were made with experts who have a good site experience in the execution of dam projects to know the factors and the criteria that affect the selection of dam site in Yemen. These experts gave their decisions on the selection of dam site; and the reasons behind their decisions were recorded and arranged as rules and criteria in the suggested management system.

2.3 Development of Expert System for Selecting Suitable Dam Sites

In developing a suggested management system for dam site selection, concepts have been developed to construct a management system that is capable of advising the engineers on the dam projects and selection of dam site. The researcher depended on the data

1. INTRODUCTION

In Yemen, there is an increase in water demand especially for agricultural, industrial and domestic uses. Also, there are limited water resources in addition to frequent repetition of dry years. Therefore, construction of dams becomes very necessary which started in the early eighties. Usually, in the selection of dam site, physical, economical, social, environmental and political factors should be taken into consideration. Unsuitable sites of some dams in Yemen caused technical problems in those dams. In this study, all factors, which influence the selection of a dam site, are considered. These factors have been used to design a management system. This management system has been developed by using an expert system to select suitable dam sites in Yemen and other countries also.

2. METHODOLOGY

The research methodology followed in this study includes five parts: literature survey, field work, developing a suggested management system, running the developed system and evaluating the system.

2.1 Literature Survey

Literature Survey was made to show the aims of dam site selection, and their requirements, and identify the available factors that affect the selection of the dam site.

2.2 Field work

In this part of the research, the possible criteria for selecting a suitable dam site in Yemen have been identified by using three ways:

تطوير نظام خبير لاختيار مواقع مناسبة لإنشاء السدود في اليمن

د. أحمد محمد الجعيد*

shamhan@gmail.com

الملخص:

يهدف هذا البحث إلى دراسة العوامل المؤثرة في اختيار مواقع السدود واستنباط معايير أساسية يمكن الاعتماد عليها في تطوير نظام خبير لاختيار مواقع مناسبة لإنشاء السدود في اليمن. إذ تعد الحاجة ماسة لحجز المياه السطحية في المناطق الجافة وشبه الجافة بوساطة إنشاء السدود في مواقع مختارة من إحدى الوسائل المهمة لاستقرار البلاد ونموها في هذه المناطق. لكن الأمر يتطلب تأمين المعلومات الضرورية من مصادرها وتخزينها وتحليلها وإنتاجها بسرعة والكيفية المناسبة للمخططين ومتخذي القرار؛ من أجل اختيار المواقع المناسبة لإنشاء السدود، والحد من مشكلات نقص المياه التي تواجه الناس في هذه المناطق ومن ثم الحد من المشكلات السلبية والآثار الناتجة عن الاختيار غير الملائم لمواقع السدود المقترحة. وفي جميع الأحوال تتطلب الأمور المتعلقة باختيار المواقع المناسبة لإنشاء السدود جهوداً فنية ومادية مضمّنية للتوصل إلى حلها مما يحدو المعنيين إلى أن يحيطوا الموضوع بالعناية اللازمة؛ لغرض توفير المياه والحد من المشكلات والآثار السلبية الناتجة عن الاختيار غير الملائم لمواقع هذه السدود.

الكلمات المفتاحية: سدود، نظام خبير، مواقع

* قسم الهندسة المدنية-كلية الهندسة وتقنيات المعلومات-جامعة السعيدة-اليمن

DEVELOPING AN EXPERT SYSTEM FOR THE SELECTION OF SUITABLE DAM SITES IN YEMEN

Dr. Ahmed M. ALGunaid*

shamhan@gmail.com

ABSTRACT

Dam construction is considered as one of the main aims of water resources development in Yemen. However, dam construction has many drawbacks such as the lack of considering integrated management in dams' construction. The choice of location is considered as one of the challenges for the development of dam construction in Yemen. In this research, many necessary criteria have been used to develop an expert system for the choice of dam location.

The development system can be used in Yemen and other countries also.

Key words: Dams, Expert System, Sites

* *Civil Engineering Departement, Faculty of Engineering and Information Technology, Al-saeeda .*