

# **A Study on Effectiveness of Information Dissemination on WWW with an Expert System as a Decision Model**

**Jonjoubsong, L.**

Department of Business Computer, Huachiew Chalermprakiet University, Samutprakarn,

**Noparatruangdeng, K.**

Department of Computer Science, Huachiew Chalermprakiet University, Samutprakarn,

**Maneewattanapluk, J.**

School of Information Technology, Mae Fah Luang University.

## **Abstract**

This research has objectives to propose a model that enhances information dissemination on the WWW named Decision Supported Web Information System (DSWS) which has an expert system as a decision model and to evaluate the effectiveness of the DSWS. The content of herbs for primary health care was used as the paradigm for information dissemination. The assumption on which the research was based is: information dissemination on the WWW with the DSWS model is more effective than without the model. The assumption has been proved by hypothesis testing (Z test) which had a positive result concerning the assumption. The DSWS was significantly more effective than the use of general web pages in information retrieval, the decision process, and content of decision features.

**Keywords:** Web information systems, expert system, decision model, information dissemination on the WWW

## **1. Introduction**

Web technology has become the universal interface for all types of information. It is a persuasive communication channel. It is a means for users around the world to promote and exchange information [1]. The World Wide Web (WWW) has been used in various fields. More than 20,000 business corporations have web pages. Web pages have been used for a variety of purposes, such as advertising products and services, doing marketing research, as a communication channel to release information to staff and customers, conduct research and development, and collaborate with partners in joint-ventures [2].

The World Wide Web (WWW) contains a lot of information, which leads many people into an information overload problem. Web pages

have many attractive points to lead users out of their target topics. However, each topic also presents too much information with lengthy steps to reach the needed information. Those factors cause users to take too much time to find out specific information, and some users get lost along the way [3]. Most of the WWW's users spend five to fifteen minutes finding the first piece of useful information [4]. 43% of 1,300 managers in the U.K. and the U.S.A. delayed decision making when analyzing too much information. 47% of the managers in the study were distracted from information collection, and 38% of them spent too much time finding out the necessary information [5]. Web pages should improve effectiveness and reduce problems in locating and collecting data. There should be an integrated decision making tool that supports

web users in quickly identifying the correct information.

The Decision Supported Web System (DSWS) is a web-based system which utilizes an integrated expert system as a decision making model to support the information management needs of web users in data selection functions.

## **2. Web-based Information System**

### **2.1 Web-based Technology**

Web technology is a client-server technology which stores web pages on the server site and sends them out on the web to be processed on the user (client) site [6]. Web pages are made of Hypertext Markup Language (HTML) which is a flexible format, that defines the structure of documents and facilitates putting additional elements into documents [7]. Web pages can be front-end mechanisms for accessing an information system and other programs that are stored on the server site [1].

Web-based Systems or Web Information Systems have more elements than web pages. They contain modules that facilitate users in performing their tasks or otherwise interacting with the systems. Such tasks and interactions include data management, transaction performance, providing reports as well as many other interactions.

Web users can remotely access information and execute tasks on the server site through two programs, the Common Gateway Interface (CGI). In Web Information systems with CGI, the system is executed on the server site. The CGI will contact the information system to provide information on the server site, integrate it into a web page and return to the user. Moreover, in Web Information systems with Java applets, the system is executed on the client site. Web users send their requests in HTML files to the server. Then, the Java applet, which is embedded in that web page for the user to download and interpret on the client site or browser.

### **2.2 Decision Model on Web-based Technology**

The heuristics model was introduced as a decision model which uses rules of thumb to solve less structured problems and does not give a specific solution. It is appropriate for complex problems and involves symbolic rather than

numerical processing [8]. The heuristics model can be used to represent problems and solutions to support the decision making process, because some rules support problem identification, some rules provide solutions, and some rules provide choices. The expert system that is a kind of heuristic model can be used for many purposes depending on the problem domain as shown in table 1. The expert system can be integrated into web systems by CGI program which is an intermediate program for handling requests between web pages and the expert system to choose matching rules from the expert system to present to user with HTML file format.

## **3. Research Method**

To evaluate the effectiveness of the Decision Supported Web Information System (DSWS) in information searching. The researchers have used herbs for primary healthcare as the paradigm for information dissemination. Research tools and detail of data collection and analysis are as follows:

### **3.1 Research Tools**

The research has three kinds of tools.

#### (1) Web pages

Web pages of Thai herbs for primary healthcare have been developed using HTML and Java script. The web pages have been approved as an integral part of knowledge provision by the Pharmacist of the Government Pharmaceutical Organization.

#### (2) The DSWS

The DSWS is a web system for dissemination of herbal information for primary healthcare. It has been developed as a web-based expert system which uses an expert system component as decision model to increase the effectiveness of information dissemination on the WWW. The expert system has been built by Jess5.0 and integrated to the WWW by Java programming with servlet architecture. Then HTML and Java script were used to create interface functions for users.

#### (3) Questionnaires

Questionnaires were based on decision supporting factors which have two parts. Part 1 was designed to collect experiences on the WWW system and the herbal knowledge of samples. The experience of the samples was designed with a three scale rating (weak, moderate and strong). Part 2 was concerned with

decision supporting factors in the DSWS. It has been divided into four topics; 1) effectiveness of the system in information retrieval 2) effectiveness of the system in the decision process 3) the content of decision support system features and 4) system accuracy. This part was designed with a 5 scale rating for the samples to express their opinions; 1 = very weak, 2 = weak, 3 = moderate, 4 = strong and 5 = very strong.

Scores in part 2 can be used to explain the effectiveness and the characteristics of the system by averaging the scores which define the meaning as follows: 1 – 1.5 = very weak, 1.6 – 2.5 = weak, 2.6 – 3.5 = moderate, 3.6 – 4.5 = strong and 4.6 – 5 = very strong.

### 3.2 Data Collection

The questionnaires were attached to the systems on the Internet. Seventy-two copies of the questionnaire were answered for the DSWS evaluation, and sixty-nine copies for the general web pages evaluation. Most of samples who answered the questionnaires were not strong in herbal knowledge and not weak in WWW familiarity (see table 2 and 3).

## 4. DSWS Architecture

The Decision Supported Web System (DSWS) is a web-based system in which an expert system is integrated as a decision making tool. It supports web users in choosing suitable herbs for primary healthcare. The DSWS was designed to have three components; web pages, an expert system, and a CGI program as in figure 1.

1. *Web pages* are developed through the use of an HTML program. They have two purposes; first of all, as an interface module to enable users to request and obtain information from the system, and second, to provide herbal information pages.

2. *An expert system* is developed as a decision-making tool designed to support web users' search for specific information pertinent to their health needs. Herbal knowledge from an expert was analyzed utilizing a decision tree, is a graphical representation which is used in problem solving. Then, herbal knowledge was expressed as set of rules to be stored in a knowledge base. Each rule has two parts: the 'if' part and the 'then' part. The 'if' part is a set of facts or conditions, and the 'then' part is a

solution or result for each condition set. Users of the expert system will get solutions from the particular rules if part of the rule matches the user information. Knowledge of herbs for primary health care was stored in five knowledge bases in order to reduce the complexity of the program. The knowledge base is organized according to disease groups. The system is designed as a selected expert system with a forward inference engine through the use of Jess 5.0 (the Java Expert System Shell) which is a set of java source file with Rete algorithm as an inference engine. The expert system was integrated into the web system with an architecture of half Jess language scripts with Java program.

3. *A CGI program is an intermediate program which is a Java program with servlet architecture to request and generate out put from the expert system to web page.*

## 5. Effectiveness of the DSWS

The effectiveness of DSWS was evaluated on four criteria: effectiveness in information retrieval, effectiveness of the decision-making process, effectiveness of the content of decision support system features and effectiveness in system accuracy.

1) *Effectiveness in information retrieval* was studied with respect to two criterion: time required to locate information and quantity of accurate information gained. The results are shown in table 4. The samples evaluated the general web pages and the DSWS and found moderate effectiveness in information retrieval, effectiveness of the decision-making process.

2) *Effectiveness of the decision-making process* focuses on three phases of the process, which includes three points: 1) problem (needs) identification capability, 2) alternative provision capability, and 3) alternative choice capability.

The samples evaluated the general web pages and the DSWS with the determination of moderate effectiveness in the decision-making process. The results are shown in table table 5.

3) *Effectiveness of the content of decision support system features* was concerned with seven features:

- direct utilization of the system by the user
- facility of use. This feature has two issues: less training or fewer directions, and less time to learn how to use the system.
- system flexibility and ease of control
- system interactivity
- quantity of information provided by the system
- the system incorporating a model to support the decision-making process
- the system is attractive

The sample evaluated the general web pages with moderate effectiveness in content of decision support system features, and the DSWS with strong effectiveness in content of decision support system features. The results are shown in table 6.

4) *Effectiveness in system accuracy* is concerned with two points: user confidence in the system's solutions (information) and users' impressions.

The samples evaluated the general web pages and the DSWS as having strong effectiveness in system confidence. The results are shown in table 7.

According to resulting data from the questionnaires, the effectiveness of the DSWS is different from the data for general web pages effectiveness in some areas. Table 8 presents the effectiveness of the systems with the hypothesis test results with the null hypothesis. Both systems exhibit similar effectiveness at the 0.05 level of significance, and the region of rejection is less than  $-1.96$  or greater than  $1.96$ .

According to the results of the hypothesis test, the effectiveness of the DSWS in information retrieval is higher than that of the general web pages. The effectiveness of the DSWS in the decision-making process is higher than that of the general web pages. The effectiveness of the DSWS in content of decision support system features is higher than that of the general web pages. The effectiveness of the DSWS in system accuracy is not different from that of the general web pages. In evaluation of the effectiveness of the system overall is higher than that of the general web pages.

In order to ensure that the levels of herbal knowledge and WWW familiarity of the samples were not related with their opinion

expression concerning the effectiveness of DSWS. The researchers have done the chi-square distribution test ( $\chi^2$ ) at 0.05 level of significance.

According to the computed chi-square values in table 9, the levels of herbal knowledge of the samples were independent of the opinion expression concerning the effectiveness of DSWS in time required to locate information, alternative provision capability and user confidence with system accuracy, and the levels of WWW familiarity of the samples were independent of the opinion expression concerning the effectiveness of DSWS in time required to locate information, alternative provision capability, the system in ease of use and system interactivity but there was relationship between levels of WWW familiarity of the samples and degree of opinion expression concerning the effectiveness of DSWS in system controllability. Even though, the level of WWW familiarity of the samples had relationship with the effectiveness of DSWS in system controllability, the majority samples of DSWS group were a moderate level of WWW familiarity while the majority samples of general web pages group were a strong level of WWW familiarity.

## 6. Discussion and Conclusion

According to the assumption of the research, information dissemination on the WWW with the DSWS model is more effective than without the model. The DSWS is significantly more effective than general web pages in information retrieval, the decision making process, and the content of the decision support system features.

The users use less time to retrieve the appropriate information, gain a greater quantity of more accurate information, and retrieve a higher proportion of useful information from the DSWS than general web pages do. The DSWS has more capability to support a decision process containing three elements: problem identification capability, alternative provision capability, and alternative choice capability than general web pages do. The DSWS has high effectiveness in content of decision support system features, which is more effective than general web pages. This means the DSWS

contains more decision support system features than general web pages.

The DSWS and the general web both have strong effectiveness in system accuracy. This means the researchers used sound sources of reference with superior accuracy as a mechanism to provide herbal information for the DSWS. The DSWS stores herbal knowledge which has been verified by herbal expert in its knowledge base. The knowledge base is a component of an expert system. The expert system has been integrated into the WWW system through CGI programming. The system

used the Java program with servlet mode as a CGI program.

For future investigation, the integrated architecture of other decision models into web systems should be studied in order to compare the effectiveness of the system performance and flexibility in the system development cycle.

### 7. Acknowledgement

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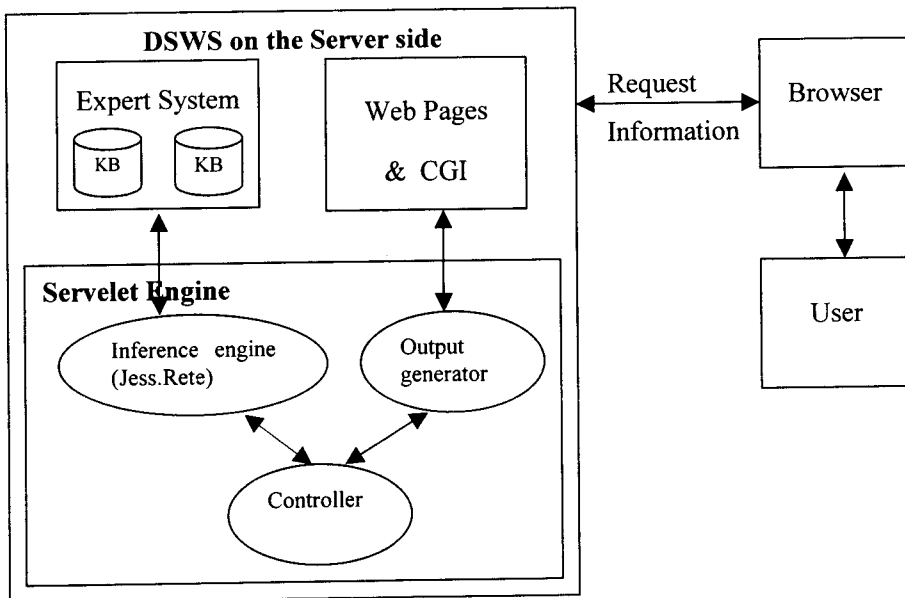


Figure 1 The DSWS Architecture [9]

**Table 1. Type of expert system by problem-solving paradigm**

<b>Expert system by problem-solving paradigm</b>	<b>Description</b>
Control	Governing system behavior to meet specifications
Design	Configuring objects under constraint
Diagnosis	Inferring system malfunctions from observables
Instruction	Diagnosing, debugging and repairing learner behavior
Interpretation	Inferring situation description from data
Monitoring	Comparing observations to expectations
Planning	Designing actions
Prediction	Inferring likely consequences of given situations
Prescription	Recommending solution to system malfunction
Selection	Identifying best choice from a list of possibilities
Simulation	Modeling the interaction between system components

Source: [10]

**Table 2 Characteristics of the population in herbal knowledge**

<b>Population characteristics</b>	<b>Group I (for general web pages)</b>		<b>Group II (for DSWS)</b>	
	<b>No. of population</b>	<b>Percentage</b>	<b>No. in population</b>	<b>Percentage</b>
Weak	32	46.38	28	38.89
Moderate	34	49.28	41	56.94
Strong	3	4.35	3	4.17
Total	69	100.00	72	100.00

**Table 3 Characteristics of population in WWW familiarity**

<b>Population characteristics</b>	<b>Group I (for general web pages)</b>		<b>Group II (for DSWS)</b>	
	<b>No of population</b>	<b>Percentage</b>	<b>No. in population</b>	<b>Percentage</b>
Weak	6	8.70	3	4.17
Moderate	31	44.93	44	61.11
Strong	32	46.38	25	34.72
Total	69	100.00	72	100.00

**Table 4 Effectiveness of information retrieval in the systems**

System characteristics	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- time to locate information	2.9	Moderate	3.2	Moderate
- quantity of accurate information	3.3	Moderate	3.5	Moderate
Average	3.1	Moderate	3.3	Moderate

**Table 5 Effectiveness of the decision-making process of the systems**

System characteristics	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- needs identification capability	3.3	Moderate	3.5	Moderate
- alternative provision capability	3.2	Moderate	3.4	Moderate
- alternative choice capability	3.3	Moderate	3.5	Moderate
Average	3.3	Moderate	3.5	Moderate

**Table 6 Characteristics of the systems concerning decision support system content features [9]**

System characteristics	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- System can be directly utilized by user	3.9	Strong	4	Strong
- System is easy to use	3.2	Moderate	3.3	Moderate
- System is flexible and controllable	3.6	Strong	3.7	Strong
- System is interactive	3.3	Moderate	3.6	Strong
- System provides extensive information	3.3	Moderate	3.4	Moderate
- System contains a model	3.3	Moderate	3.4	Moderate
- System is attractive	3.4	Moderate	3.5	Moderate
Average	3.4	Moderate	3.5	Strong

**Table 7 Effectiveness in systems accuracy**

System Truthfulness	Group I (for general web pages)		Group II (for DSWS)	
	Average	Result	Average	Result
- user confidence	3.6	Strong	3.6	Strong
- users' impressions	3.6	Strong	3.6	Strong
Average	3.6	Strong	3.6	Strong



**Table 8 Hypothesis of the systems effectiveness**

System Characteristics	Group I (General web pages)			Group II (DSWS)			Z score	Accepted/ Rejected
	No. in sampl e	Mean	SD	No. in sampl e	Mean	SD		
- Information Retrieval	69	3.1	0.6	72	3.5	0.6	4.59	Rejected
- Decision-making process	69	3.3	0.7	72	3.5	0.7	11.56	Rejected
- Content of DSS features	69	3.4	0.4	72	3.5	0.5	3.65	Rejected
- System accuracy	69	3.6	0.6	72	3.6	0.6	0.00	Accepted
- Over all effectiveness	69	3.4	0.4	72	3.5	0.5	4.69	Rejected

Hypothesis test at 0.05 level of significance, the region of refection is less than  $-1.96$  or greater than  $1.96$

**Table 9 The results of hypothesis testing using chi-square distribution ( $\chi^2$ )**

Problem	$\chi^2$	df	Asymp.Sig.
1. Time required to locate information			
- level of herbal knowledge	3.173	2	0.205
- level of WWW familiarity	0.585	2	0.746
2. Effectiveness of the system in providing alternatives			
- level of herbal knowledge	1.809	1	0.228
- level of WWW familiarity	3.561	1	0.083
3. Effectiveness of the system in ease of use			
- level of WWW familiarity	4.279	3	0.233
4. Effectiveness of the system in system controllability			
- level of WWW familiarity	5.178	1	0.035
5. Effectiveness of the system in system interactivity			
- level of WWW familiarity	1.091	1	0.325
6. Effective of the system in user confidence with system accuracy			
- level of herbal knowledge	0.607	1	0.476

Hypothesis test at 0.05 level of significance

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