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WDSS: Web-Based Decision Support Systems

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ABSTRACT

Web technology has been the platform for building decision support system DSS and the activity developing center of DSS. Web-based DSS consists of a computerized system that provides decision support information or the tools to the users through the web browser. Previously conducted researches emphasis on the application of DSS and the implementation by utilizing the word wide web. our insight in this paper is to document the evolvement of web-based DSS and the impact of the web analysis on DSS. Different techniques involved with the collecting, analyzing and extracting knowledge from data such as web mining, social analytics, and data mining were examined. The web-based analysis of different aided techniques resulted positively toward the improvements of DSS.

Key words— Decision Making; DSS; Web-based DSS; Web mining, Text mining; Social analytics**.**

1. INTRODUCTION

The active decision-making process requires access to relevant information. Information relevance depends on accuracy and timelines [1]. However, good decision-making depends on the management understanding of the information available [2]. A research investigated by Turban, Sharda, and Delen [3] on the successful corporate decision-making process identified three significant steps that enhance decision making. These steps include collecting, analyzing, and storing data for future reference.

Therefore, decision support tools aid the organization's decision-making process. Power, Sharda, and Burstein [4] define Decision Support Systems DSS as computer-based systems that assist business managers in making an effective decision. DSS were conceptualized using various decision theories in early 1970 where the major feature of the DSS is usability. According to server-side and Ross [5], DSS should pose the element of ease of use. That is, people with little technical knowledge should be able to use DSS. Comer [6] echoes the same sentiments, and he states that DSSs require little programming knowledge as a factor that enhances their usability. Additionally, the systems possess superb interaction capability which enables facilitation of decision-making process [5].

However, the distinguishing feature of DSS is the ability for repeated usage resulting from incorporation of large databases which enable information storage. Owing to the benefits accrued from the DSS, the support systems have evolved rapidly in the business field. Correspondingly the significant development of DSS is web-based DSS development. One of the most important ways to deliver both quantitative and qualitative information to the decision maker is the World Wide Web because of its architectures and networks which allow the expertise to centralize and control information and provide it efficiently for managers to use it. Web-Based DSS supports manager and business analyst by providing them decision support information or decision support tools by the thin-client Web browser such as Netscape Navigator or Internet Explorer. It is basically a DSS that built with web technology. Web-based DSS has been widely used to support customers in the configuration of a particular product and service according to their needs or for customizing ads according to the client preferences. These DSS may be data note, communication driven, model driven, document driven, or knowledge driven.

This paper will illustrate the significant development of DSS which is web-based DSS that allows various techniques of collecting, analyzing and conceptualization of information. These techniques include data mining, content mining, and social analytics. Thus, to address the impact of web-based analysis on DSSs and how it affects the decision-making process in organizations. The following section of this paper introduces the type of DSSs and examples of some web-based DSS for each type. The third part is about the web-based DSS structure, web analytics tools and techniques, and social analytics. The fourth and last section is the conclusion.

2. TYPES OF DSS

According to Power [7], DSS is classified into five main categories as the following, see Table [1].

Data-Driven DSS is the first type that includes different systems such as file drawer, management reports, data warehouses, analysis systems, executive information systems and spatial DSSs. It allows access and control of the large database. One of Data-Driven DSS example is Microsoft CarPoint that considered as a web-based system that lets users compare between car models. Another example [8] is Stock finder which helps stakeholders to classify stocks upon some criteria.

Model-Driven DSS is a type of DSS that allows access and control of models, especially accounting, financial, representational, and optimization models. One Model-Driven DSS example is Fidelity 'Retirement Planning Calculator' which help the user to decide how much the needed amount to invest each month for retirement [8].

Knowledge-Driven DSS helps managers to make decisions by a person to computer systems with specialized problem-solving expertise which include the knowledge about the particular domain, understanding the problem and its domain, and problems solving skills. An example of this type is Netscape Decision Guides which offer different decision guides [8].

Document-Driven DSS is the newest type of DSS that helps managers to recover, use, unstructured documents and web pages by integrating different and control storage and processing technologies. Using the web allows access to the large document and too rich content databases that include hypertext documents, images, sounds, and videos.

Communication-Driven and groups DSS includes communication, collaboration, and decision support technologies that are not suitable for other DSS types and that is the reason for considering it as a particular category. It uses both communications and decision models; also it is an interactive computer-based system that solves problems by a group of decision-makers supported by groupware supports e-communication, scheduling, sharing documents, and all of the group productivity and enhanced decision support activities. An example is TCB Works which allow people to interact, discuss and make decisions [8].

Table 1: Decision Support System Types

Attribute	Data-Driven DSS	Model-Driven DSS	Knowledge - Driven DSS	Document - Driven DSS	Communications-Driven and Group DSS
Purpose	• Helps to solve mainly unstructured problems and Query a data warehouse, ad hoc analysis. • Make decisions by displaying the developments and finding relations or patterns. • User mainly interacts with the data [7].	• Solve clear and structured problem by using what-if-analysis. • Helps to understand the impact of decisions on organizations and Crew scheduling, decision analysis • User mainly interacts with mathematical model and its results	• Management advice. • Choose products.	• Search Web pages, find documents.	• Establish a meeting, • post on a Bulletin Board.
User Group	• Managers. • Staff. • Intra- and inter-organization.	• Managers and staff. • Customers.	• Internal users. • Customers.	• Specialists. • Managers.	• Intra- and inter-organization users.
Enabling Technology	• Mainframe, LAN, Web-based	• Stand-alone, Web-based, PC	• LAN or Web-based.	• Web-based.	• Web-based. • LAN.
Model Type	• Contains, in general, simple models.	• Contains, in general, various and complex models.	• Use special model. • An interface engine for processing rules or identifying relationships in data.	• Cognitive Modeling. • Fuzzy theory models that use parameters for searches based on relative commonality or reason to the keyword.	• Communications. • Decision models.
Data Quantity	• Large amounts of data are crucial.	• Large quantities of data are not necessary.	• Called knowledge warehouse so it needs a large amount of data according to its purpose.	• Oral. • Written. • Video data needs large data.	• A large amount of data.
Primary tool or component	• Historical data. • Online Analytical Processing. • Reporting tools	• Algebraic. • A decision is analytic. • Financial. • Simulation. • Optimization models.	• Business rules and knowledge bases	• Document storage and processing technologies	Decision rooms, two-way interactive video, whiteboards, bulletin boards, chat rooms and email systems [8].

On the other hand, Power, Sharda, and Burstein [4] contends that this categorization is general and unfocused. Thus he categorizes DSS in a more focused way and achieves two groups which include Inter and Intra-organization systems and hybrid DSS. Gupta and Sharma [9], observes that hybrid DSS incorporates various types of systems such as model and communication models. The hybrid DSS is also known as web-based data systems. Also, it is classified as Online Analytical Processing OLAP systems [3].

4. WEB-BASED DSS

The basic structure of web data DSS includes users, input, and outputs. The architecture of web DSS includes various techniques supported by different DSSs. The techniques include data, content mining among others. Turban, Sharda, and Delen [3] characterize information mining as the way toward watching the different inborn relationship between web information.

According to Power and Wren [10], Web 2.0 technologies has a significant impact on DSS design especially mobile DSS. Web 2.0 applications support information sharing, user-centered design, and collaboration. Some of Web 2.0 examples are Blogger, Flickr Maps, YouTube, and Wikipedia. Web 2.0 has seven principles which include the web as a platform; collective intelligence importance; database management and data owning importance; software release cycle end; lightweight programming models usage importance; multiple software device importance; and user experiences importance. Web 2.0 technologies improve managing, accessing and using the decision support content [10]. Some technologies will help to create a new generation of DSS that associated with building Rich Internet Applications (RIA).

A. Web Analytic

In today's world, organizations are moving aggressively in line with the changing technology to support their operations. The business environment has also proved to be complex resulting in business opportunities and at the same time creating more problems. It is, therefore, crucial for an organization to use web-based tools for their success. These tools include web mining, social analytics, and web analytics. As mentioned earlier, web mining involves discovering and analyzing data from the web. Social analytics is when digital interaction is monitored, analyzed and measured (See Table 2).

Web-based DSS should enable the user to evaluate the situation, problem, and tentative solution [3]. Web-based DSS acts effectively through the incorporation of sophisticated models in multiple databases. The techniques entail content mining using textual mining software such known as search engines. Ranking of information on the search engines depends on originality which enhances the Search Engine Optimization (SEO) content, and helps in optimizing the website and the information lives on it to attract search engine traffic. On the other hand, social analytics enable evaluation of consumer behavior based on repeated use and the effectiveness of per click adverts.

B. Web Mining Types and Techniques

1) Effect of Web Mining On Decision Support System

Web mining is an application used in data mining that mainly focuses on identifying and extracting targeted material from the web. There are unique forms of web mining that include web structure mining, web content mining, and web usage Mining. Table [3] lists three essential types of web mining from manyperspectives.

Web usage mining helps in analyzing website usage such as users' navigation behavior. The main source of information is a log file that provides the server-side data about clickstreams. Client-side data like cookies and log files are occasionally used in research to record the behavior of users. Advanced analysis of web usage mining focuses on sophisticated statistical methods aimed at understanding the history of user navigation in a given website or undertakes analysis across websites [11]. Web structure mining performs analysis and provides explanations about website structures and links by applying Graph theory [12]. Traditional techniques of data mining like classification, visualization, association rule, and clustering are still applicable, today. Classification algorithms are useful in categorizing users into various classes depicting their browsing behavior such as the time spent browsing the web. Clustering is quite similar to classification, with the only difference being the pre-definition or supervision of the latter technique. The association rules method highlights and group together the pages that are referenced more often. Visualization refers to a special technique for web mining that enables the recognition and understanding of data using graphics and other visual means.

2) Impact of Web Mining on Decision Support Systems

Web mining techniques are instrumental during the extraction of massive amounts of data through data analysis and proper application of the extraction technique. Web structure mining, web content mining, and web usage mining are data mining techniques utilized in DSS. Web data analysis occurs through an automated data mining technique referred to as Knowledge Discovery [11]. This process explores and analyzes extensive data with the specific target of discovering important rules and patterns as well as finding information from unprocessed data. Data mining plays a significant role in enabling organizations to understand browsing behavior of customers, anticipate stock movements, develop sale policies, and achieve competitive advantage.

Web mining techniques are different from conventional operations of databases because the later database ends up passive after handling large data to help in future retrieval of

specific data. The various web mining techniques extract data that does not become passive but helps in serving valuable information that guides the development of DSS [12]. Web mining techniques reflect statistical calculations from artificial intelligence and database administration, not as a replacement to the traditional statistical methods, but extensions to these techniques using statistical and graphical techniques.

Table 2: Comparison between Web Mining, Data Mining, and Social Media Analytics.

Attribute	Web Mining	Data Mining	Social Media Analytics
Definition	• The process used to extract information from web documents.	• The process used to extract hidden information from the database.	• It refers to the statistical collection and analysis, digital data that show the user's interaction interface especially online. Recently, it becomes the main form of business intelligence that helps the organization to identify, predict, and respond to their consumer behavior [3].
Structure	• The information obtained from structured, semi-structured and unstructured web forms. • It gets the information from a wide database.	• It obtains the information from an explicit structure. It is not able to get all the information from a wide database as compared to web mining.	• It has a networked structures consists of nodes, ties, edges, or links which connect them.
Access	• Data is accessed publicly. In this, data not hidden in web database and only permission is required to access the data from web log master.	• Data is accessed privately, and the only authorized user can access the data.	• Data depends on its authentication, and it could be neither private nor public data.
Data	• It works upon on-line data.	• It works upon off-line data.	• It works upon on-line data.
Data Storage	• Data is stored in server logs and web server database.	• Data stored in data warehouses.	• Social data stored in Big Data
Application Areas	• E-learning. • Digital Libraries. • E-Government. • Electronic Commerce. • E-Politics. • E-Democracy. • Security & Crime Investigation. • Electronic Business.	• Banking. • Marketing. • Manufacturing & production. • Health-care. • Insurance. • Law. • Airlines. • Computer hardware & software. • Government &defense.	• Social Networks Application [10].
Disadvantages	• URL's can be tracked to access the data. • The multiplicity of events and URL. • A large amount of data remain unused	• Privacy issues, security issues. • Misuse of information/ inaccurate information.	• Each data point can belong to one and only one group. • For social media outlets without such limitations where it will be difficult to assign data points to one and only one group.
Challenges	• Complexity. • The web is too vast. • Relevancy of information. • The Web is a dynamic data source. • The diversity of user communicates.	• Network settings. • Data quality. • Privacy preservation. • Scalability. • Complex and heterogeneous data.	• Supplying social media metrics to the right people. • Visualization. • Unstructured data is challenging. • Increasing the signal to noise. • A wait and see attitude.

Techniques	• Web Content Mining. • Graph-Based Web Mining. • Utilization in Web Mining. • Text Mining and many others.	• Artificial Neural Network, Decision Trees. • Rule Induction. • Nearest Neighbor Method and many others.	• Text-based techniques. • Relevance filtering via graph-based methods. • Network-based techniques. • Classical techniques such as SVD. • Supervised and competing for semi-supervised techniques. • Traditional clustering techniques, modelingtechniques [19].

Web mining techniques help to improve DSS using various statistical algorithms, classification, shape recognition, machine learning, neural networks, fuzzy logic, and data viewing. These methods allow the achievement of classification, clustering, visualization, and association rule. Decisions trees in web mining represent the rules adopted by the joining rule or the tree-view structure. This tree creation technique entails the collection of the variables that help in decision making to determine their impact on the estimation of results. Categorizing helps in defining new categories of variables that divide raw data into regions. Clustering helps to determine the similar and different characteristics of items placed in various cluster regions.

C. Text Mining and Data Mining Techniques

According to Jayanthi and Sheshasaayee [14], text mining is an important tool that applies in web-based DSS. The aim of this technique is to collect unstructured or semi-structured data form of data type available on the web: e-mails, news and image, and extract information by automatic categorization or summarization to gain knowledge. There is five main industry applications where these techniques add value at most [15]. These include retail, banking, insurance, healthcare, transportation, and medicine. Applying these techniques to extract knowledge from data stored in Web server can help organizations to determine the lifetime value of clients, design marketing strategies for their products and services, and design effective logical structure.

D. Social Media Analytics

Social media analytics is about developing and evaluating the informatics tools and the frameworks that used for the purpose to collect, monitor, analyze, summarize, and visualize the data of social media [16]. By April 2011, the Wikipedia definition [10] was simplified as "Social media are media for social interaction, using highly accessible and scalable communication techniques. It is the use of web-based and mobile technologies to turn communication into interactive dialogue". Social media analytics have different purpose as shown in Table 4.

Hung, et.al, [11] explained how the web mining techniques with all the three different types could be used for social network analysis. Web usage mining has a significant role in online social networks analysis. Social networks construction contains relational data come from the conversion of the usage data and user communication. Web structure mining always uses of graphs and visualized ways in representing the data analysis. The online social analysis contains the continuous process of using web mining. According to the project requirements and analysis goals, the process modifications of this process are important [17].

Table 3: Web-Based Decision Support System Techniques.

Specification	Web Content Mining	Web Structure Mining	Web Usage Mining
Data View	• Structured • Semi-structured • Unstructured	• Structure linkage	• Interactive data
Main data	• Text document Hypertext document	• Link structure	• Browser logs • Server logs
Representation	• Concepts or ontology • Relational • Edge labeled graph n-grams • Terms, Phrases	• Graph	• Relational Table • Graph
Method	• Machine Learning Association Rules Proprietary algorithm • Statistical method	• Proprietary algorithm	• Machine learning Statistical method
Tasks	• It tells about the discovery of useful information from	• It discover the model underlying web's link structure	• Its work is to make sense of the data generated by web surfer's behavior [11].
Scope	• The scope of data is local in Global DB and is global in IR.	• Global	• Global
Goal	• It mainly targets to discover knowledge	• To generate structural summary about the web [12].	• To analyze the behavioral pattern and users profile while interacting with websites

Application areas	• Clustering Categorization • Finding extraction rules and patterns • User modeling • Finding frequent sub- schemas	• Clustering Categorization	• User Modeling Site Construction Marketing • Adaptation and Management
Challenges	• Data/Information extraction • Opinion extraction • Segmenting web pages and noise detection [15]	• Not all pages have relevant meta information • Entire text of predecessor page is not relevant	• Preprocessing challenges about the users i.e. who will be the user, how long it stays, where will it go and user view [18].

Table 4: Social Media Analytics

SMA Motivation	Goals	Capabilities
Awareness	• Gather customers insights	• Sentiment analysis: sentiment polarity, behavioral sentiment. • Text mining and web analytics: customer behavior intentions and preferences.
	• Access online marketing campaigns	• Real-time market intelligence: revenue growth, product usage, marketing success and brand mentions.
	• Discover new ideas	• Trend analysis and crowd intelligence: new insights and innovations (service and products). • Weak signal analysis: emerging trends early. • Competitor's analysis: tracking of competitive brands and products.
Persuasion	• Identify Social Influence:	• Influence analysis: identify impact for marketing and sales. • Social networks analysis: mapping of relationships between online users.
	• Identify Popular social media channel	• Data mining and machine learning: identify popular buys and buying smart by wish list recommendation. • Channel optimization and propensity modeling: identify profitable social media platforms and influence buying decision.

5. CONCLUSION

One of the most important ways to deliver both quantitative and qualitative information to the decision maker is the World Wide Web because of its architectures and networks that allow the expertise to centralize and control information and provide it quickly for managers to use it. Web-Based DSS supports manager and business analyst by providing them decision support information and tools by the thin-client Web browser. This paper discussed the different techniques and various tools used to improve the web decision-making process. Also, this research found out other essential techniques played the main role in web decision-making processes. Web 2.0 shows that it can improve decision-making rationality and effectiveness while it can't be in some other cases. For example, social media usage aids organizations to amend consumer decision behavior may not usually result in better decisions by consumers. As a conclusion, these different techniques and tools follow different strategies to improve the process of web decision making by analyzing, and extracting knowledge from data to aid decision-making through web-based DSS tools.

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