Personalized Decision Support Systems

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INTRODUCTION

Decision support systems (DSS) are computerized systems that assist humans to make decisions. Early versions were designed for executives, but over time DSSs were designed for workers at any level in the organization (Keen & Morton, 1978; Rockart, 1979). Due to increasing costs in providing benefits and services, organizations are forcing workers and consumers to take increasing responsibility for insurance, health care, and financial planning decisions. Extreme events, such as terrorism, pandemics, and natural disasters will swamp the capacity of governmental agencies to serve their citizenry. Individuals in affected communities must turn to local agencies or ad hoc groups for assistance. **Personal decision support systems** (PDSS), consisting of databases, model-based expertise, and intelligent interfaces, along with wireless communications, Internet resources, and personal computing, provide sufficient resources to assist informed individuals and groups in solving problems.

This article reviews the typical components of a DSS and the different types of systems that have evolved. The article poses three types of problems facing individuals, including routine problem solving, immediate survival needs, and long-term evolutionary growth. Personal decision support issues of acquiring information, processing information, and dissemination are outlined. Future trends and research opportunities are discussed.

BACKGROUND

DSS aid human thinking by accessing information, integrating this information in some way, structuring decisions, and optimizing decisions (Sprague & Carlson, 1982). These benefits are obtained using three major system features of a DSS, which include a database, which records knowledge; a model base, which models or represents expertise and problem-solving; and an interface, which provides a user with a means to interact with the other system components (Sprague, 1980).

Powers (2007) characterized DSS in terms of how the system provides assistance. Model-driven DSSs for individuals include spreadsheets. Data-driven DSS, such as **Executive Information Systems** (EIS), are used by organizations and institutions for strategic and tactical decisions. Communication-driven DSSs can be seen in groupware, video conferencing, and bulletin boards. A document-driven DSS, such as provided by search engines, facilitates document retrieval. A knowledge-driven DSS would be used to solve specialized problems and consist of knowledge represented in terms of rules, procedures, hierarchical frames, or networks. Most recently, web-based DSSs are found in browser searching, intranets, and portal use.

Decision support systems are based on the notion that human reasoning is a rational process, although this is not always the case particularly when humans are faced with complexity and stress (Druzdzel & Flynn, 2000). Experts' decisions in real settings have been shown to demonstrate less quality than linear models (Hastie & Dawes, 2001). Judgmental heuristics reduce cognitive load but decrease the quality of decisions. Characteristics of the DSS components vary in a PDSS in order to compensate for the type of problems faced by individuals. In general for a PDSS the data bases are customized, the model bases are organized along preferential outcomes (e.g., more or less, quantitative), decisions (e.g., lists and value ordering), and uncertainty (specific actions resulting in gain considering constraints and price).

PERSONALIZED DECISION SUPPORT

This article summarizes three problem types facing individuals, including routine problem solving, extreme survival needs, and long-term change. The article outlines system architecture requirements in terms of acquiring and processing of information, interacting

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with this information, and the dissemination of information and recommendations.

PDSS Problem Types

The consumer of the 21st century faces numerous **routine problems**, such as career choice, self-improvement, volunteerism, financial planning, retirement, insurance, consumer purchases, health care physician, and personal health. PDSS applications can be seen in health care ranging from point-of-care use of personal data assistants (PDA) to helping patients make decisions on health care (Crawford, 1997; Pierce, 1998). Routine problems consist of complex options with short-term benefits and unknown long-term implications. However, individuals tend to discount the need to make decisions and/or the belief that institutions and governmental agencies will impose decisions on them.

A second problem type can be classified as **survival**. Three examples include natural disasters, terrorism, and pandemics. Natural disasters, such as hurricanes, tornadoes, floods, drought, volcanic eruptions, earthquakes, and meteorite impacts, can also include gradual changes brought about by global warming. Radical changes could involve results of nuclear winter, the shift of the moon's orbit, or pole shifting of the earth's magnetic field. PDSS applications involve disaster management and attempts to connect satellite mapping technology with government agencies (Hegde, Srivastava & Manikiam, 2004). Terrorism provides a more recent survival problem brought about by racial cleansing, violence between religious groups, undermining of governments through corruption and assassination, chemical warfare, and destruction of neighbourhoods and infrastructure. PDSS applications for this problem type has emerged for counter-terrorism applications (Alward, 2004). Pandemics have always occurred throughout human history but have taken on serious implications given technological developments in genetics. Survival problems cannot be predicted, fully characterized, and their impact overwhelms the capacity of a DSS. The value of a PDSS is its proactive potential by identifying national, state, and local resources, recommending action, and triggering the development of institutional support and awareness that did not exist before.

A third problem type is evolutionary or long-term change brought about by a realization that existing decision paths may lead to significant consequences. Awareness of **change problems** signal a need for people to make long-term proactive decisions in light of multiple paths or scenarios (Schellnhuber, Crutzen, Clark, Clausssen, & Held, 2004). Proactive decision-making enables humans to become aware of and address serious consequences of prior decisions by individuals, groups, institutions, and governments, as well as the impact of technological innovations. However, change problems tend to be low priority, require significant resources, and they resist consensus due to their apparent intractability. Simulations and virtual environments may be needed to help citizens interact with potential paths (Stanney, 2002).

Personal Decision Support Architecture

Early views defined a personal DSS as one which focused on a discrete task or decision (Rockart & Bullen, 1986). Examples frequently involved group support, such as Morton's (1971) DSS which involved both marketing and production planning. Keen and Hackathorn (1986) identified three main parts of a personal DSS to include the interface between machine and user, relevant operators (i.e., action verbs, such as "help"), and a database. Development of a personal DSS requires attention to dialogue, refinement of the vocabulary-operators, and evolution of the data structure of the database.

PDSS, as described here, would involve both individual and social needs, and thus would be hybrid versions of several DSS types (Powers, 2007). A PDSS would include mathematical and statistical tools (model-driven) to calculate and make inferences on numerical data. They would retrieve forms and information (document-driven) to support decision-making. They would use information and data as input to address specialized needs (knowledge-driven), such as health care, insurance, career options, and travel planning, among others. The PDSS would consist of both localized (personal computer system) resources and distributed (web-driven) sources where information and computing may be conducted at other sites.

The major systems of a PDSS include databases, reasoning models, interface, and communication options. Each of these four systems can be equated to acquiring information, processing this information in ways that make it amenable to specialized decision modules (e.g., insurance, health-care, travel planning), interacting with the information visually, and com-

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