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ABSTRACT

An architecture was developed from a synthesis of concepts derived from the literature and field observations to identify and integrate the total decision support (DSS) function in organizations. Four distinct types of decision support systems were identified (corporate planning systems; functional decision support systems; executive information systems; and local decision support systems) and were integrated within a framework that incorporated organizational level, system formality, and decision making mode. The architecture is used as a cohesive framework for discussing research and management issues for organization-wide DSS.

1. INTRODUCTION

Since the term "Decision Support Systems" (DSS) was first coined by Gorry and Scott Morton (1971), a prolific literature on DSS has evolved (Sprague and Watson 1986). Yet, despite the high level of interest and activity, neither the research literature nor the reported individual cases of DSS in practice provide a comprehensive organization-wide view of decision support activities. A conceptual gap exists in identifying, let alone planning and managing, the total DSS function in the organization. The objective of this paper is to integrate the diffuse concepts and the diverse practices so that DSS can be viewed from an organizational context as a system of well defined, distinct, interrelated components rather than an amorphous collection of individual projects.

Research literature has focused almost exclusively on single applications of DSS. In a comprehensive review of DSS research, Henderson (1987) identified three distinct areas: application, design, and technology. In all three cases the focus was on individual decision support systems. Even recent expansions to Group DSS (DeSanctis and Gallupe 1987; Huber 1984) and cooperative computing (Stefik et al. 1987) refer only to an expanded set of users of a single DSS and do not take into account the presence of multiple DSSs within the organization. Hogue and Watson (1983) recognized the need for research on managing DSS as an organizational activity, but they did not pursue the concept. While researchers seem to have made an assumption about a homogeneous type of DSS in organizations, reports of managerial practice provide clear evidence of the development of many different types of DSS.

This study was motivated by the demand of several information systems executives for a conceptual model encompassing all DSS organizational practices to provide a basis for the total DSS function. This exploratory research incorporated an analysis of the DSS literature with field observations collected from a sample of eight organizations. The results of this study consist of a synthesis of concepts and practices that culminate in an architectural framework that could facilitate further research as well the as organization-wide planning and management of the DSS function.

2. FIELD OBSERVATIONS

The catalyst for this study occurred as a result of a day-long joint meeting between academic researchers and information systems executives from six organizations, representing a cross section of industry and government (one bank, two utilities, two manufacturers, and a government agency). The purpose of the meeting was to discuss issues of developing, managing, and controlling the seemingly unrelated variety of DSS projects that were evolving in practice. The executives attended the meeting to seek the benefit of sharing views and plans about the DSS practices in effect in their respective organizations. During the extensive discussion session it became clear that the term DSS referred to quite different phenomena across organizations. There were considerable differences in perceptions about the means to support DSS development and there were wide variations in applications for DSS, as the following illustrate:

- One organization had a well developed corporate planning model that was established centrally but was

in the process of being distributed for use by a number of executives;

- Another organization emphasized DSS aimed at the specific functions of customer analysis and financial management;
- In another organization, an Information Center was created to assist personal computer based DSS throughout that organization; and
- In contrast, another organization was planning to use the corporate data base as the focus and was concerned with utilization of corporate data for ad hoc analysis by top executives.

These observations led to the conclusion that even though participants discussed a diverse set of applications and orientations, there was no reason to consider that any of them were mutually exclusive. None of the six organizations were aware of a comprehensive means by which to fit all of their DSS activities into an organization-wide function, the DSS function. Moreover, they all recognized that a comprehensive viewpoint is necessary to help understand and manage the similarities and differences among various DSS related activities.

A more detailed field study was conducted using unstructured interviews and included eight organizations (the original six, one manufacturer and one government agency). The field study confirmed the initial observations that the DSS function for an entire organization can be multifaceted. A synthesis of the field observations with concepts in the literature led to a comprehensive delineation of DSS types from which an organizational architecture for DSS was developed.

3. TYPOLOGY OF DSS IN THE ORGANIZATIONAL CONTEXT

A variety of organizational types of DSS has been reported in the literature. For example, DSSs are used to support specific business functions (Alter 1980; Hogue and Watson 1985; Keen and Scott Morton 1978; McCosh 1984), personal computing (Hackathorn and Keen 1981), corporate planning (Naylor 1979), and executive information systems (Rinaldi and Jastrzembski 1986; Rockart and Treacy 1982). However, there is a need for a typology of the distinctly different types of DSS. Identification of the different types can be an effective perceptual tool for theorists and can serve as a valuable guide for organizations to plan, design, and manage the DSS function. Considering DSSs from an organization-wide viewpoint, we identified four types of decision support systems.

3.1 Corporate Planning Systems (CPS)

Almost all large corporations engage in the use of corporate planning models. This activity is at least 20 years old, has undergone three distinct generations of development (Naylor 1982), and precedes the creation of the "DSS" term. The literature on corporate planning systems and on DSS have followed separate paths, although the relationships between the two occasionally have been discussed (Scott Morton 1982). Indeed, the separation is especially puzzling in view of the reported predominance of corporate planning in DSS applications. For example, in a recent study, fifty percent of the reported DSS applications consisted of "corporate planning and forecasting" (Hogue and Watson 1985).

Corporate planning systems have all the typical structural and usage characteristics of decision support systems as well as enough unique characteristics to justify CPSs as a distinct class of DSS. The distinguishing characteristics include the corporate-wide scope of such models, the high organizational level of the end users, the long-term time horizon of the decision tasks, and the resource commitment and degree of formality involved. Corporate planning systems tend to be developed by formally designated "corporate planning departments" whose exclusive responsibility is development and maintenance of the CPS.

3.2 Functional Decision Support Systems (FDSS)

Many of the DSS cases reported in the literature (Alter 1980; Keen and Scott Morton 1978; Klein 1982; McCosh 1984) have a functional orientation. Such systems are designed to provide support in a functional area such as sales management, investment analysis, and human resource management. These types of functional support systems may be called the "classic" DSS since they have been the cornerstone examples of specific DSS referred to in the literature during the past fifteen years.

Functional DSS clearly can be differentiated from corporate planning systems. In contrast to the corporate-wide scope of the latter, the scope of FDSS is limited to a single function within an organization. A direct consequence of such limited scope is the relatively lower organizational level of the users, the shorter time horizon of the decision tasks, and the less extensive commitment of human resources to assist in the development and use of such systems. A "project team" is the likely organizational group for FDSS development, rather than the planning "department" characterizing CPS development.

3.3 Executive Information Systems (EIS)

A strong case has been made that top executives of large multidivisional corporations need a special kind of deci-

sion support -- executive information systems (Rockart and Treacy 1982, Burkan 1988). That view maintains that the traditional (functional) DSS are not well-suited for top executives in large organizations. Such executives like to track and monitor performance data relating to the critical success factors of their organization. In essence, EIS are designed to assist top-level executives in the conduct of ad hoc analysis of current performance and projected operations. Unlike corporate planning systems whose main purpose is to support long-term strategy formulation, executive information systems have a more short-term time horizon and place greater reliance on the availability of well-organized performance data. Model building and other analytic capabilities are available in EIS but they tend to be simpler and to focus on typical what-if analysis and projections. Mittman and Moore (1984) provide indirect reinforcement for the EIS concept through their survey of computer use by senior management. They found that senior managers consider DSS generators and other general purpose tools more useful than specific DSS.

The extensive use and reported benefits of EIS in large organizations have been well documented (Jordan 1988, Rinaldi and Jastrzembski 1986; Rockart and Treacy 1982). EIS are identified as a separate type not because they differ in their fundamental structure as decision support systems, but rather because they are a distinct activity within the context of organizational structure; they serve ad hoc decision analysis needs of top executives in large organizations.

3.4 Local Decision Support Systems (LDSS)

The wide availability of software and hardware tools that support personal and mainframe end-user computing has been responsible for the development of what may be referred to as "local" decision support systems. The general characteristics of LDSS include development under local control, response to local needs, and relatively little formal structure. The presence and characteristics of such systems have been recognized in the literature and a number of issues have been discussed about their design and management (Hackathorn and Keen 1981; Henderson 1987). Local DSS have sub-functional scope contrasted to functional DSS, cover a wide range of managerial levels as well as professional staff, are informally developed and maintained, and tend to be used for ad hoc decision support.

4. ARCHITECTURE FOR ORGANIZATION-WIDE DSS

The preceding DSS typology provides the foundation for a coherent architecture that could serve as the basis for planning, designing, and managing organizational DSS. The need for an architecture for organizational DSS seems to have been overlooked in the literature. When the term "architecture" has been used the reference is to individual DSS on a one-at-a-time basis (Henderson 1987; Sprague and Carlson 1982; Sprague and Watson 1986) rather than from an organization-wide viewpoint. Hogue and Watson (1983) do recognize that managing DSS as an organizational activity is one of the most neglected areas of DSS research, but they limit their attention to management issues of individual DSS. Young (1984) has focused on a need for a corporate strategy for DSS but has not recognized the different types of DSS and the need for a corresponding architecture. Ariav and Ginzberg (1985) emphasize the role of the environment in DSS design, and they define environment to include task structurability, organizational level, functional area of application, and relationship to other computer-based systems. However, they limit their focus to the implications of the environment for the internal structure and architecture of individual decision support systems.

4.1 System Formality

Donovan and Madnick (1977) describe the concepts of "institutional" and "ad hoc" DSS that relate to the decision context. Institutional DSS are ones designed to provide support in environments where there are recurring types of decisions. In contrast, ad hoc DSS are designed for environments where support for decisions are on a demand basis.

There is a need for both institutional and ad hoc systems at all levels of management (Garnto and Watson 1985). CPS support decisions affecting organization-wide functions, whereas FDSS are generally limited to a specific function. On the ad hoc side, EIS are different from local DSS because of the type of data needed, the extent of staff support required, and the relative importance and scope of the decisions involved.

CPS and FDSS are "institutional" types. Such systems are designed to support a well defined class of decisions that have been identified through some formal systems design activity. In contrast, EIS and LDSS are "ad hoc" and may not even be systems but capabilities for decision support. The highly variable, ad hoc nature of the decision making environment does not support well-defined, formal systems. Instead, the approach is to provide a collection of tools or capabilities that can be applied in the unpredictable decision making process. In the case of LDSS, it is possible to encounter "institutional" types of cases: a local DSS could be developed for routine decision making. However, LDSS should tend to be predominantly ad hoc due to their informal design process, minimal documentation, and personnel turnover factors that tend to discourage system formality.

4.2 Decision Making Mode

During the last few years there has been increasing interest in Group DSS (DeSanctis and Gallupe 1985). It is reasonable to expect that management practice will parallel the heightened level of research activity in GDSS. Rathwell and Burns (1985) suggest that DSS could be utilized to help groups undertake planning activities especially within a distributed information systems structure. Group DSS are a recent enough phenomenon to disallow definite statements about their design, structural, and usage characteristics. Nonetheless, it is quite clear that individual and group DSS constitute two distinct types. All four organizational DSS types (CPS, EIS, FDSS, and LDSS) could potentially be designed and used as either individual or group types, although there may be a tendency for some DSS types to be more individual in their mode of use (EIS, LDSS).

4.3 Organizational Level/Scope

A third useful dimension for viewing the DSS function in an organization-wide context is the organizational level and scope associated with decision support systems. We have identified two organizational levels: corporate/strategic and functional/operational. Although it is conventional to identify three levels of management (strategic, management control, operational control, per Anthony 1965), the distinction between corporate versus functional management represents a clear division: a corporate scope involves management issues affecting more than one business function. Corporate planning and executive information systems are designed for decision support of managers having a corporate viewpoint. On the other hand, functional and local DSS are designed to support decisions involving individual business functions.

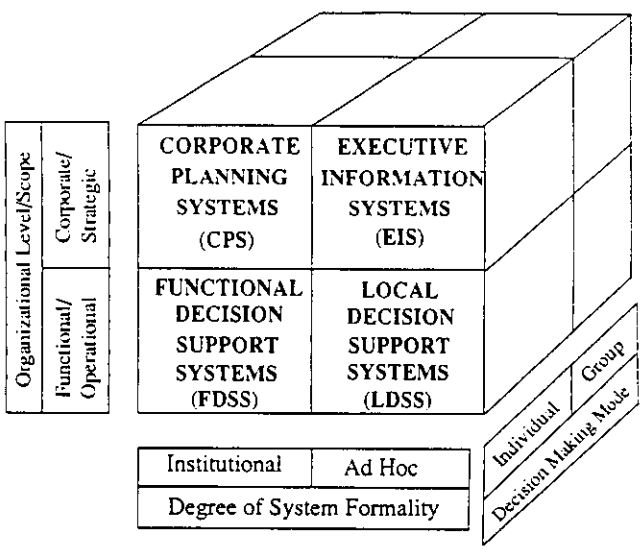

Figure 1. An Integrated View of Decision Support Systems

4.4 Integrated View of DSS

Figure 1 relates the four main types of organizational DSS--CPS, EIS, FDSS, LDSS--to the three dimensions of organizational level, system formality, and decision making mode. System formality is represented by the institutional versus ad hoc classification. This classification is consistent with the systems versus capabilities characteristics of corporate and functional DSS on one hand and EIS and LDSS on the other. Decision making mode includes the individual versus group classification. Organizational level/scope is represented by the corporate/strategic and functional/operational classification.

This integrative framework provides a fundamental guide for organizational planners of the DSS function. A main ingredient in this architecture is the organizational assignments for the different types of DSS. Corporate planning systems have been traditionally designated to a "Planning Department" or a similar organizational unit (Naylor 1979). Executive information systems also tend to be administered under a separate organizational entity. Rockart and Treacy (1982), in a sample of sixteen major organizations, found that EIS support staff were "organizationally separated."

Figure 2 portrays the organizational position of the different DSS types. Corporate planning and executive information systems are positioned at top levels in the organization because their scopes involve more than one functional area. On the other hand, functional and local DSS can occur in any organizational function, and they are limited to their respective functions. There may be none, one, or more than one of either FDSS or LDSS in a given organizational function. Given such multiplicity and the limited scope, it follows that the latter two DSS types are not administered by well defined organizational entities, but rather they tend to be run by individuals or teams embedded within the corresponding organizational function.

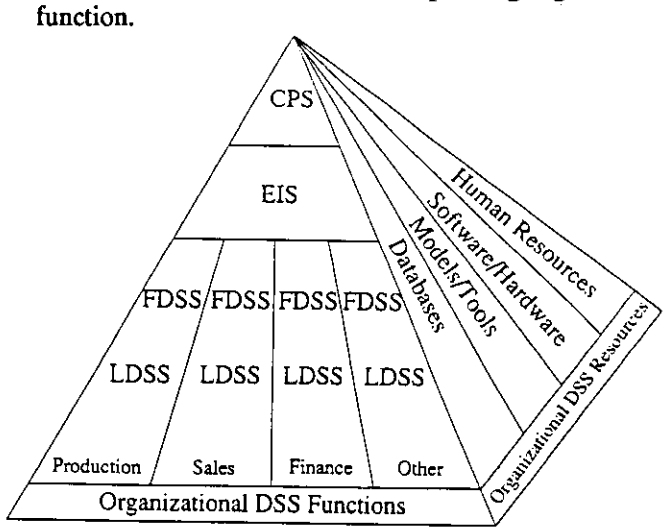

Figure 2. Organizational Architecture for DSS

All four DSS types are likely to draw upon shared organizational DSS support resources such as internal and external databases, DSS generators and modeling tools, systems software, communications networks and other hardware, and human resources as shown in Figure 2. This view is supported by Hogue and Watson (1983). In their study of eighteen companies, they found that in seventy-two percent of the cases the administration of a DSS is limited to a single department. At the same time, they observed that there was extensive contribution of resources from the computer based information systems group. Shared organizational DSS support resources provide the main reason for an organization-wide DSS architecture. Shared resources emphasize the need for organizational planning, design, and control of the DSS function by making explicit the interrelationships among DSS types and the resultant need for central managerial coordination and control. The total DSS function in the organization can be planned and managed rather than be left to individual DSS champions or random circumstances.

5. DISCUSSION AND IMPLICATIONS

This exploratory investigation developed an architecture identifying and integrating four types of DSS in organizations and relating them to decision making mode, organizational level, and degree of formality for DSS. The study presented an architecture that can be used as a basis for management control, resource allocation, designation of independent and shared resources, and, above all, a vision of a DSS-mature organization.

Practitioners tend to focus on partial DSS capabilities without an integrated view of DSS. There is a pressing need for organizations to engage in strategic planning for the DSS resource (Henderson, Rockart and Sifonis 1987). As organizations mature with DSS experience they should eventually develop and manage all four types of decision support systems: corporate planning systems, functional decision support systems, executive information systems, and local decision support systems. The architecture suggested in this paper could assist administrators in planning for and controlling DSS as an organization-wide resource. When planning for DSS, administrators must recognize that there may be different resource requirements depending upon the DSS type.

There are several organizational implications deriving from the proposed architecture. For example, we conclude that CPS and EIS are cohesive enough functions to require their own organizational units. Their reporting level and type may vary but an initial suggestion is to have Finance and Administrative Services as the reporting units for CPS and EIS, respectively. Functional and Local DSS are embedded within individual organizational functions and do not exist as separate organizational units. However, a manager of Decision Support Services reporting to Information Management could be thought of as an explicit organizational entity. Some of the likely activities of such a manager would include administering shared external and internal databases for DSS; acquiring and maintaining generators and other tools such as analytic models, dialogue facilities, databases, graphics, communications and systems software; consultative support for evaluation of alternative options of software/hardware; development of standards; training; and liaison with users and vendors. It is apparent from these activities that Decision Support Services would be very similar to a DSS-oriented Information Center as supported by Watson and Carr (1987) and as observed by us in several organizations in our field study.

From a research perspective, the architecture presented in this paper provides a rich basis for the study of DSS systems development, DSS resource utilization and evaluation, DSS modeling characteristics, and DSS organizational impact. Systems development for DSS differs from typical systems life cycle methods (Sprague and Carlson 1982). An adequate distinction in methods for development of different types of DSS needs to be made. The extent of requirements definition, prototyping and logical design, documentation, coding and testing will be different for the development of a CPS versus a LDSS. Further work in the systems development arena is necessary to identify potential differences associated with DSS type as well as to contribute to our general understanding of DSS systems development activities. For instance, the contingency framework of Ginzberg and Ariav (1986) for designing DSSs could be further developed to apply to our DSS typology and architecture.

DSS resource utilization and evaluation is a topic of great interest. The architecture suggested in this paper would serve those researching the productivity of resources devoted to DSS. Each of the four types of DSS (CPS, EIS, FDSS, and LDSS) may have uniquely different resource requirements such as hardware, database access, models, staff support, technical support, communications, and report generation. Resource differences could affect systems development as well as managerial control over DSS resource allocations and future growth of DSS. Evaluation of decision maker productivity and evaluation of DSS productivity also could be facilitated by the proposed architecture. The architecture would assist productivity evaluation by delineating organizational goals and resources to specific types of DSS as well as studying how well DSS resources are deployed for given purposes. Research on productivity measures for decision making activity has been limited. Some studies, such as Keen (1981) and Sanders (1984) have begun to explore the productivity measurement of DSS.

Modeling characteristics of each type of DSS may be another fruitful area for research. The proposed architecture could guide researchers in addressing what types of model support are required for the different types of DSS.

Modeling features may be important dependent variables in some DSS research (see, for example, Green and Hughes, 1986) and it would be beneficial to empirically determine if there are decision maker usage differences based on the modeling features in relation to the DSS types in the organizational architecture.

Research on the organizational context of DSS could be dependent on the type of DSS. What are the differences and similarities between the types of DSS and what are the resources common to them? What are appropriate administrative assignments corresponding to each type? From a central organization viewpoint, how does the organization plan for the development of each type? Should organizations phase-in one type of DSS at a time or proceed with parallel development of several types? What is the delineation of roles between DSS users and the traditional information services group? Given recent evidence of extensive management involvement in DSS (Hogue 1987), what might be the effect of a new generation of managers highly trained in computer usage on the resources of an information system? These questions deserve serious attention from both the academic and practitioner communities.

The proposed architecture in this paper has integrated the DSS function based on the literature and field observations. This architecture provides the means for better managing and understanding DSS as an organizational function. The architecture also can serve as a vehicle for fitting the seemingly unrelated collection of DSS experiences into a comprehensive and integrated body of knowledge.

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7. ENDNOTES

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