Decisive & Incisive - The Path of DSS

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Abstract

Through this study we explore the literature discussing what management information systems are what decision support systems are in an attempt to clarify the taxonomies available in the literature into a holistic discourse. The concepts are defined and discussed, the historical path of the systems' definitions are diagrammed and discussed and each taxonomy found through the literature search is framed with regard to the whole. In this work we offer a diagram charting the systemic elements which are core to the definition of what each of these systems are. This diagram is useful in explaining where an information system fits into the taxonomies found in the literature.

Through this we have described the path of information systems from the processing of electronic transaction data through to expert systems. In particular we have focussed on the elements of management information systems and decision support systems and their place within the available taxonomies.

Keywords: Decision Support Systems, Management Information Systems, Meta study, taxonomies, frameworks.

Introduction

Information systems include hardware and software, people and procedures, policies and processes which are involved with the collection, storage, transformation and retrieval of data and information. In our context we will discuss information systems in terms of their relevance to business organisations, their relevance to management and then their relevance to decision making.

In this article we discuss the path of information systems from those first described to the state of the field today. Beginning with management information systems we discuss the elements necessary for a system to be considered as a management information system and distinguish the boundary between those and earlier data processing systems. We then map the discourse from management information systems to the introduction and development of the term decision support system and proceed to discuss the similarities and differences between management information systems and decision support systems.

There is some disarray concerning the classification of information systems. A multitude of papers deals with frameworks and taxonomies to structure our thought in the field of information systems (Leavitt and Whisler (1958); Gorry & Scott-Morton, 1971; Dickson (1977); Sprague (1980); Doke, 1994). Nichols (1969) explains that classification is necessary to help relate observations to other situations. This paper attempts to amalgamate the literature which discusses the taxonomies available to allow a more cohesive understanding of the established thought on what management information systems are and how decision support systems are distinguished.

Management Information Systems

The view of information systems as lying on an evolutionary continuum is well supported (Sprague, 1980; Kendall, 1982; Shim, 2002; Power, 2007), although the exactness of where a specific system lies on that continuum remains quite debatable. Its natural location appears to centre on the level of functionality it has developed. Mason (1969) described an approach to information systems on a continuum from 'Databank' where everything of interest is simply *stored* to 'Decision-taking' where the system *initiates the action* of the decision. Ackoff (1967) takes a view of MIS as earlier on that continuum, he suggests "Information systems are subsystems of control systems". Sprague (1980) begins with describing Electronic Data Processing as the genesis of these systems which were said to have a focus on data. When this focus shifted to information, they became Management Information Systems and, as that focus turned toward management decisions, the term Decision Support Systems was initiated. Sprague specifically refers to differing views of systems' progression as having been referred to as "natural evolutionary advancement" to newer systems being seen as subsets of previous generations to them being "just another 'buzz word'". Holsapple and Whinston (1996, p141) similarly describe MIS as an extension of data processing systems where provision of standardised reporting is emphasised above the translation of transactions into records as per automation of data processing systems. Laudon and Laudon (2002) use the term scope rather than evolution, but like the evolutionary metaphor they describe how information systems have expanded in their relevance from the 1950's where their role was largely technical through managerial control systems in the 1960's & 70's and further increasing in scope by affecting more core management activities through the 1980's onwards. More modern manifestations are again widening the scope of information systems in the supply chain to include vendors and customers. The evolutionary metaphor can be misleading in that it implies an extinction of the lower order systems, however the unique internally-focussed data collected in these transactional, data-processing systems are the life-blood of the higher order MIS, the DSS, and all other systems, all other advances in MIS are based on this level (Dickson, 1968 pp18-19) or as Turban (2006) puts it: "[W]ithout data you cannot have most IT applications, nor can you make good decisions" (p409).

The concept of a Management Information System appears to stop at its ability to be flexible, specifically in its analyses, simulation and or modelling capabilities over its transactional capabilities. Turban (2006) views all data processing in an organisation as either transactional or analytical (p417). Described and prescribed attributes of Management Information Systems include everything from basic retrieval, collection and storage of the data (Laudon and Laudon, 2002) to the middle-ground providing standardised and, to a lesser extent ad-hoc reporting (Sprague & Watson, 1996); to the blurred border between DSS and MIS where DSS sports a broad definition. Doke (1994) provides a useful meta-study describing the categorisation of systems into

Transaction Processing Systems (TPS); Management Information Systems (MIS); and Decision Support Systems (DSS) as unworkable because of an inability to accommodate many modern systems. However, through his discussion, the TPS-MIS-DSS taxonomy is clearly the popular descriptive approach. Doke's proposal of a two-dimensional taxonomy, utilising user type and system support type as the dimensions, echoes the Scott-Morton (1985) approach which Doke also describes, that classifies by the type of support provided. This view was also visible in Gorry and Scott-Morton's earlier (1971) work classifying the systems in terms of the problem type and management activity. These perspectives are distinguishable from the EDP-MIS-DSS or TPS-MIS-DSS classifications in their reliance on organisational factors to classify rather than the system attributes employed by the latter. It is also useful to note the Gorry, Scott-Morton and Doke's classifications produce matrices whereas the EDP-MIS-DSS classification is hierarchical. Leavitt and Whisler's [1958] discussion of the new technology which "does not yet have a single established name", described by Doke as 'prophetic', talks of three parts; firstly the techniques for processing vast amounts of information rapidly through the use of fast computers; secondly the application of statistical and mathematical modelling to decisions and thirdly the simulation of "higher-order thinking". This division evokes the same acronym-laden hierarchical taxonomy which is so popular through the literature.

We can see there are two lenses which information systems are viewed through. The continuum, classified by system and the matrix classified by organisational features. The latter receives less support in the literature, from this discussion we see that the hierarchical taxonomy is the more popular one, likely so because it is more readily explainable. As with many hierarchical frameworks, its attractiveness in its simplicity is also its flaw. Frameworks which produce matrices may be more holistic but tend to be harder to explain and are also limited by their dimensionality.

Perhaps the term Laudon and Laudon (2002) prefer i.e. *scope* should be preferred in distinguishing the boundaries than using evolutionary terms, thusly we see that Management Information Systems are Electronic Data Processing, or Transaction Processing Systems whose scope has moved on from mere processing to include some distillation of the information in the form of reports.

Systems include people

When we speak of information systems we probably first think of the hardware and software parts of the system, what Turban (1986) refers to as ‘formal information systems’. He distinguishes these from the informal which may include ‘informal email’ and ‘office gossip’. Huber (1981) makes a similar point in differentiating between the management information system and the Management Information System, the latter being absent of the formers’ human and organizational support attributes. The sources of data for Huber include ‘sales reps’, ‘recollections’ and ‘telephone conversations’. He describes mis without direct reference to computer systems. "[E]very manager has and uses a management information system (an mis), a combination of information sources and channels, and procedures for drawing on these sources" (Huber, 1981, p1.) Turban (1986) states it simply, "in most cases an information system also includes people" (p20). As we distinguish ourselves from computer scientists and as we seek to understand the relationships between information systems and the management of enterprise, we necessarily place ourselves in the realm of social science with interests in a number of distinct disciplines. As Laudon and Laudon (2002, p15.) state, "sociologists study information systems with an eye toward how groups and organizations shape the development of systems and also how systems affect individuals, groups and organizations. Psychologists study information systems with an interest in how decision makers perceive and use formal information. Economists study information systems with an interest in what impacts systems have on control and cost structures with a firm and within markets". When we study management information systems we must envision those systems as including to a large and important extent the human information systems that exist within and between organisations. Following these characterisations the lowercase mis is the superset including the human systems and the capitalised MIS. In information systems we must recognise that the inclusion of people and their interactions are core to our studies, to distinguish ourselves from other fields of endeavour.

Kendall & Kriebal's (1982) work talks about the contributions made to MIS by the management sciences, in particular operations management, planning and control and strategic planning. What is interesting to note is the terms used when describing the systems which these disciplines have informed, as the discussion progresses through the three areas. Operations management's contribution to integral parts of the information systems surveyed surround optimization; efficiency in controlling; short term forecasting; simulation; and also inventory models; heuristic models. Management planning and control has informed through cause and effect analysis; statistical analysis; simulation for medium-range planning; scheduling for 6-12 months (medium term) in the future; budgetary control. Strategic planning contributed regression; Goal programming, smoothing and analysis; econometric forecasting and risk analysis. Techniques and models such as these are inherent parts of Management Information Systems and are what makes them Management Information Systems. Here we also see a hierarchical structure in the change of techniques employed from the short-term operational level to the longer term strategic level. Culnan & Swanson's (1986) bibliometric analysis of the MIS field includes a useful discussion on the appropriateness of Management Science, Computer Science and Organisation sciences as the basis for the MIS field. Notwithstanding their recognition of the contributions of other fields, their choice of these three interestingly parallels the three major components of what we call Decision Support Systems. The occupation of computer science with data, software and hardware and their employment by organisations mirrors the data and computer system aspects of decision support; management science's modelling for problem solving mirrors model bases in DSS; and organisational science's occupation with individuals and organisations' social contexts reflects the human elements required in DSS. Viewing information systems thusly, in terms of their roots in other distinct fields informs us of the lens which MIS practitioners view the field. Management Information Systems, as an academic discipline, pushes knowledge forward by reconciling management science, operations and strategy with the practicality of implementing computer and social systems.

Decision Support Systems

Descriptions and prescriptions of Decision Support Systems can be allowed to range from the inclusion of any system which aids in the making of a decision to systems considered intelligent which take action such as in Mason’s (1969) taxonomy. Those lower-order aids to decision making are cognisant with Sprague’s (1980) description of DSS tools. Sprague describes two other levels of DSS, the higher-order sounding “Specific DSS” and the middle ground of the “DSS generator”. Sprague diagrammatically describes these three levels' relationships to each other showing that DSS tools may be used as Specific DSS and combinations of DSS tools create DSS generators which can then be used as Specific DSS. Sprague sees "Specific DSS" as the information system application itself and infers that it is more than a DSS generator. The DSS generator designation concerns the technologies which are available separately for some time such as various disperse data and manipulation software but are combined or meld-able into a Specific DSS working on a 'common set of data' using a 'common command language'. The 'common command language' element here is what Sprague refers to as the "DSS tools", examples which he provides are such things as new languages, better operating systems and in particular new graphical abilities of languages. To place a system within the realm of Decision Support Systems though, a number of commonly described attributes are necessary. Authors converge in describing DSS as having a database, a model or rule base, an interface and a user (Turban, 1986; Todd, 1987; DeSanctis, 1987; Laudon & Laudon, 2002). Sprague's (1980) designation of specific DSS appears to be the only delineation from his three which qualifies as what is now commonly called a DSS.

Turban (1986, p122) references six classifications of DSS by Atler:

> "1. Retrieving a single item of information.
> 2. Providing a mechanism for ad hoc data analysis.
> 3. Providing prespecified aggregation of data in the form of reports.
> 4. Estimating the consequences of proposed decisions.
> 5. Proposing decisions.
> 6. Making decisions."

Doke (1994) argues that Atler's categories are too broad, that his DSS includes DSS, EXS and to a lesser extent MIS. Doke's views on Atler's classification supports the notion of lower-order and higher-order systems, within MIS and also DSS. He suggests Atler's categorisation of EDP includes TPS and MIS and Atler's DSS includes DSS, EXS and to a lesser extent MIS, views which are reconcilable if Atler's EDP classification encroaches a little on MIS and his DSS classification, while being broad at the higher end, encroaches on higher-order MIS.

In light of the distinguishing features of MIS and DSS outlined here, the elements of this classification which are DSS specific attributes are the ability for "ad hoc data analysis"; the estimation of consequence and the proposal of decision alternatives. The retrieval of a single, or multiple information items; and the provision of "prespecified aggregation" reports are attributes which are necessary and sufficient for MIS but simply necessary in DSS. The ability of a system to make decisions would suggest a less tangential, more core role than support per se.

Gorry and Scott-Morton (1971, p61) discuss Anthony's (1965) taxonomy for managerial activity describing Strategic planning; Management control and Operational control as the three categories of managerial activity which differentiate the systems that support management. They continue then to discuss Simon's (1960) analysis of a management decision making process as comprised of three distinct phases, intelligence gathering, designing solutions and choosing a course of action. Gorry and Scott-Morton use the combination of these two views to construct a matrix describing systems in terms of their support for structured to unstructured decisions for the three management activities described by Anthony's taxonomy. Gorry and Scott-Morton place what had been called MIS up to that time within the structured-decisions top-half of their matrix and call them "structured decision systems". They note that the area of most interest to management is the bottom half where the decisions are unstructured and the "decisions have a significant effect on the company".

We have discussed the necessity of people as core components of information systems however the level of involvement and interaction appears to be a distinguishable feature of DSS over MIS. Further to this there is some convergence in recognising that DSS necessitates interaction between the system itself and the user. Huber (1981) makes the same distinction here between decision support systems in the lowercase form and Decision Support Systems in the capitalised form as he does for MIS to draw out the idea of seeing the system as comprised of computer systems and human systems. The non-computer elements he suggests are part of the human decision system include staff analysts and policy manuals, whereas the DSS is the part which is "computer enhanced" (Huber, 1981, p2). The interface is the confluence of interactivity for computer and human DSS. Todd (1987, p501) recognises this when he calls it a "human-computer interface subsystem, which manages the interaction between the user and the computer system" Shim (2002, p112) argues a similar point saying whereas the computerised part deals with the structured portion, the “judgment of the decision-maker” is employed in the unstructured part to constitute the complete system. Moreover, a well tuned synergy between people and the computer system allows people to focus on their competencies, pushing the processing and analysis to the better suited computer system. E.g. Todd (1992, p374) referencing Taylor (1975) spoke about a preference for decision makers to do a more complete analysis but being hampered by human information processing limitations. Thus, the level of interaction between people and the system itself can help distinguish DSS from MIS.

There is a second enlightenment in describing a rule or model base as a necessary attribute of a DSS. Use of such a set of structures implies analyses of the data above the simpler presentation or aggregation which we recognise as more in the realm of MIS. Turban (1986, p124) found that “quantitative, mathematical, and computational reasoning” are typical in DSS. Holsapple and Whinston (1996) describe DSS as having the ability to present a “desired subset” of information from the database, which echoes the aggregation and filtering abilities of the ‘higher order’ MIS, or “deriving new knowledge in the course of problem recognition” implying analyses which is recognised as within the domain of DSS. Turban (2006, p417) asserts that there are just two types of data processing in organisations, transactional and analytical. Viewed in terms of their processing activities, transactional systems are more likely data-processing operational-level management information systems whereas the analytical systems are more likely DSS. This analytical processing can also be referred to as ‘business intelligence’ (Ibid, p417). In light of this, a second distinguishing attribute of DSS over MIS is the ability for modelling or analyses.

The further one moves on up the chain of DSS to higher-order DSS one begins to encounter Expert Systems. Turban (1986, p121) describes expert systems as combining “knowledge of a particular application area with an inference capability”. The step above analyses to inference appears to be a distinguishing feature of expert systems above DSS. An "ES is a computer program that includes a knowledge base containing an expert's knowledge for a particular problem domain, and a reasoning mechanism for propagating inferences over the knowledge base" (Ibid, p122). A similar situation of Executive Information Systems appears to be valid. Laudon and Laudon (2002. p45) assert that EIS tend to make *less use* of analytical models than

DSS, which implies that they do use analyses. They are described as those systems which serve strategic management in making decisions by summarising, filtering and compressing data from MIS and DSS and incorporating data from external sources to help provide insight in solving problems for which there is no agreed model or procedure for. The use of data from MIS and DSS suggests they are, to use evolutionary terminology again, higher-order systems. The reduction in model use may be reconcilable with their positioning as higher-order DSS because of the absence of agreeable models for the decisions they attend to.

Figure 1 displays the frameworks proposed in the literature superimposed on each other. The vertical lines display the transitions on the continuum between systems. We have placed each of the frameworks found where we believe they best fit upon the well accepted basic framework.

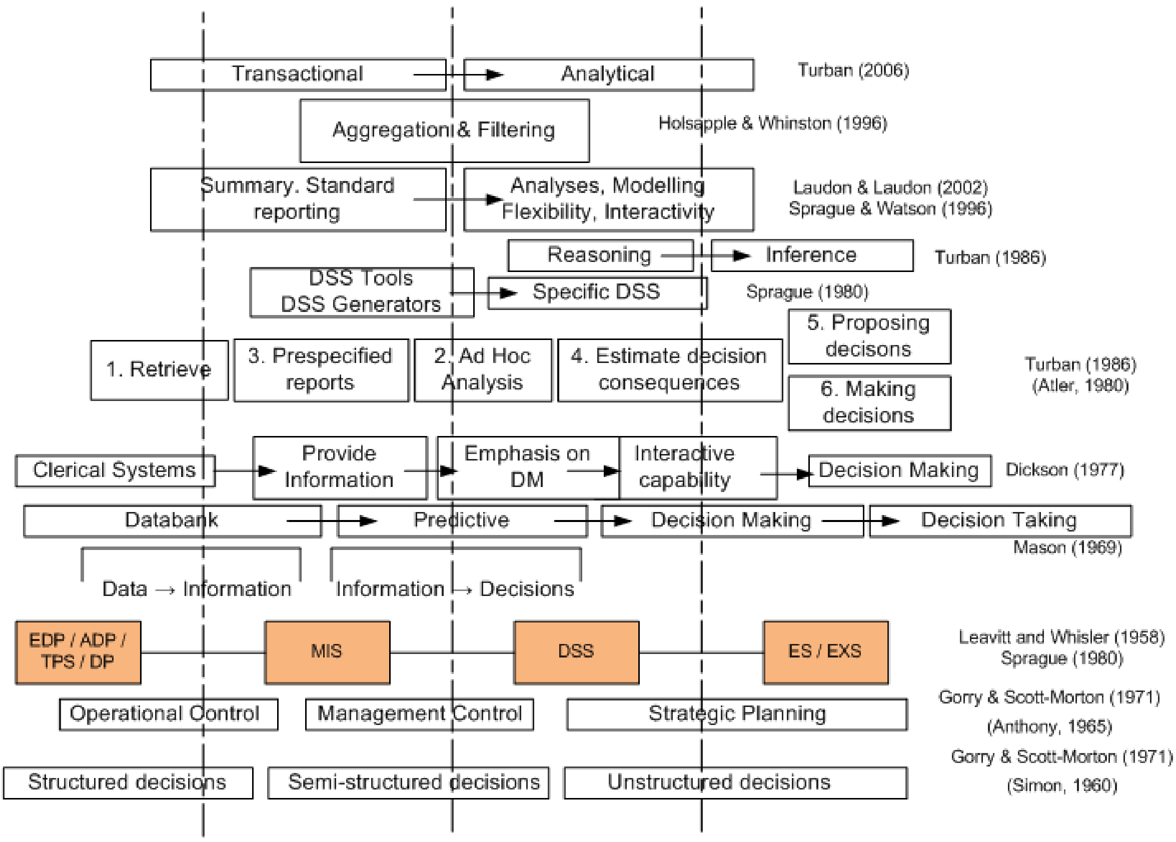

Figure 1

Discussion & Conclusion

It is arguable that all but the primordial, data-processing focused MIS are describable as DSS. Indeed, Gorry and Scott-Morton (1971, p56) assert that "information systems should only exist to support decisions". Nichols (1969, p73) believes information only has meaning in the context of a decision. Many authors speak of management decisions with reference to MIS (Laudon and Laudon (2002); Keen (1980); Nichols (1969)). The point where DSS are distinguishable from MIS is notable. Whereas MIS may indeed support management decision making, MIS are not described as analytical. Once analyses are introduced, especially when modelling aids in that analysis thenceforth a DSS is born. Sprague & Watson (1996) say an MIS is missing attributes required for a decision support system. They specifically refer to “analytic aids” as necessary for a system to be describable as decision supporting.

Laudon & Laudon (2002) make this distinction in saying that MIS support decision making in that they provide summary and exception reports. They do not tend to have mathematical models or analysis capabilities but rather use summarisation and comparisons in the standard reports. DSS is contrasted in that they use data from Transaction Processing Systems (TPS) and MIS and may also incorporate data from external sources. They are described as being more flexible, more analytical, more interactive and more explicitly user oriented. (p44)

The path to DSS is distinguished by signs of analyses, the introduction of models and use of modelling techniques, the ability of the system to predict and the level of interaction with people which the system can support. As we pass through DSS and into less charted territory, we encounter fewer models. This is where we see what are called Expert Systems. Fewer models are a result of the absence of agreed models and procedures in these situations. The incorporation of data from external sources is more common here. Expert systems are seen to have inference capabilities, apply some reasoning to the data set, include external data and have fewer agreed models, yet are placed above DSS in the hierarchical taxonomy because their scope is at a strategic business level, a more macro view dealing with inter-organisational relationships and having an external focus.

Viewing systems on the continuum with regard to the attributes of the types of systems discussed here we can create a diagram as in Figure 2.

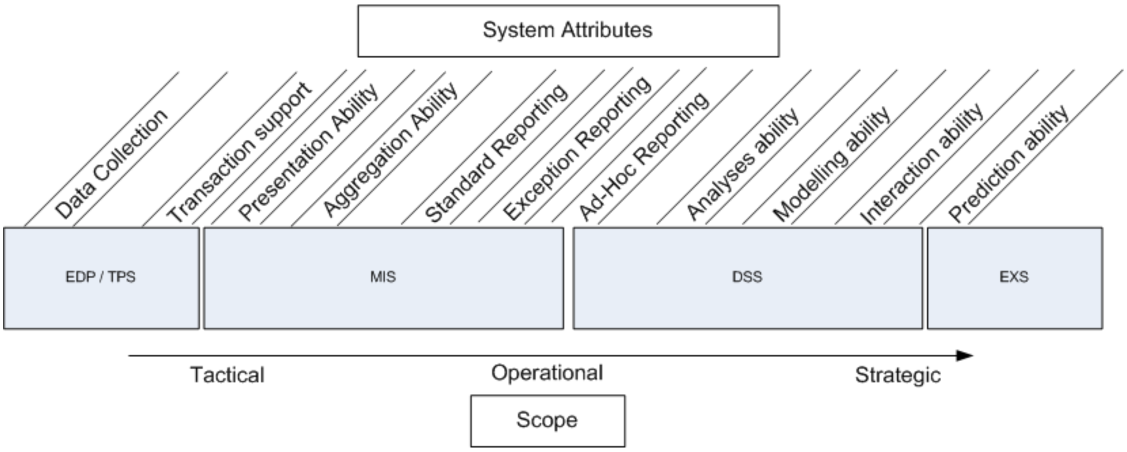

Figure 2

From this diagram we can distinguish EDP and TPS from MIS by the degree to which the system in question is transaction supporting or has an ability to present the data collected. The system moves more toward the centre of what an MIS is as it attains the ability to aggregate data and provide reports. As the ability to report in a less standard and more interactive and dynamic way is introduced the system can begin to be regarded as DSS. The introduction of analysis capability, the use of models and increased interaction ability denotes the system as a DSS. The ability of the system to help make predictions denotes the system is moving toward an expert system. It is also useful here to note the tendency of these systems' usage to move up in organisational scope from EDP being a tactical system to EXS being a strategic system.

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