Issues and Opinions

Comments on "Price and Value of Decision Support Systems"

Abstract

Pieptea and Anderson's (1987) article promised to reconcile the conflicting approaches in cost-benefits literature on DSS. However, we find several weaknesses in their conceptual framework and their use of Simon's phases of decision making. We argue that the true relationship between the phases of decision making and the intangibility of DSS benefits is exactly the opposite of what Pieptea and Anderson claim it to be. In the construction of Dimension II, Pieptea and Anderson unjustifiably collapse four criteria into one. Furthermore, some of their criteria appear in the definitions of both the dimensions of their framework. They equate the intangibility of benefits with "value-price gap," which could mislead managers into believing that all DSS with high degree of intangibility are ipso facto justified.

Introduction

Pieptea and Anderson's (1987) article in *MIS Quarterly* entitled "Price and Value of Decision Support Systems" seemed important as it promised a framework for reconciling conflicting approaches in the cost-benefit literature on decision support systems (DSS). Pieptea and Anderson attempt to map all DSS on a two-dimensional classification scheme. Their Dimension I consists of Simon's (1977) phases of decision making, namely *intelligence, design,* and *choice.* On Dimension II, they combine several criteria (including the degree of structure, managerial level, degree of uncertainty, and the source of information) to propose three classes (Class 1, Class 2, and Class 3) of decisions. The resulting framework consists of nine cells for classifying DSS. Pieptea and Anderson label these cells by referring to their respective categories on the two dimensions, e.g., Intelligence/Class 1 cell, Design/Class 1 cell, Design/Class 3 cell, etc. They suggest that there is a relationship between the "price-value gap" and the DSS attributes in each cell of this framework. They go on to reconcile contrasting views on cost-benefit evaluation of DSS and assert a contingency view in which the suitable evaluation method for a particular DSS depends upon the cell to which it belongs. Thus, Pieptea and Anderson claim that DSS belonging to certain cells are more amenable to traditional cost-benefit analysis than DSS belonging to certain other cells.

We consider such an explanatory framework very promising. However, as we read the paper in detail we find it increasingly confusing. For example, the executive summary (written by the editor) says, "The value of DSS to support highly unstructured decision processes is much harder to assess than that of DSS to support highly structured decision processes, particularly where the DSS is aimed at simply identifying a potential problem" (p. 514). In other words, the executive summary says that the value of a DSS is harder to assess in the Intelligence/Class 3 cell of Pieptea and Anderson's framework. In direct contradiction to this, in the body of the paper, Pieptea and Anderson say, "As one moves from nonstructured [i.e., Class 3] to highly structured [i.e., Class 1] decisions and from Intelligence to Choice, the intangible benefits become the more important motivating factors for system selection" (p. 523). Insofar as intangible benefits are difficult to measure, here they are suggesting that the value of DSS in Choice/Class 1 cell is harder to assess. Furthermore, both of the above statements differ from another statement where Pieptea and Anderson say, "we conjecture that this [value-price] gap is related to the intangibility of benefits that increases as we move towards the Choice/Class 3 cell" (p. 523). As another example of inconsistency, note that on page 522 they state, "DSS systems. . . classified as supporting highly structured [i.e., Class 1] decisions and addressing the Intelligence phase of the decision-making process are sometimes described as TPS [Transaction Processing Systems]." However, on page 523 they say, "systems in the Intelligence/Class 3 cell can sometimes be associated with Transaction Processing Systems."

To clarify this confusion, we undertake a careful scrutiny of their article, assuming that Pieptea and Anderson's Figure 1 represents their true views, notwithstanding any of their other state-

ments that may be contradictory. We take issue with several points of Pieptea and Anderson's conceptual framework, as detailed below.

Use of the Phases of Decision Making as Dimension I

Although Simon's (1977) phases of decision making (namely: intelligence, design, and choice) clearly provide a powerful model for understanding decision-making processes, we do not believe that they constitute a good basis for classifying DSS. First, decision-making situations do not present themselves to decision makers in clearly separated, sequential phases. Rather, decision problems must be dealt with and solved as totalities. Simon (1977) himself recognizes the interwoven, overlapping and dynamic nature of these phases when he says:

> Generally speaking, intelligence activity precedes design, and design activity precedes choice. The cycle of phases is, however, far more complex than this sequence suggests. Each phase in making a particular decision is itself a complex decision-making process. The design phase, for example, may call for new intelligence activities; problems at any given level generate subproblems that, in turn, have their intelligence, design, and choice phases, and so on. There are wheels within wheels within wheels" (p. 43).

Second, we must recognize the relativity and certain limitations of scope that are implicit in the phases of decision making. To begin with, the phases are defined (1) at the level of a specific decision problem, and (2) from the vantage point of an individual decision maker. As such, they cannot capture complexities of an organization, where many individuals at different levels of hierarchy are dealing with several differently interwoven decision problems. What may be intelligence activity for one organizational level may well belong to the choice phase for another. For example, from a physician's point of view MYCIN is conventionally associated with the problem identification phase because it helps identify the patient's disease. However, it is equally logical to say that from the patient's standpoint MYCIN supports the choice phase by facilitating the selection among possible alternative treatments.

In view of such overlaps and interactions among the phases of decision making, Simon's framework should not be expected to support a neat and clear-cut classification of DSS as proposed by Pieptea and Anderson. To our knowledge, Simon has never used his phases to classify information systems. The unsuitability of Simon's framework for classifying DSS is further confirmed when we observe that in Table 2, Pieptea and Anderson had to classify six out of the 19 DSS in their sample (AAIMS, MDS, PMS, PAMS, BONDS, and MUB) into more than one cell along Dimension I. This means Pieptea and Anderson's Dimension I is not discriminating enough.

Interpretation of the intelligence phase

We believe that Pieptea and Anderson's interpretation of the intelligence phase falls short of a complete and accurate representation of what Simon defines as intelligence. It is true that Pieptea and Anderson's basic description of Simon's intelligence phase ("Intelligence corresponds to identification of problems and calling for decisions") is consistent with Simon's definition. However, in applying it, Pieptea and Anderson seem to limit themselves to its "problem identification" aspect. This is evident from their statements such as: (1) "This phase refers to detecting. . . anything that does not match *a predetermined plan,* norm or standard," and (2) "To this category belong DSS applications that create *trend reports, exception reports* and ad hoc inquiries" (pp. 516–517) (emphasis added). Thus, Pieptea and Anderson seem to believe that DSS aimed at the intelligence phase are basically transacting processing systems (TPS) that qualify as DSS because they support certain types of decisions. Perhaps through such statements, Pieptea and Anderson are trying to show that their framework is comprehensive enough to allow the classification of a continuous spectrum of information systems, including TPS, MIS, and DSS.

If so, Pieptea and Anderson should not have restricted themselves to only three of the four phases of decision making that Simon identified. In his original work, Simon (1977) recognizes a fourth phase called "review activity," which is aimed at assessing past decisions. We believe that most TPS, through their trend and exception reports, support this fourth phase. Of course, we recognize that Simon's phases are overlap-

ping, and such routine reports can indeed help problem identification. Pieptea and Anderson's example of a warehouse manager identifying a stock below its order point level is precisely an example of such routine monitoring. However, problem identification is only a part of what Simon calls intelligence, and a not-so-important one at that. Unfortunately, Pieptea and Anderson seem to focus exclusively on that part, ignoring the more important part, namely, "searching the environment for conditions calling for decision" (Simon, 1977, p. 40). This requires much more than routine monitoring. In Simon's words,

> Intelligence information. . . is mainly used for *attention-directing* and parameter-measuring purposes. It helps management determine where they are and what problems need attention. . . *particularly problems originating from changes in the external environment* (p. 128, emphasis added).

Thus, in Pieptea and Anderson's example, in addition to identifying which stocks are below their order point level, the company (perhaps the production manager's level) must also see if the order point levels themselves need revision. Perhaps the most valuable form of intelligence activity in this context (at the vice president's level) might involve an on-going, global, yet "hawk-eyed" scanning of such aspects as the competition, the changes in technology, and the organizational culture, to decide when to put the whole question of converting to a just-in-time production system on the corporate agenda. Clearly, the information one needs for this kind of intelligence activity does not come from transaction processing systems (TPS). Moreover, a DSS aimed at facilitating this type of activity is clearly associated with a high degree of intangibility of its benefits. Consequently, contrary to Pieptea and Anderson's assertion, such a DSS would be less amenable to traditional cost-benefit analysis.

Simon (1977) himself describes the *non-routine* character of intelligence activity and its implications for the applicability of cost-benefit analysis:

> Often the crucial step in the introduction of a computer into a company was the initial step of putting the question on the agenda: Few companies that carried their investigations of computers to the point where they had definite plans for a major possible application failed to install them. Commitment to the new course of action took place gradually, but usually irreversibly, as the intelligence and design phases of the decision were going on. . . . Bringing the first computer into a company was not only a decision; it was also a major piece of *intelligence activity.* By increasing awareness of computers, it provided new occasions for decisions about potential applications. . . . The first investment in a computer, preferably one of modest size, was not to be judged by its cost-saving potential—it might have none—but by its contribution to intelligence capabilities and subsequent decisions" (pp. 42–43).

It is clear that Simon considers the intelligence phase to have a high enough degree of intangibility of benefits, high enough for him to suggest the inapplicability of the traditional cost-benefit analysis. Pieptea and Anderson (1987) seem to directly contradict Simon's view in this regard when they say: "As one moves from. . . Intelligence to Choice, the intangible benefits become the more important motivating factors for system selection" (p. 523). We attribute this contradiction to Pieptea and Anderson's narrower interpretation of the intelligence phase.

Interpretation of the choice phase

Pieptea and Anderson's interpretation of the "choice" phase is as follows: "Choice involves the selection of a particular course of action. This phase is more complex due to difficulties such as multipreference, uncertainty, conflict of interest and control" (Pieptea and Anderson, 1987, p. 517).

We believe that attributes such as multipreference, uncertainty, and conflict of interest characterize a decision situation as a whole rather than any particular phase of decision making. In fact, Pieptea and Anderson themselves use uncertainty as one of the criteria for their Dimension II, which attempts to classify various *decision situations.*

We also disagree with their assertion that the choice phase of decision making is necessarily more complex than the previous two phases. In fact, owing to the "order-producing" nature of information, we expect that any complexities or unstructuredness associated with a specific decision situation should diminish as the decision-making process moves from the intelligence phase to the choice phase. For example, con-

sider the plant location decision that Pieptea and Anderson mentioned as an example of their Class 3 decision situations. The intelligence phase of a plant location decision involves the determination of whether to put the question of a new location on the corporate agenda. In this determination of the agenda, the top management group must deal with its multiple preferences, uncertainties, and conflicts of interest, e.g., one vice president preferring a proven site in spite of declining long-term prospects, while another is willing to consider abandoning it. As the decision makers assimilate and exchange information and move forward beyond putting the question on the agenda (i.e., from the intelligence phase) to the consideration of specific alternatives for the new location (i.e., to the design phase), they would have reduced the degree of multiplicity of preferences, chosen to ignore some of the uncertainties involved, and even negotiated some of the conflicts among their individual interests. Thus, as compared to the intelligence phase, there would be lower levels of multipreference and uncertainty during the design phase of the problem-solving activity. In the design phase, the decision makers must arrive at a consensus on the set of alternatives to be considered (from which one would finally be chosen), further reducing the levels of multipreference and uncertainty. Thus, by the time the decision makers reach the choice phase, the multipreference and uncertainty associated with the decision situation would be at their lowest levels.

Construction of Dimension II

The various criteria found in the MIS literature for classifying decision situations include: (1) degree of structure, (2) level of managerial activity, (3) degree of uncertainty, and (4) source of information used. Pieptea and Anderson point to a number of studies in the literature that suggest high correlations among these criteria. Based on these correlations, they collapse all four of these criteria into a single dimension (Dimension II) for their classification framework. We believe that although such a simple approach may suffice in most cases, it is perhaps too simplistic, and a number of practical DSS may escape a clear categorization on Pieptea and Anderson's Dimension II. For example, consider a top manager who, for reasons of confidentiality, refuses to delegate a highly structured decision (such as the determination of bonuses for division heads based on a quantitative formula) to his assistants but may be willing to use a computer-based DSS for this purpose. Would Pieptea and Anderson put this DSS in Class 1 because it supports a highly structured decision, or would they put it in Class 3 because it supports decision making at the top management level? As another example, consider a DSS aimed at helping a fire company dispatcher whose task is seen as fairly structured but whose information source is primarily external. Is this a Class 3 DSS because it uses external information, or is it a Class 1 because it is at the level of a dispatcher? These examples may be atypical, but they show that Pieptea and Anderson's framework may not lead to clear-cut categorization of all DSS.

Another problem with Pieptea and Anderson's construction of Dimension II is that some of the factors used to define this dimension (e.g., uncertainty) are also involved in the definition of their Dimension I. In an ideal classification scheme, the factors used on one dimension must not overlap with the factors on the other dimensions. Furthermore, several factors may be collapsed into one dimension if, and only if, there is perfect correlation among those factors. We find that Pieptea and Anderson's scheme falls far short of the ideal.

In spite of its imperfections, Pieptea and Anderson's scheme would be useful for classifying a majority of DSS, particularly if it helped to understand what they claim to be the associated value-price gap. However, in what follows we show that the notice of "value-price gap" is unnecessary to explain why certain types of DSS are amenable to traditional cost-benefit analysis while other DSS are not. More importantly, we point out that Pieptea and Anderson's use of this phrase may mislead managers into choices that may not be truly justified.

The Relationship Between DSS Attributes and Intangibility of Benefits

Figure 1 depicts our visualization of the relationship between DSS attributes and the intangibility of DSS benefits. Like Pieptea and Anderson, we believe that along Dimension II, as the degree of structure decreases from Class 1 to Class 3,

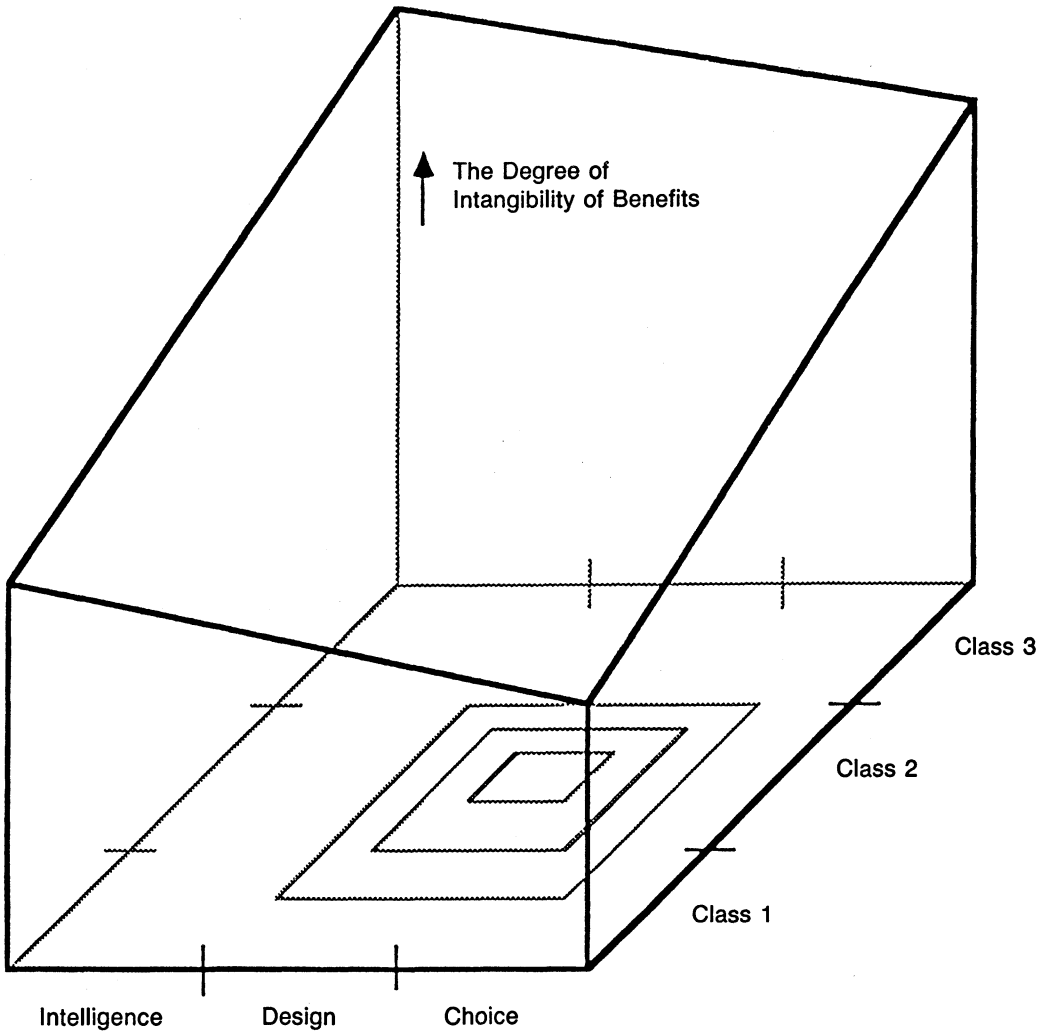

Figure 1. A Revised Concept of the Relationship Between DSS Attributes and Intangibility of Benefits

the degree of intangibility increases. On the other hand, we argued earlier in this article that as decision makers move from the intelligence phase to the choice phase of a decision situation, they are engaged in a process of reducing the uncertainties and conflicts of interest, etc. Thus, we believe that the relationship between the phases of decision making and the intangibility of benefits is exactly the opposite of what Pieptea and Anderson claim it to be. As Figure 1 shows, we believe that the intangibility of benefits must be relatively high for a DSS that supports the intelligence phase as compared to the intangibility of benefits of a DSS supporting the choice phase.

Observe that in Figure 1, unlike Pieptea and Anderson, we do not use the phrase "value-price gap" to represent our vertical axis. We simply label our vertical axis as "the degree of intangibility of benefits." King and Schrems (1978) point out that intangibility of benefits means either that we are unable to identify appropriate variables to measure the benefits, or we lack adequate precision in measuring those variables. In either case, if somehow we do estimate the value of an intangible benefit, such an estimate is likely to suffer from a large standard deviation. However, one cannot assume that the mean of such estimates will be either higher or lower than the

true mean value of that benefit. Similarly, we cannot assume that the true mean of some intangible benefit is necessarily larger or smaller than the true mean of some tangible benefit.

Thus, if the benefits of a DSS are characterized by a higher degree of intangibility than are its costs, all we can assert is that our estimate of its "value" is less precise than our estimate of its "price." Bear in mind that what we have identified is a gap "between the precisions" (of the two estimates) and not between the two estimates themselves. We believe that it is misleading to label this gap between the precisions as "value-price gap," insofar as such a label suggests the unwarranted conclusion that what is more intangible is more valuable and that a DSS with a high degree of intangibility of benefits deserves funding without any formal cost-benefit assessment.

In contrast, our diagram relates only the degree of intangibility to the DSS attributes. We believe that in situations of low intangibility (i.e. Choice/Class 1), traditional cost-benefit analysis may be the best approach for selecting a DSS, and in situations of very high intangibility (i.e., Intelligence/Class 3), the McLean and Riesing (1977) approach that, as noted by Pieptea and Anderson, "DSS are discretionary in character and have no justification or right to exist beyond the user's ability and desire to use them" (Pieptea and Anderson, 1987, p. 515) should be adopted.

Conclusion

At first glance, we were excited to see Pieptea and Anderson's (1987) article because it promised to reconcile conflicting approaches in the cost-benefit literature on DSS. Having encountered a number of instances of mutually contradictory statements within their article, we undertook a careful scrutiny of their framework. We found that Pieptea and Anderson's use of Simon's (1977) phases of decision making (as Dimension I of their framework) falls short of a complete and accurate interpretation of Simon's ideas. In our view, the relationship between the phases of decison making and the intangibility of benefits is exactly the opposite of what Pieptea and Anderson claim it to be. In the construction of Dimension II, they have collapsed four criteria into a single dimension. Although there may be broad partial correlations among the four criteria, we believe that in order to permit their collapse into a single composite criterion there would have to be much stronger one-to-one correspondence among individual categories across the four criteria in their Table 1. Furthermore, Pieptea and Anderson have used some criteria (e.g., uncertainty and degree of structure) in defining both Dimension I and Dimension II.

We also showed that the notion of "value-price gap" is not necessary to explain why certain types of DSS (namely those with highly intangible benefits) are not amendable to traditional cost-benefit analysis. We have argued that it is incorrect to equate intangibility with "value-price gap." We are most concerned that managers reading Pieptea and Anderson's article may be misled in believing that all DSS with a high degree of intangibility promise significant "value-price gap" and are ipso facto justified.

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