

Research

Decision making under time pressure: A model for information systems research

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Abstract

Time pressure affects decision making and, therefore, should be considered in the design of decision support systems. Although long recognized as an important variable, time pressure has received little attention from information systems researchers. A model of decision making under pressure is developed here. Drawing from existing theory and empirical research in psychology and human behavior, the model defines the role and relationship of relevant variables.

Keywords: User/machine systems; Human factors; Time pressure; Decision support

1. Introduction

Time is important and has been the subject of numerous studies in various disciplines [5]. In the field of information systems (IS), researchers have examined different features to determine which result in shorter response times. Except for this, however, other aspects of time (e.g., time pressure and time horizon) have received little attention from IS researchers. Meanwhile, the extensive body of literature on the effect of time pressure has implications for the design and development of information systems. Drawing from existing theory and empirical research in psychology and human behavior, the paper develops a model and describes the role of relevant variables and their relationships. The utility of this model is illustrated through the generation of several research propositions.

2. Time pressure as a design variable

Time pressure is important, because managers often need to make quick decisions. Decision making can also be affected by this pressure, when the amount of information overwhelms the decision maker. Time pressure has long been recognized as an important variable in information systems design [7]. However, empirical testing of this variable has been surprisingly sparse. The study of time pressure takes on a new urgency as systems are being designed to support groups as well as individual users. Group performance inevitably is influenced by the time pressures experienced by its members. In addition, time pressure is a common feature of many tasks undertaken by groups (e.g., a board of directors considering a hostile takeover bid). Therefore, time pressure studies can benefit the design of group decision support systems.

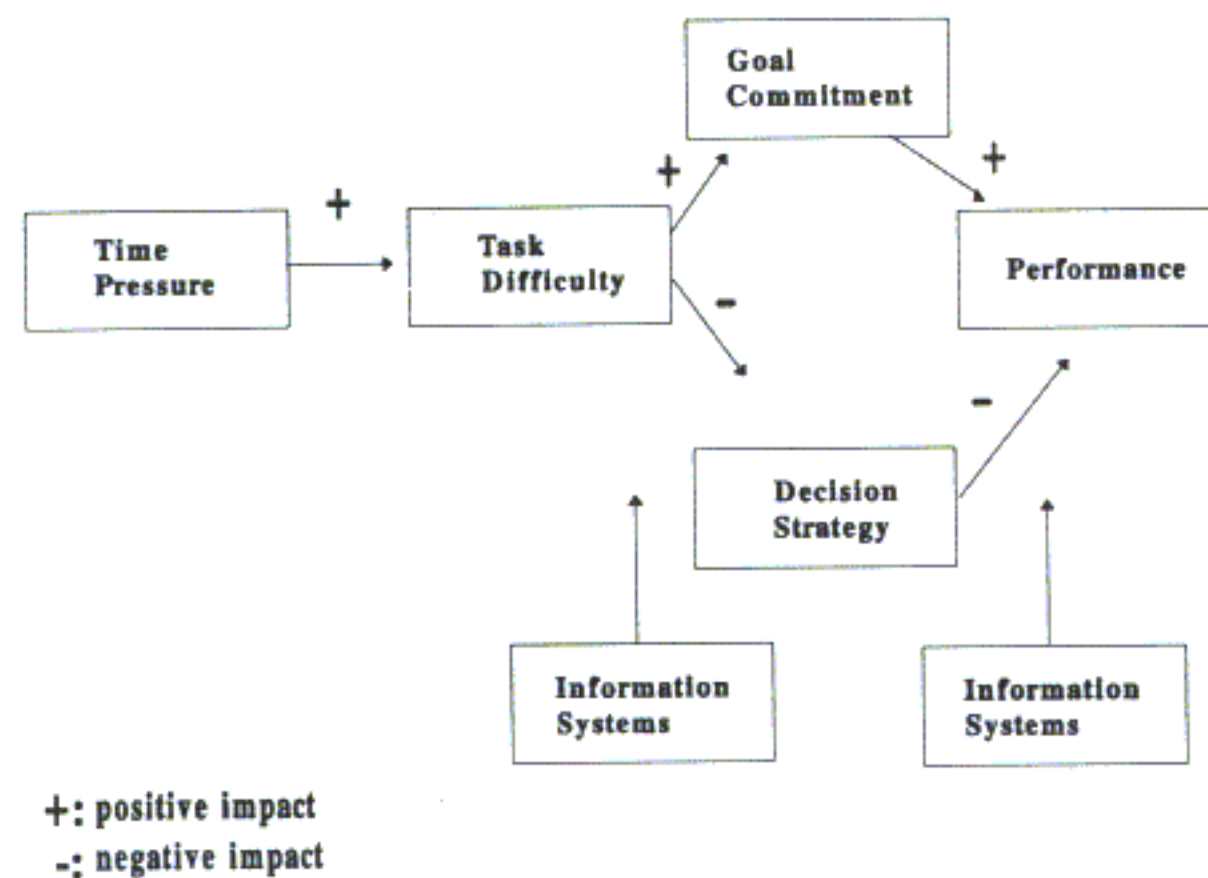


Fig. 1. A model of decision making under time pressure.

3. A model of decision making under time pressure

A model for studying the impact of time pressure on decision making is depicted in Fig. 1. A detailed discussion of the variables involved and their relationships follows.

3.1. Time pressure

Although time pressure has been studied intensively by psychologists and behavioral scientists, a generally accepted definition does not exist. Nevertheless, it has been commonly operationalized as the time available for task performance. Treatment in time pressure studies usually consists of two levels: low and high. Low time pressure groups are given a time limit that is considered sufficient, and high time pressure groups are given one-half or less of that amount of time (e.g., [3,6]). The intent of prior research, therefore, seems to have been the investigation of the effects of varying time constraints or time limits on task performance. Here, no distinction is made among time pressure, time constraint, and time limit.

The traditional method of operationalizing time pressure is convenient yet conceptually deficient: high time pressure may or may not be created by providing 50 percent less available time. Different levels of pressure may be manifested by a change in the task, which in turn

causes performance variations. The task characteristic that is likely to be changed through varying time pressures is task difficulty. Thus, a better manipulation of time pressure may be to assign time limits so that the same task is considered simple by one group but difficult by another. The change in task difficulty is likely to cause performance differences, which then may be appropriately attributed to varying time constraints. In sum, one should consider manipulation checks not only on time pressure, but also on task difficulty. Also, if two levels of time pressure (e.g., low vs. high) are to be used, time pressure should be manipulated so that the task is simple to one treatment group but difficult to the other.

3.2. Performance

Decision performance is expected to suffer when time pressure increases (e.g., [21,29]). However, researchers have also found situations in which increased time pressure has been associated with, or responsible for, better performance. Andrews and Farris [1], who studied the performance ratings of NASA scientists and engineers, found that performance ratings were related to the subjects' perceived time pressure at work. In addition, performance tended to increase with increased time pressure, only to fall off when the time pressure became too severe. Peters et al. [22] replicated similar results in a study of employees of a commercial bank. Consequently, they proposed a theory suggesting that the overall relationship between time pressure and performance is an inverted U-shaped one. Increasing time pressure leads to better performance up to a certain point; beyond that point more time pressure reduces, rather than increases, performance. The decrease in performance may be due to the selected decision strategy.

3.3. Decision strategy

Various decision strategies have been discussed in the psychology literature. Beach and Mitchell [2] proposed that these strategies be divided into three categories: aided-analytic, unaided-analytic, and nonanalytic. The first requires

the decision maker to apply a prescribed procedure to analyze and solve a problem with the help of some decision aids. This category includes all normative decision models and all formalized, prescriptive approaches to solving complicated and information-laden problems. Unaided-analytic strategies are applied when an attempt is made to explore the dimensions of the problem but no decision aids are used. Strategies which have been intensively studied by psychologists, such as the additive utility, the additive difference, the conjunctive, and elimination-by-aspects [24], belong to this category. Nonanalytic strategies include fairly simple, preformulated rules that are applied by rote to the task at hand. Little or no information is acquired or processed in the decision process. Decisions based on flipping a coin, rules-of-thumb, custom, or habit are examples of nonanalytic strategies.

The major difference among the three categories of decision strategies is in the degree of analysis required and, hence, the amount of resources (time and money) required. Generally, aided-analytic strategies require the most, unaided-analytic strategies require less, and nonanalytic strategies require the least resources. When resources are limited (e.g., under time constraints), strategies requiring a high degree of analysis may be excluded from consideration. This may force selection of a strategy that yields less gain than otherwise is obtainable. The use of computers to compensate for the lack of time is discussed later.

Findings from several empirical studies support this theory. Wright [28] found that decision makers adopted simplifying strategies when time pressure was high. In addition, he found that subjects under high time pressure placed greater weight on negative information about alternatives. If individuals are more sensitive to the negative outcome of their decisions, they should become more conservative. Hansson, Keating, and Terry [11] found that time pressure led subjects to vote more conservatively in a simulated election. Ben Zur and Breznitz [4], who used students in a gambling choice study, found that subjects preferred less-risky alternatives and gave greater attention to negative information when time pres-

sure was high. Zakay and Wooler [29] replicated Wright's findings and, additionally, found that decision quality decreased as time pressure increased. In summary, time pressure results in the selection of a suboptimal strategy, which in turn causes a decrease in performance. Being conscious of the worse outcome, the decision maker is therefore more conservative and sensitive to negative information.

3.4. Task difficulty

For time pressure to have an impact on strategy selection, it must be strong enough to make a substantive change in the task. Wright also suggested that task complexity can be varied by changing time pressure. However, task complexity is generally considered a function of the task itself, such as the number of elements under consideration and their interactions [23]. Increasing time pressure is likely to increase task difficulty rather than task complexity. Task difficulty may be defined as the degree of cognitive load, or mental effort, required to identify a problem solution [18]. Task difficulty contains both objective and subjective components and may be measured accordingly [16]. The objective measure of a difficult task is obtained when worse performance or prolonged decision time or both is observed [9]. If a difficult task requires more time to complete, cutting short the time available for processing should make the task more difficult. In sum, time pressure causes an increase in task difficulty. The more difficult task may force the selection of a suboptimal strategy, which would then reduce performance. On the other hand, through its effect on goal commitment, the more difficult task may also have a positive impact on performance.

3.5. Goal commitment

The effect of goals on performance has been heavily researched [15]. Two aspects of goals are positively related to performance: personal goal level and goal commitment [27]. Both goal level and goal commitment are subject to the influence of various situational and personal factors. Task

complexity and difficulty have been suggested as the determinants of goal commitment [12,15]. In a meta-analysis, Wofford, Goodwin, and Premack [27] found that task difficulty was positively related to goal commitment, but that task complexity was negatively related to it. Apparently, the challenge of a difficult task raises one's determination to reach a goal, while the demands of high complexity reduce commitment. If so, the positive impact of time pressure on performance confirms that it increases task difficulty rather than task complexity.

3.6. *Information systems*

The role of information systems is to counteract the negative impact of time pressure on decision strategy selection and performance. Two studies have examined the effect of the use of information systems under time pressure [3,13]. However, no research has addressed the effect of the use of information systems on decision strategy selection under time pressure.

Benbasat and Dexter [3] compared the performance of subjects using tables and graphics under various time constraints and found that graphics led to shorter decision times than tables in the low time constraint group. When time pressure was high, the use of graphics or tables did not result in significant differences in decision time or quality. They also found that multi-color reports resulted in better performance than monochromatic ones when time pressure was high. More recently, Hwang [13] conducted a series of experiments to examine the effects of presentation format and time pressure on decision making. He concluded that graphics are better than tables under increased time pressure because graphics enhance the positive impact of time pressure, and offset the negative impact of time pressure on performance. In sum, the available research supports the use of graphics and colors for decision making under time pressure. The use of other systems features, such as action and presentation languages [10], under time pressure remains to be studied.

4. **Research propositions**

4.1. *Decision strategy*

Unaided-analytic strategies have received the most research attention in psychology literature. IS researchers have just begun to study the impact of computers on the use of such strategies (e.g., [14]).

Unaided-analytic strategies may be classified as compensatory or non-compensatory (e.g., additive vs. conjunctive), and alternative or attribute based (e.g., additive vs. additive difference) [19]. Compensatory strategies evaluate each attribute of each alternative separately and then compare the summed utility of all alternatives. They require intensive information processing and are cumbersome for the unaided decision maker [2]. Consequently, individuals shift from compensatory to non-compensatory strategies when task complexity increases [17,18,20]. The shifting of strategy may also occur when task difficulty increases and the decision maker tries to ease the cognitive load resulting from the more difficult task. If so, since time pressure increases task difficulty, it may be proposed:

PROPOSITION 1.1. Under time pressure, decision makers without computer aid will adopt non-compensatory strategies.

Computer aid may include decision models which facilitate compensatory or non-compensatory processing. Hence, a related proposition is:

PROPOSITION 1.2. Under time pressure, decision makers with a computer aid that facilitates compensatory processing will adopt compensatory strategies; decision makers with a computer aid that facilitates non-compensatory processing will adopt non-compensatory strategies.

Ample evidence in the literature suggests that information presentation affects whether alternative or attribute based strategy will be selected [14,25]. In general, individuals will use alternative processing if information is presented in alternative forms. Conversely, attribute processing can

be expected if information is presented in attribute forms. However, information presentation is not the only factor that affects the selection of decision strategy. Jarvenpaa [14] showed that task demands interact with information presentation (in various graphical formats) to affect different stages of the decision process differently. Generally, decision making is described as consisting of three interrelated stages: information acquisition, evaluation/action, and feedback/learning [8]. Jarvenpaa also found that, during the information acquisition stage, information presentation had a predominant effect on decision strategy. However, during the information evaluation stage, decision strategy was affected by the congruence between task demand and information presentation; that is, when both the task and information presentation encouraged the same type of strategy. The congruence between task and information presentation has been termed “cognitive fit” and shown to lead to better performance [25]. The basic assumption of cognitive fit is that humans have limited information processing capability and, therefore, try to reduce task complexity in solving problems. Effective problem solving results if task complexity is reduced through the match (cognitive fit) between problem-solving aids (e.g., information presentation) and task requirements.

Since increased time pressure causes an increase in task difficulty, a decision maker under time pressure may also try to reduce cognitive load by using the same strategy emphasized by both the task and the information presented.

PROPOSITION 2.1. Under time pressure, decision makers will use alternative processing in information acquisition if information is presented in alternative forms; decision makers will use attribute processing in information acquisition if information is presented in attribute forms.

PROPOSITION 2.2. Under time pressure, decision makers will use alternative processing in information evaluation if information is presented in alternative forms and the task requires alternative processing; decision makers will use attribute processing in information evaluation if

information is presented in attribute forms and the task requires attribute processing.

4.2. Performance

In applying the concept of cognitive fit to information presentation, Vessey [25] argued that graphics are spatial in nature and that tables are symbolic in nature. Cognitive fit, and hence better performance, is achieved when graphics are used to solve spatial problems, or tables are used to solve symbolic problems. In addition, cognitive fit is not limited to information presentation; it applies to all kinds of decision aids or problem-solving aids [25]. However, the advantage of cognitive fit may not be observable under high time pressure due to its detrimental effect on performance. Consequently, the following propositions are made for low time pressure only:

PROPOSITION 3.1. Under low time pressure, decision makers will perform a spatial task better with graphics; decision makers will perform a symbolic task better with tables.

When the decision strategies stressed in the task and information match, better performance is expected [14].

PROPOSITION 3.2. Under low time pressure, decision makers will perform better when both the task and information presentation stress the same type of processing; that is, alternative or attribute processing.

Cognitive fit may also be applied to the use of action and presentation languages.

PROPOSITION 3.3. Under low time pressure, decision makers will perform better when the action language facilitates the same type of processing required by the task.

PROPOSITION 3.4. Under low time pressure, decision makers will perform better when the presentation language facilitates the same type of processing required by the task.

Extending the notion of cognitive fit, Vessey and Galletta [26] argued that matches between problem-solving skills and problem representation or task improve decision performance. In a laboratory experiment, they operationalized problem-solving skills as spatial and numeric skills and found that the matching between skills and tasks was significant, while the matching between skills and problem representation was not significant. Thus, it may be proposed:

PROPOSITION 3.5. Under low time pressure, decision makers with high spatial skills will perform a spatial task better; decision makers with high numeric skills will perform a symbolic task better.

5. Conclusion

Time is important and is a built-in factor in all human activities; most endeavors must be finished within a certain time. The need to process large amounts of information in a relatively short period has a definite impact on decision strategy selection and performance. Information systems have an important role in supporting decision making under time pressure. The model proposed here helps to define that role.

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