Available online at www.elixirpublishers.com (Elixir International Journal)

Management Arts

Elixir Mgmt. Arts 35 (2011) 2825-2829

ISSN: 2229-712X

Structural equation modeling of an integrated information processing and decision making

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ARTICLE INFO

Article history:
Received: 5 April 2011;
Received in revised form:
19 May 2011;
Accepted: 25 May 2011;

Keywords
Information Processing model,
Environmental Scanning,
Decision Quality.

ABSTRACT

Information processing model developed for management and psychological literature were from the basis of four general models, which provide a guiding framework for research. These models were term as rational, limited capacity, expert, and cybernetic models of information processing and behavior. Previous researcher argued that each model provides a different explanation of processing in several theoretical domains and has different methodological implications. However, the findings of the present study advanced and tested using structural equation modelling on the data collected from a sample of 118 Malaysian companies suggest that integrated information processing model is more appropriate in explaining extent of environmental scanning and information processing capacity and having a significant bearing on the quality of the decision made.

Introduction

In the last few decades management practitioners and psychologists had applied information-processing principles and theory to improve their management and organizational practice. Much of the information-processing researches were characterized in terms of one of four general models, which provide a guiding framework for research. These models were term as rational (Friedman, 1976), limited capacity (Simon 1957), expert (Glaser, 1984), and cybernetic models of information processing and behavior.

Theoretically, researchers can become so immersed in particular information-processing applications and do not consider the possibility of alternative frameworks. For example, much of the management literature implicitly adopts either rational or limited capacity models of information processing. However, expert or cybernetic models often are more congruent with descriptions of information-processing behavior (Lord and Maher, 1990).

Researchers however should reevaluate their current theoretical perspective particularly that often resulting in interventions which required difficult information processing model and not duly bound by particular perspectives,.

Therefore, the existing theories need to be looked beyond a particular substantive area to assess the general application of information-processing principles in improving decision-making quality of an organization.

To help remedy this situation, four models that encompass a large portion of the information processing work will be discussed and explored. Possibility of adopting an 'integrated' paradigm, that links information seeking behaviour and information processing capacity to impact investment decision quality will be proposed.

The next section of this paper will scrutinize four accepted models in Information Processing research, followed by the empirical analysis to propose a new model and concluded the paper with discussion and recommendation.

Rational Information Processing Model

Rational models assume that people thoroughly process all relevant information in order to maximize a relevant outcome and using formal method to gather the information. Applications consistent with rational models often require explicit instruction and the use of formal procedures or informational aids such as computers for data analysis. On the other hand, according to rational model, information was seeking vastly from impersonal sources rather than personal sources. Traditionally, prescriptive, rational models dominated management science and economic theory. Economic theory (Becker, 1976; Friedman, 1976; Lucas, 1981) provides a general decision-making framework for allocating scarce resources to alternative ends. This framework asserts that individuals assign probability and utility values to hypothetical events and choose among available alternatives to maximize expected utility (Friedman, 1976). Thus, a general class of information-processing models, labeled rational models, underlies prescriptive economic, management, personnel, and motivational theories. Although rational models are appropriate in some situations and they can be followed by people, they do not provide a very general explanation of human behavior (Simon 1957).

Limited Capacity Information Processing Model

In contrast to rational model, limited capacity model focus on how people simplify information processing while still generating adequate but not optimal behaviors. These explanations of human behavior require only limited amounts and limited processing of information. Interest in these models stems from recognition of human information-processing limitations. Limited capacity models do not require extensive knowledge or omniscience, as do rational models. Instead, people work within a very limited conceptualization of problems, considering only a few of all possible alternatives. Thus, limited capacity models are more congruent with short-term memory capacities than rational models because they

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require the use of less information at one time and simpler evaluation procedures. Limited capacity models emphasize the role of cognitive heuristics and simplifying knowledge structures in reducing information-processing demands. Though the use of implicit theories and heuristics is associated with limited capacity models, these models reflect general heuristics thought to be common across individuals. From this perspective, the role of expertise in specific content domains becomes important. Experts are also limited capacity, heuristic-driven processors, but the heuristic principles involved are likely to be different than those of novices (Sherman & Corty, 1984). Limited capacity information processing theorist claimed that information can be gathered faster from personal sources and using informal methods of data gathering.

Expert – Information Processing Model

The recognition that expertise supplements simplified information processing defines a set of models which are labelled as expert information processing (Lord and Maher, 1990). The key assumption underlying these models is that people rely on already developed knowledge structures to supplement simplified means of processing information (Lord and Maher, 1990). Several studies illustrate that experts and novices differ in the way information is processed. Generalizing this model of the human information processor, Glaser (1984) argued that experts store and retrieve information from long-term memory differently than novices. Therefore, the argument on capacity to process the information as important factors to influence quality decision can be connected with the model. Thus, the capacity to process the information of the expert and novice is measured based on the greater knowledge base that they acquire through experience in a specific domain as well as the knowledge and skills they possess (Glaser, 1984). Abelson and Black (1986) suggested that individuals with experience in familiar contexts (e.g., computer programming) have different knowledge structures than those unfamiliar with the context. Therefore, they can apply different problem-solving strategies. In this sense, heuristic processing under expert information-processing models is something to be developed, not overcome, as it is in limited capacity models. Being relatively new, expert models have not generated extensive theory in the management area. However, interesting theory will develop around the superb intuitive judgment and recognition abilities of experts. The prescriptive value of such models is unexplored in the management literature. However, recent development in using expert systems (Harmon & King, 1985) suggests that it may be high. Moreover, work in artificial intelligence indicates that many problems that cannot be solved merely by extensive computer processing can be solved quickly by incorporating the content-specific knowledge of experts.

Cybernetic – Information Processing Model

The final set of information processing models is more dynamic than the previous three model.. Like rational models, cybernetic models may be optimized in the long run, but they do this by learning and adaptation, rather than by sophisticated processing before choice or behavior. Another advantage of cybernetic models is that they are as applicable to learning as they are to the generation of behavior. An emphasis on learning is characteristic of information processing work ranging from viewing organizations as interpretative systems (Daft & Weick, 1984) to depicting performance. These information- processing models were used extensively for two very general substantive topics namely; attribution theory and decision-making. Thus, according to cybernetic model, skill, knowledge, experience and capacity to process the data into useful information will determine the results regardless of how the data was gathered and processes.

Based on the above theoretical arguments and decision making theory, the present study is trying to empirically test all of the four information processing behavior model looking on the perspective of scanning behavior of the decision maker (i.e. method of scanning, sources of scanning and extent of scanning as well as capacity to process the information) to conceptualized rational, limited capacity, expert and cybernetic behavior respectively. The major objective in detailing these models is not to favour one over the other, but rather to test if each model provides a substantially similar explanation of how people process information to gain quality decision and further proposed the integrated information processing model.

Research Methodology

Cross-sectional survey was used to collect the primary data for describing a population of strategic decision. A survey through personal contact and personally distributed questionnaires of 181 was carried out to the CEOs and higher-level managers of the companies located all over Malaysia. The data relates to an investment decision, which therefore forms the unit of analysis. This unit of analysis is chosen to enhance internal validity as choosing the manager or the organization which makes the decisions will only confuse the issues to be addressed. Therefore, isolating the focus on a specific decision, and measuring the associated scanning behaviour and quality, will strengthen the validity of the relationship thus established. The data was analyzed using Structural Equation Modelling (SEM) via AMOS software package Version 17.0.

Empirical Findings

The proposed model was tested based on the survey of 118 data collected from Malaysian decision makers (high level executives) of all organizational sectors. The measurement and structural model used to test the relationship was AMOS 17. To conform for goodness of fit, various measures of fit was applied including the Comparative fit index (CFI), Incremental fit index (IFI), Tucker-Lewis index (TLI), Norm fit index (NFI) and the Root mean square error of approximation (RMSEA). For the recommended of acceptance for a good fit to a model, it requires that CFI, IFI, TLI and NFI values be greater than or equal to .90. In addition, an acceptable value of RMSEA should range from .03 to .08 (Hair, 2006).. The results of the analysis were summarized in table 1 to 3 below:

The results from the Structural Equation Model (SEM) analysis reported in Table 1 indicate that χ^2 is 104.6 with 87 degree of freedoms (d.f.) (p 0.001) which is (χ^2/d.f.) less than 3.0. On the other hand, the CFI, IFI, TLI and NFI was greater than 0.9 and the RMSEA was within the range. The fitness's of the indices in the analysis indicates that, the theoretical model provides a reasonably good fit of the data. This finding further suggests that each item is uniquely related to the dimension to which it was assigned. Based on the resultant standardized path coefficients of the model displayed in Table 2, all t-tests investigating the null hypothesis of each coefficients equal to zero were found significant at $p < 0.01$. This result suggested that all paths are assisting in the prediction of their assigned dimensions. The result shows that all the standardized path coefficient values are above 0.60 thus provide evidence supporting the convergent validity of the indicators (Bagozzi & Yi, 1988).

Table 3 summarizes the results of testing the causal paths. The relationships between all variables under studied were found significant accept for sources of scanning with method of scanning. For method of scanning, positive effect on decision quality were found even in the absence of extent of scanning and information processing capacity. The study found that method of scanning had positive effect on extent of scanning and the effect on decision quality was insignificant in the presence of extent of scanning. In other words, instead of direct effect, method of scanning has an indirect effect on decision quality. These results indicate that method of scanning was fully mediated by extent of scanning to impact investment decision quality. On the other hand, sources of scanning were found to have significantly negative effect on decision quality. It was also found that sources of scanning had a negative effect on extent of scanning and the effect of sources of scanning on decision quality was significantly reduced in the presence of extent of scanning. This means that, instead of a direct effect, sources of scanning have an indirect effect on decision quality that partially mediated by extent of scanning. Finally, both extent of scanning and information processing capacity reveal significant positive effects on decisions quality.

A role of mediator is considered as partial mediation if the effect of variable is reduced significantly. Full mediation on the other hand occurs, if the effect of variable becomes insignificant (Baron & Kenny 1986). For information processing capacity, it was confirm that the mediation role was fully mediated the relationship between method of scanning and decision quality as well as between sources of scanning and decision quality. This was explained through the effect of method of scanning and sources of scanning on decision quality were insignificant in the presence of information processing capacity. With the new structure obtained, from the three dimension of information processing capacity namely skill, knowledge and experience, it shows that knowledge (0.80) has strongest influence on information processing capacity followed by skill (0.73).

From the evidence of the above analysis, it's indicating that both extent of scanning and information processing capacity are found to have direct influences on decision quality. However, method of scanning and source of scanning were found to have indirect effect on decision quality.

Thus, without sufficient amount of information gathered to make the decision and the capacity to process the information to mediate both variables (method and sources), it will not determine the quality of the decision made. Therefore, whether the information sought was based on formal data or personal judgment, it must depends on the relevance of the information and amount of the information needed as well as the knowledge/skill available to process the information to lead for a better decision quality.

'Integrated' Information Procesing Model

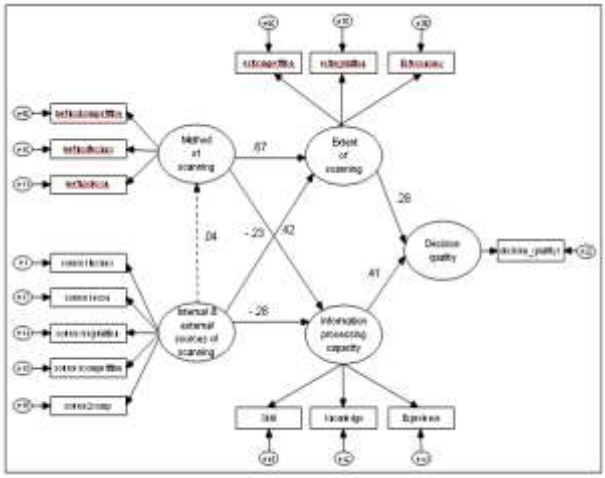
Information processing behaviors in the present study were based on rational, limited capacity, expert and cybernetic behavioral model. Rational behavior was conceptualized based on the method used to scan the information.

Limited capacity behavior on the other hand was conceptualized from the sources of information utilized in making the decision of either from internal/external or personal/impersonal sources. Information processing capacity of an individual will measure expert and cybernetic behavior that is based on the skill, knowledge, and experience possesses by an individual.

The survey carried out from the present study found that, information processing behavior of the decision makers were influenced by the extent of useful information gathered and capacity to process the information into quality decision. How and where the information is gathered only having indirect influence towards the quality of the decision made. This argument was supported by the above empirical findings where method of scanning was fully mediated by extent of scanning to impact investment decision quality. Sources of scanning on the other hand have both direct and indirect effect on decision quality as it partially mediated by extent of scanning. Thus, this finding support the researcher's argument that rational model was not the sole model in determining the decision making quality as decision quality does not merely depends on formal method to gain the information. A personal/external source (i.e heuristic judgment) of information also shows a significant influence. Furthermore, method and sources of scanning has no direct impact to decision quality as it depends upon the extent of information scan and the capacity to process the information in determining the quality of the decision made. This empirical findings strongly support that rational model should integrate with limited capacity, expert and cybernetic model in identifying information processing theory of decision making quality. Thus we proposed that none of the independent model (of either rational, limited capacity, expert and cybernetic) can explained the information processing behavior in relation to decision-making quality. Therefore, based on that assumption, a new model called 'integrated' information processing model should be proposed.

The findings of the present study advanced and tested using structural equation modelling suggest that integrated information processing model is appropriate in explaining the relationship between method of scanning, sources of scanning and mediating role of extent of scanning and information processing capacity to have a significant bearing on the quality of the decision made. The proposed model is depicted in the figure 1 below:

Figure 1 The estimated structural model: **An Integrated Information Processing Model**



Discussion

The above model implies that, in making quality decision, no specific model dominates one another as, all the attributes were connected to each other to influence the decision making process. Method used to seek for information; sources of information, amount of information and capacity to process the information are all integrated to each other in determining the quality of the decision made.

Rational models implicitly assume that decision makers systematically use all relevant information, reflecting from a very complicated analysis (formal data/impersonal sources), which is beyond the capacity of most people to make quality decision. Our findings support the arguments as we found that method used to scan the information did influence the quality of decision, however it mediates by extent of scanning. This indicates that, whatever method used to scan the information to make a decision, is still depends on whether the extent of information scan is sufficient and relevant for the decision to be made (Nik Maheran, Muhammad, 2007). Method of scanning however, does not influence by source of scanning, meaning, information sought doesn't need any formal method to achieve quality decision. Thus, it can be conclude that decision maker sometimes make a decision particularly for operational or tactical decision within their limited capacity, using heuristics judgment and consider more on information gathered through ad hoc or personal sources.

The present study also found that information processing capacity particularly knowledge and skill mediate the relationships between method of scanning as well as sources of scanning with decision quality. This indicates that whatever method used or sources of information utilized to scan the information, if the decision maker's capacity to process the information is limited, quality decision might not be achieved. Thus, knowledge and skill are required to process the data and turn it into useful information in generating quality decision (Nik Maheran, Muhamad, 2007). This argument is associated with 'expert' information processing models, which is the ability of the individuals to process the information (i.e. information processing capacity). The model also emphasized on operating in highly developed knowledge systems, which are organized around context of relevant goals, plans, scripts, and themes (Read, 1987). Information processing capacity is also associated with cybernetic models where learning and experience is applied in making quality decision. Therefore, the integration of rational, limited capacity, expert and cybernetic induced the researcher to propose a new information processing model called "Integrated Information Processing Model". The proposed model proclaim that, method of scanning and sources of scanning has significant contribution to decision quality, However, even though formal method were used to gather the information, or using ad hoc source to make the decision, it doesn't given direct impact to the quality of the decision, it depends on the relevant of information scan. Therefore, since extent of scanning mediates the relationship, this result confirm that, even within rational boundaries, the dimension were interconnected and not independent to each other. This information processing approach of decision-making is relevant, as the attributes of rationality, heuristics, experts, and learning need to be incorporated in making good decision.

From the finding of this study, we found that in order to make quality decision, managers need to focus on the relevant information needed for the decision made and the ability/capacity to process the information in making the decision. What ever method they used to seek the information, does not permit the quality of the decision. On the other hand, sources of information of either from personal or impersonal sources were also offer no significant impact to the quality decision but the capacity of the decision maker to process the information highly contributes to the quality of the decision.

Conclusion

From the evidence of the above analysis, it's indicating that both extent of scanning and information processing capacity are found to have direct influences on decision quality. However, method of scanning and source of scanning were found to have indirect effect on decision quality. Thus, without sufficient amount of information gathered to make the decision and the capacity to process the information to mediate both variables (method and sources) will not determine the quality of the decision made. Therefore, whether the information sought was based on formal data or personal judgment, it must depend on the relevant of the information and the knowledge/skill available to process the information to lead for a better decision quality. The extent to which information were process related dynamically with their environment and situation for the decision to be made. The findings from this study proposed that, in making quality decision, all four main information-processing approaches, seem to be compatible with integrated Information Processing model.

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Table 1 Goodness of fit indices of the model

	Criteria	Indicators
χ^2 - test	p > 0.05	
χ^2	< 3.0	1.202
χ^2 /d.f.		
Fit indices	> 0.9	0.968
CFI	> 0.9	0.970
IFI	> 0.9	0.956
TLI	> 0.9	0.900
NFI		
Alternative indices	0.03 – 0.08	0.042
RMSEA	Close to zero	0.000
RMR		

Table 2 Standardized Path Coefficient of the model

Constructs and Items	N = 118
Method of scanning	.72
Technology information	.71
Economic information	.74
Competition information	
Internal & external sources of scanning	.64
Technology information (internal)	.61
Economic information (internal)	.86
Regulation information (internal)	.75
Competition information (internal)	.73
Competition information (external)	
Extent of scanning	
Economic information	.83
Regulation information	.65
Competition information	.65
Information processing capacity	
Skill	.73
Knowledge	.80
Experience	.66
Decision quality	
Decision quality	.71

All paths significant at p < 0.01 level

Table 3 Test results of the causal path

Causal path	Estimates	Standard error	*t*-values	Test results
Method of scanning → Extent of scanning	0.750	0.153	4.899	Supported
Method of scanning → Information processing capacity	0.410	0.109	3.749	Supported
Sources of scanning → Method of scanning	-	0.128	0.351	Not Supported
Sources of scanning → Extent of scanning	-0.284	0.127	-2.230	Supported
Sources of scanning → Information processing capacity	-0.297	0.115	-2.581	Supported
Extent of scanning → Decision quality	0.305	0.116	2.638	Supported
Information processing capacity → Decision quality	0.530	0.131	4.033	Supported

All paths significant at p < 0.01 level