Application of Decision Alternatives Evaluation Models to the Selection of Computer Systems

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ABSTRACT

The selection of a computer system is a process dependent on many factors and irrespective of how the process proceeds; ultimately the monetary factors will play a major role. It is important to recognize the initial costs of the acquisition of the new hardware and the immediate attendance software, and also the continuing costs associated with the maintenance of hardware, software and upgrading devices that must be budgeted for to continue the infusion of viable applications. However, the selection of a given computer system from a choice set is becoming a difficult task following the proliferation of computer brands by various computer manufactures. This paper reviews different computer systems selection methodologies, draws from this background, and provides alternative models with illustrative examples to assist organizations, individual consumers or prospective buyers in arriving at specification or configurations that meet their established needs or requirements. The paper helps to educate the consumers or prospective buyers on the selection criteria and evaluation procedures for analyzing proposal submitted by vendors. The selection models adopted in this paper are evaluated using the weighted values of the different attributes submitted by vendors.

Keywords

Computer system, configuration, manufacturers, proliferation of computer, consumers

1. INTRODUCTION

Changes in organizational needs worldwide are driving the rapid changes of computer technology. Many organizations are decentralizing their computer facilities (or systems) to meet new needs and take advantage of new technology. The speed, with which computing needs change though, is remarkable and increasing the uncertainty of computer systems selection processes among different organizations (or consumers). To compensate for this increased uncertainty, organizations tend to acquire families of computer systems, which are compactable with their business needs in one hand, and in other hand, compactable with one another to allow system growth. As this may be, a computer system may be treated as a black box and examined through the masks of diagnostic software, such as the control program, or other specialized programs [1]. The capability of the hardware to support the totality of various uses to which the computer system is to be put is paramount. Capability for performance of different tasks (computation, data retrieval, communications etc) will vary with the design as do the technical details (word-lengths, number of registers, memory module size, etc). Error detection and correction capability bears heavily on the overall reality. One will want to do more by comparing design criteria and techniques of the various available systems, but no matter how sophisticated the overall design or how advance the designed components, and for the user the decisive factors will have to be those that deal with reliability, support and capacity. Scores of computer manufacturing companies have been lured by high profit opportunities into developing products in series to meet the growing demand for computers. Buying a computer therefore can be a harrowing experience if one approaches the acquisition of a computer haphazardly. The question is how the prospective buyer or the consumer chooses among the alternative brands in the choice set? Fortunately, the manufacturers or vendors will make available to prospective buyers attributes or specifications available in their computers. Such attributes are processor types, memory capacity or size of memory, internal or memory bus width, hard disk capacity/speed, processor speed (clock speed), graphic capabilities, software available, available expansion slots, ports (USB, serial, parallel), price, support, etc.

The above attributes are of normal interest; however prospective buyers or consumers will vary as to which they considered relevant. In [2], consumers or prospective buyers will pay the most attention to those attributes that are connected with their needs. In order to select the best computer brand that meets the needs of the prospective buyers out of the ever increasing brands, the consumer must therefore arrives at attitudes (judgments, preference) towards the brand alternatives through the application of some evaluation procedures. The objective of this paper is to assist or help consumers or prospective buyers arrive at specification or configurations that meet their established needs or requirements and to educate prospective buyers or consumers on the selection criteria and evaluation procedures for analyzing proposal submitting by vendors by committing financial and other important organization's resources.

2. REVIEW OF COMPUTER SYSTEM SELECTION MOTHODOLOGIES

When selecting suitable computer systems it is important for an organization (i.e., users and IT personnel) to be aware of the characteristics of the intended needs and user population. Such knowledge of the specific characteristics of user group in the organization will help to define suitable computer systems choices for the group and so reduce the number of candidate systems that may be tested. This is particularly true of user groups with disabilities, such as those with high-level spinal injuries, where the type and level of disability greatly influences the range of usable input devices available [8].

The most popular selection procedure is the weighted scoring or the additive weight process [9], [10]. In this method, each attribute category is assigned a weight factor before evaluation of the alternatives. Then the individual alternative attributes are evaluated and assigned a score. The alternative's total score is a summation of all its attribute scores multiplied by their respective weight factor. The preferred alternative is the one with the highest total score. This method, although simple and easily

understood, is not normative, which means it is not based on system of axioms expressing rational behaviour of the evaluator. The cost-effectiveness ratio is similar to the weighted scoring method; however, it also uses cost as a decision variable [11]. The procedure is relatively simple, in that the same procedure as the weighted scoring is used. However, the sum of the scores is divided into the system's total cost. The resulting ratio or score is used to determine the system selection. The computer system with the lowest ratio is selected.

The efficient-frontier model is another method used to compare competing systems [10]. This method compares the attributes of two alternatives, determines which alternative's attribute dominates the other. By comparing all of one alternative's attributes against another, alternatives which are obviously inferior in most or all attributes is eliminated from consideration. Selection is then made from the remaining alternatives. However, this method does not provide a decision maker with a clear choice, rather it only acts as a screening process in which clearly inferior alternatives are eliminated.

The lexigraphical ordering [10] is similar to the efficient-frontier model but differs slightly from the efficient-frontier model in that it requires ranking based on the alternatives' dominant attribute. This method is only successful though when a dominant attribute exists [12]. Other methodologies such as cost value, requirement costing, and cost benefit ratio are provided in [5], [13], and [14] respectively. In Section 6, we evaluate computer system selection using the expectancy value (linear) and ideal brand models, which are versions of the weighted scoring and cost-effective ratio methodologies.

3. CONSUMERS' BUYING CULTURE

Besides organizations, consumers may vary tremendously in age, taste, education level, mobility pattern, income level, etc. Consumers find it useful to search products that meet or tailored to their needs. The choice of a given computer is greatly affected by one's economic circumstances. Consumers' economic circumstances consist of their spendable income (i.e. its level, stability, and time pattern), savings and assets (including the percentage that is liquid), borrowing power and attitude towards spending versus saving. In as much as people want to buy a computer, their brands choice will be limited by their spendable income [7]. Since a computer system is an income sensitive good or product or high-involvement item, continuous attention must be paid to trends in different alternatives to help prospective buyers select a given computer system that meet their income level as well as their needs or requirements. Most prospective buyers or consumers really pass through the normal belief/attribute/behaviour sequence whenever making a decision to purchase a computer system. Prospective buyers need to search extensively for information about brand features, evaluate their characteristics, and make a weighty decision on which one to buy. In most times this is not the case, instead they are passive recipient of information as they watch television or see prompt adverts. Adverts repetitions create brands familiarity rather than brand conviction. Prospective buyers do not really form an attitude towards a brand but select it simply because it is familiar, and as a result they are not involved with the brand. So the buying process is brand beliefs formed by passive learning followed by purchase behaviour, which may or may not be followed by analysis and evaluation based on the prospective buyer's needs or requirements.

In order to save time, cost and help the prospective buyers in their brands learning process characterized by first developing beliefs about a given brand than attitudes, the prospective buyers should be assisted in evaluating several alternatives of different brands of interest. This process helps prevent post purchase dissonance of the chosen brand and hence, eliminating the situation of spending more money than necessary.

4. STEPS THAT MAY BE ADOPTED IN SELECTING COMPUTER SYSTEMS

In [3], J. Spencer gives some choices that could be adopted in selecting a computer system;

i. Achieve some Level of Computer Literacy.

It is quite unreasonable to buy any computer system without a good understanding of its capability and limitations. Therefore, all prospective buyers are, as a matter of necessity, be educated on the capabilities and limitations of some brands prior to acquisition.

ii. Establish and Define the Needs

The environment in which the computer is to function should be clearly defined. A research oriented organization exhibits characteristics different from those of an education institution or an individual user. It becomes necessary, therefore, for each user whether an organization or a research institution or an individual to study its own identity and to prepare a definition of its needs. The more thoroughly and clearly this is done, the easier it will be to evaluate the proposals submitted.

iii. Request for Proposal

As soon as it becomes apparent that there is a reasonable expectation of acquiring a new computer, it is prudent to notify computer vendors of this expectation. From this time on, the informal dissemination of the needs to the vendors and their active participation in helping to organize the requirements has the advantage of giving the vendors access to the prospective buyers thereby having input to the request for proposals (RFP), and this also improve their understanding.

5. COMPUTER BUYERS' ANALYSIS

Before we discuss the evaluation models, lets us quickly look at the various attributes that the prospective buyers will look for when making decision as to what computer system to buy. On the technical side, questions will be asked on two broad categories – software and hardware, and on the management side; the viability and reputation of the vendor that will handle submitted request. One format for presenting the attributes which will enter into the evaluation process is to state clearly at the front page of the request for proposal (RFP). For example, memory type and a brief description indicative of the characteristics sought and the reasons these should be given. For example, memory access time influences processing time and consequently throughput. Then for each of the vendor submitting a proposal, a listing of a succinctly stated comment evaluating vendors responses on a given attributes is very important or appropriate for the evaluation process. It is very necessary at this level to indicate significant attributes, remembering that these may vary depending on the particular environment in which the computer is to function. The following presents a summarized but not limited to only these attributes;

- Processor upgradeability
- Clock speed
- Memory(memory transfer speed, maximum memory size)
- Disk capacity and access speed.

- Availability of ports (Ports are used to connect peripheral devices to the system unit)
- Disk Drives
- Control program (Operating System) Characteristics (security, reliability, etc)

6. ALTERNATIVES EVALUATION MODELS

Based on the various questions asked by the prospective buyer or consumer in request for proposal, the various vendors will eventually submit proposals which they think will satisfy the prospective buyer or consumer. The question now is how the prospective buyer or consumer does choose among the alterative brands in the choice set? The vendors need to know how the buyer or consumer processes information regarding the various attributes or features to arrive at brand choices. In [4], M. Fishbein argued that there is no single evaluation process used by all consumers (prospective buyers) or even one consumer in all buying situations. In [6], there are several decisions evaluation processes of which most are usually cognitively oriented- that is, they see the buyer (consumer) forming product judgment largely on a conscious and rational basis. Hence, the application of two mathematical models for the evaluation of the prospective buyers (consumers) decision alternatives. These two mathematical models which are expectancy-value (linear) and ideal brand models will be demonstrated. Before the mathematical evaluation procedures, we will look at certain basic concepts that help simplify the buyer (consumer) evaluation processes.

6.1 Product Attributes

These are the attributes of interest of a given product or brand. The prospective buyers (consumers) will pay more attention to those relevant attributes that are relevant to their needs.

6.2 Important Weight

The consumers will attach "important weight" to those relevant attributes of a given brand.

6.3 Brand Beliefs

The consumer is assumed to develop a set of 'brand beliefs' about where each brand stands on each attribute based on the consumer particular experience and the effect of selective perception, selective distortion and selective retention.

6.4 Utility Function

The utility function for each attribute describes how the consumer expects product satisfaction to vary with alternative levels. For example, a consumer may expect his satisfaction from a computer to increase with its memory capacity, graphics capability and software availability, and to decrease with its price.

6.5 Evaluation Procedures

The consumer arrives at attitude (judgments, performance) towards the brand alternatives through some evaluation procedures which include;

I. Expectancy-Value (linear) Model

$$A_{jk} = \sum_{i=0}^{n} W_{im} B_{iab} \quad \text{---------- (1)}$$

Where;

A_{jk} = consumer k 's attitude score for brand j

W_{im} = the important weight assigned by consumer i to attribute m

B_{iab} = consumer b 's belief as to the amount of attribute i offered by brand a

n = the number of important attributes in the selection of a given brand

From model (1), numerical weight (W_i) assigned to specific attributes could scale from 0 to 100%, with 100% assigned to the most significant attributes and smaller values assigned to less significant ones. Then, for each of the attributes, each vendor is ranked on a 10-point scale i.e. 0 to 10 as far as a specific attribute is concerned. We multiply the rank by the weight and sum over all of the attributes considered. The vendor with the highest score is considered the desired choice.

We evaluate the expectancy value model by taking a typical example. Suppose an establishment is interested in buying a computer system and the attributes of interest are memory capacity, graphics capability, software available, and price. If the establishment assigns 40% of the importance to the computer's memory capacity, 30% to graphics capability, 20% to software availability, and 10% to price, based on the proposals submitted by four vendors, each computer from the vendors is rated as shown in Table 1 follows:

Attributes

	Memory Capacity		Graphic Capability		Software Availability		Price		Attitude Score
Computer									
Computer 1	0.4(10)	+	0.3(8)	+	0.2(6)	+	0.1(4)	=	8.0
Computer 2	0.4(8)	+	0.3(9)	+	0.2(8)	+	0.1(3)	=	7.8
Computer 3	0.4(6)	+	0.3(8)	+	0.2(10)	+	0.1(5)	=	7.3
Computer 4	0.4(4)	+	0.3(3)	+	0.2(7)	+	0.1(8)	=	4.7

Table 1: Results of Expectancy-Value (Linear) Model

In Table 1 above, the establishment weights are multiplied by her beliefs about each computer, resulting in the perceived values of the establishment attitude scores. In selecting the best computer from among the alternatives, our results predict that the establishment, given its attitude scores would select computer 1.

II. Ideal Brand Model

This is another model used by prospective buyers (consumers) to evaluate alternative brands. This model is built on the premise that the consumer holds an image of the ideal brand and compares actual brand to this ideal. The closer an actual a brand comes to this ideal, the more it is preferred. The model is mathematically stated as follows:

$$D_{jk} = \sum_{i=0}^{n} W_{im} |B_{iab} - I_{im}| \quad \text{---------- (2)}$$

Where;

D_{jk} = consumer k 's dissatisfaction with brand j

I_{im} = consumer i 's ideal level of attribute m

W_{im}, B_{iab}, and n are as defined in model (1) above

Following from model (2), the lower the value of dissatisfaction (D_{jk}) the more favorable consumer k 's attitude towards

brand j . For example, using the establishment with the same parameters (values) in the model (1), but with the ideal level of each of the attributes different i.e. all the computers submitted by vendors given as computer 1 to computer 4 with the attributes and their associated ideal level: (memory capacity, graphic capability, software availability, price) = (6, 10, 10, 5). Hence, we carry out the following evaluation:

	Attributes				
	Memory Capacity	Graphic Capability	Software Availability	Price	Attitude Score
Computer					
Computer 1	0.4|10–6|	+ 0.3|8 – 10|	+ 0.2|6–10|	+0.1|4–5|	= 3.1
Computer 2	0.4|8– 6|	+ 0.3|9–10|	+ 0.2|8–10|	+0.1|3–5|	= 1.7
Computer 3	0.4|6 –6|	+ 0.3|8–10|	+0.2|10–10|	+0.1|5–5|	= 0.6
Computer 4	0.4|4 –6|	+ 0.3|3–10|	+0.2|7– 10|	+0.1|8–5|	= 3.8

Table 2: Results of Ideal-Brand Model

Using the ideal-brand model, the vendor would interview the prospective buyers (consumers) and ask them to describe their ideal brands. The vendor would obtain three classes of responses: some consumers would clearly state their ideal brand, others would mention two or more ideals that would satisfy them, and the remaining consumers would have trouble defining an ideal brand and would find a wide range of brands equally acceptable. However, from Table 2, the establishment would decide to select computer 3, which has the strongest performance with least dissatisfaction of 0.6.

7. DISCUSSIONS AND FINDINGS

The models evaluation process yields different results, which are the perceived values of the different alternatives. These values from the models are subjected to sensitivity analysis or test, a very significant step in the final selection process.

The sensitivity test itself can be significant. If a small change in the numerical values of the weights does not produce a change in the relative ordering of the vendors, then it would be reasonable to assume that the ordering that was produced originally by the models is stable and probably reflects the best choice of the consumer (prospective buyer) or installation. However, if small variations in the weights produce different orderings of the vendors, then, clearly the models are not stable and this shows that there are no apparent differences between the proposals. In that case, one would have to go back and examine these attributes (factors) which are producing this shifting in relative values and further study would be needed in order to ascribe any degree of confidence in these models.

It would be difficult at this stage to try to justify either the expectancy-value model or ideal-brand model. It would equally be difficult to justify any other mathematical model. Their only defense would be their ease of use and the ability to test the sensitivity of the models to different weighting factors [5].

8. CONCLUSIONS AND FUTURE WORK

The process of selecting computer systems is complex. We have demonstrated with examples using the formalized expectancy-value (linear) and Ideal-brand models to aid decision makers in selecting computer systems. This process significantly reduces the uncertainty the decision maker faces in choosing the right system for an organization. Moreover, it yields a normalized, weighted choice which represents the best selection for the organization. However, this selection process requires a decision maker to collect and analyze a large amount of Information with regard to organizational established criteria such as cost, processor, modularity (upgrade), software availability, reliability, etc. What the prospective organization must attempt to do is to match its needs and objectives against the capabilities (attributes) of the computer systems offered by the different vendors or manufacturers and then proceeds by applying the procedural steps and the evaluation models presented in this paper to evaluate the different alternatives submitted by vendors. The application of these models apart from helping the prospective user to evaluate the detailed technical specifications, selection criteria and the evaluation procedures for analyzing proposals submitted by vendors are very pertinent in eliminating or reducing drastically the difficulties organizations often face in an attempt to select a given computer system of choice that meets some established needs of the organization.

The administrative tasks associated with the above processes significantly increases the amount of time an organization must spend on the evaluation and selection process. Through the use of a decision support system, which incorporate computer facility selection procedure though, a decision maker can efficiently and effectively evaluate this information and choose a computer system which is best for the organization. **A** decision support system would eliminate much of the time consuming administrative tasks associated with handling the information and allow the decision makers to concentrate on the evaluation and selection process.

Our future work would review some available decision support systems (DSSs) with a view to developing a robust DSS that can be tailored to different organizational needs to assist in decision making to quickly handle computer systems selection process to resolve organizational or individual consumer's needs.

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