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Abstract

In this study, we examine the differences in judgments made by expert and novice information system (IS) managers in selecting computing architectures for their organizations. This problem is interesting because of the wide variety of computing architectures available today, and the current rapid placement of fresh IS graduates in decision-making, managerial roles.

Introduction

Recently, there has been considerable interest in the promise of new technologies, such as application development languages like Java (Cornell & Horstmann, 1996) that are write-once run-anywhere, and cheap, disk-less computers (*e.g.,* (Anonymous, 1996; Anonymous, 1997; Phillips, 1997) that allow the centralization of data and programs on a network server. In the popular press, the debate between proponents and opponents of these technologies has largely focused on the Total Cost of Ownership (TCO). Thus, several articles have stated that disk-less computers will be cheaper to purchase and maintain (*e.g.,* (Bray, 1994; Francis & Johnston, 1997; Jones, 1992)) while other articles maintain that the cost will be transferred to maintaining the network (or that "thin clients require a fat network") (*e.g,* (Johnston & Francis, 1997; Phillips, 1997)).

For the purpose of this study, we define a computing architecture to be *a new computing infrastructure that significantly affects the purchasing and maintenance of hardware and software in an organization, and that has significant effects on end-user patterns of access to data and programs, within the organization*.

Depending on one's notion of "significant", this definition allows several computing infrastructures to be considered architectures. For example, we can consider four basic architectures: a **mainframe** architecture, with dumb terminals, where data and programs are centralized on the mainframe, and primarily a text based end-user interface, a **client server** architecture, where data and programs are shared between a client and a server, and primarily a graphical user interface (GUI), an **intranet** architecture with disk-less network computers, with data and programs centralized on the server, and primarily a GUI, and a **fully distributed** architecture, where data and programs are scattered fairly uniformly, with either a text-based or GUI interface. We feel that each of these is significantly different in terms of purchasing and maintenance of hardware and software, and offers significantly different patterns of end-user access.

The judgments of Information Systems (IS) personnel to adopt an architecture can have far-reaching effects on the future of IS within the organization, and ultimately can affect the organization's competitiveness. In addition, adopting an architecture involves large sunk costs for an organization. Since IS is a relatively new area, and the demand for IS people far out strips the supply, several organizations are hiring IS personnel with fresh IS degrees and with limited or no industry experience. It is likely that these personnel will soon be positions of decision making authority, as regards adopting architectures for the organization.

The goal of this work is to examine whether there are any differences in the judgments made by expert IS personnel and novice IS personnel in the decisions to select architectures for an organization.

Previous Work on Expert-Novice Differences and Judgments

There has been considerable work in the past on measuring expertise. In the psychology literature, this work can be broadly divided into the *Information Processing* (IP) perspective, and the *developmental* perspective. The IP perspective has dominated the study of expertise in computer systems (*e.g.,* Anderson, 1995). Classic studies in the IP perspective include (Chase and Simon, 1973) and (Chi et al, 1981).

The IP perspective proposes the binary paradigm of experts and novices (Campbell, 1992). Work within this paradigm presumes that: novice-expert is a binary distinction, novice knowledge and expert knowledge can be compared statically and experts are people with more experience (the Power law of Practise, (Newell, 1987)). In a summary of the IP perspective on expertise, (Glaser, 1989) stated that experts structure their knowledge into meaningful chunks, their knowledge is more **procedural** than **declarative**, and the knowledge experts has a theory or schema that can undergo change.

In contrast to the IP perspective, *developmentalists* focus more on the emergence of knowledge than the end-states of novice or expert. Thus, Hubert and Stuart Dreyfus (1986) proposed a 5 stage sequence of developmental stages from novice to expert: *novice, advanced beginner, competent, proficient* and *expert*. These stages differ not just along experience, but also along the commitment to the problem (increasing with expertise), the degree to which knowledge has been automated, and the degree of awareness of theory behind knowledge. This five stage scheme has been applied for chess playing and flying fighter planes

(Dreyfus & Dreyfus, 1986). The goal in the developmental approach is to come up with explanations of the **process** behind evolution to the different stages.

In the area of judgments, three broad approaches have been used to study judgments: the *black box* approach, that looks at outcomes alone, the *protocol analysis* approach that looks at the events that occur during the judgment process, and finally, the *program-first* approach, that attempts to build a computer program that mimics the same judgment outcomes as the human decision maker, and then see what processes in the program are responsible for reaching these outcomes. (Kleinmuntz, 1968, Ericsson and Simon, 1984).

In this study, we follow the **binary paradigm** of experts and novices, and the **black box** approach to studying judgment. In particular, we are interested in judgment decisions made by expert and novice IS managers, when faced with selecting architectures for their organizations.

We **define** experts as senior IS managers with at least 5 years of experience in industry. For novices, we use subjects who are about to complete their masters in information systems degree, and who have no industry experience. These subjects satisfy the novice requirements of having good declarative knowledge but poor procedural knowledge of industry practices.

Evaluating Judgments Made by Experts and Novices

The first step in our study was the identification of orthogonal dimensions that would describe an architecture, from the pint of view of IS managers. We used a grounded theory approach and conducted a series of interviews with randomly selected IS managers of large corporations, until theoretical saturation was reached. The factors that we identified are described in Table 1.

Table 1. List of Factors Derived Empirically from Interviews and Previous Theory

No.	Factor	Broad definition
1.	Software Quality	The quality of software associated with the architecture. This can include response time to end-users, quality of user interface and features provided by the software.
2.	Centralization v/s distributed nature	A centralized architecture means that software resides in a centralized location, and most of the hardware investment is also centralized.
3.	Costs	The costs of an architecture include the costs of acquisition of hardware, software, the costs of maintenance of hardware, of controlling different versions of the software and the costs of personnel trained in maintaining the hardware and software.
4.	Acceptance of the Architecture	This factor represents the degree to which a particular architecture has been accepted by IS magazines, the media, model organizations and software and hardware vendors.
5.	Backward Compatibility of the Architecture	This factor models the degree to which an architecture will cause changes in the organization. Changes include: converting old data to be read by the new CP, retraining users to use and IS personnel to maintain the software and hardware.

In order to evaluate experts' and novices' judgments, we use conjoint analysis. Conjoint analysis has the following advantages over other techniques like survey based techniques and case studies (Bajaj, 1998):

a) It creates a trade-off situation between different architectures, which is more realistic than having subjects evaluate the importance of different dimensions considered in isolation, as would be done in a regression based survey.

b) It allows a richer operationalization of the dimensions than would be permissible in a survey, which is usually administered remotely.

c) It allows statistical validity, unlike the case study approach, which allows for rich operationalization but no statistical validity.

We have created a study packet that describes 20 fictitious architectures, based on the dimensions described in table 1. Figure 1 shows one such architecture.

The 20 paradigms are chosen to obtain a main-effects only model of the effect that each dimension will have in the judgement making of the experts and novices. The study consists of getting experts and novices to rank order these architectures in descending order of preference, as seen from the point of view of their real organization (for experts) and a fictitious organization they work for (for novices). After rank ordering the cards, the subjects have to write a descending metric score on each card, starting with 100 for the top card, and 1 for the bottom card. This information will allow us to generate relative weights of each dimension in the minds of experts and novices.

Paradigm A

Centralized/Decentralized: Centralized
Costs: Medium
Acceptance of the Paradigm: Low
Backward Compatibility of the Paradigm: Medium
Software Quality: Medium

Figure 1. Example of Fictitious Architectures Used in Our Conjoint Study

Hypotheses Tested

We are testing the following hypotheses in our study:

Hypothesis 1: The variance between weights of each dimension in the experts sample will be less than in the novices sample.

This hypothesis is derived from the proposition that experts have greater consistency of structure in their knowledge than novices.

Hypothesis 2: There will be an ordering of dimensions in the experts sample, but not in the novices sample.

This hypothesis is derived from the proposition that experts will all have procedural knowledge of implementing architectures in organizations. This knowledge will be more consistent than declarative knowledge gleaned by novices from different courses and books.

Contributions of this Study

Given the choice of computing architectures available today, as well as the large sunk costs of adopting a particular architecture, the results of the study, which are being presented at this conference, indicate the suitability of allocating decision making responsibility to expert versus novice IS managers.

References

References and data available from the author on request (akhilesh@andrew.cmu.edu)