REPLANTING THE ANSWER GARDEN
Cultivating Expertise through Decision Support Technology

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Abstract: A growing body of literature established within the information technology field has focused on augmenting organizational knowledge and expertise. Due to increasing environmental complexity and changing technology the exogenous assumptions found within must be readdressed. Expert systems, group decision support systems, and collective intelligence tools are presented to illustrate how expertise needed in organizational decision-making is changing and may not reside within the traditional organizational boundaries. This paper suggests future research streams of how expertise can be cultivated through decision support technologies and how organizational expertise and problem-solving can be augmented reflecting the changing roles of experts and non-experts.

1 INTRODUCTION

Over the past several years the information technology (IT) field has contributed to the understanding of where the best source of expertise can be found for problems organizations face. IT researchers have made arguments for the benefits of expertise recommendation systems and expertise locating systems (McDonald and Ackerman, 1998) such as the Answer Garden. For several conferences within the IT research field have presented field study findings from the Answer Garden to help match organizational problems to solution providers in the organization (Ackerman, 1994; Ackerman and McDonald, 1996) and have made contributions to the understanding of location mechanisms of expertise. However, the altering organizational landscape due to increasing environmental complexity and changing technology has required us to readdress some of the exogenous assumptions. Though salient issues critical for future development and theory of decision support technologies surfaced, (Ackerman and McDonald, 1996) such as highlighting the limitations of experts and the need for future systems to ameliorate social and behavioural environments, these studies narrow use of experts and focus on advanced users of technology make generalizing limited. Furthermore, investigation into joint support systems that organizations use that augment knowledge and expertise can be beneficial. Consequently, by readdressing these suppositions and shortcomings on where the best source for organizational problem-solving and expertise can be found, IT research can replant and further cultivate expertise through decision support technology. Thus, additional investigation relevant to today's organizational demands and constraints are needed in the IT literature.

To understand how organizations have managed expertise through technology, this study focuses on expertise supported by expert systems (ESs), group decision support systems (GDSSs), and collective intelligence tools (CI tools) and provides a comparative analysis of them. These three decision support technologies will illustrate and provide insight into how expertise needed in organizational decision-making is changing and may not reside within the traditional organizational boundaries. A support styles framework for practice is introduced mapping dimensional styles of decision-support technology.

The paper is organized with an introduction of the changing paradigm between organizations and their environment. Then we move to defining expertise and its components. Next, we discuss three decision support technologies that organizations use to cultivate expertise. Then we analyze dimensions

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of decision-making as a practice that combines art, craft, and science as different styles of decision-making. Finally, we discuss future work for IT researchers.

2 PERMEABLE BOUNDARIES OF EXPERTISE

A new paradigm has emerged that allows IT researchers another opportunity to aid organizations in finding the best problem-solver for their given predicament. This new paradigm allows organization to tap into a larger pool of resources, knowledge, information, and expertise that is vastly superior then any human or organization can apply or build internally. This new paradigm diverges from traditional thought where high levels of expertise are thought to be the best source for problem-solving, to creating a new approach using a more permeable boundary of organizations.

Similar sediments are expressed within other research areas emphasizing that "the boundary between a firm and its surrounding environment is more porous' (Chesbrough, 2003, p.37). Investigation into this alteration of solution providing is needed in IT research with its objectives in mind. Seminal decision theory research (Simon, 1947) has highlighted 'to secure all the advantages of expertise in decision-making it is necessary to go beyond the formal [organizational] structure…' (Simon, 1947, p.189) To help rectify direction within IT research and provide insight into how organizations are haltering expertise using support technology, three decision support technology will be presented that reflects the changing paradigm of the role that experts and non-experts are playing.

3 SEEDING AND GERMINATING EXPERTISE

Before researchers can build support technologies to assist organizations and decision-makers in finding or harnessing expertise, a review of what expertise is and what the components of expertise are is needed. A peak into the expertise literature offers help in defining its make up as a multidimensional construct with expert knowledge as the essential part.

Expert knowledge consists of three principle components (1) formal knowledge, (2) practical knowledge, and (3) self-regulative knowledge (Tynjala, 1999). As a result of the complexity of expert knowledge, full articulation from experts may be difficult if not impossible (Spender, 1996).

Figure 1 illustrates the components of expertise using the example of a lawyer. Formal knowledge is explicit where learning is the focus of factual information. For instance, a lawyer would know the laws and case histories from law school. Practical knowledge develops in the skill of "knowing-how" and is the tacit knowledge, where intuition plays a role making expert knowledge difficult to explicitly express. Lawyers have practical knowledge through their extensive experiences from being in a legal setting which better prepares them to make a legal argument or judgment. The third component, self-regulative knowledge consists of the reflective skills that individuals use to evaluate their own actions. For self-regulative knowledge, a lawyer would monitor his argument, presentation, and reasoning while presenting to the judge or jury.

Researchers within the expertise literature would agree the scarcity of expertise and difficulty in representing it makes whoever possesses it extremely valuable because of its influence on decision-making. Nonetheless, expertise is thought of as a highly specialized or domain-specific (Chi et al., 1988) set of skills that have been honed through practice for a specific purpose (Jackson, 1999) and perform consistently more accurate in relation to others.

Since many decisions are dependent on the available information at hand when a human expert cannot be found, decision-making can be compromised if decision-makers do not have access to the resources, information, and expertise needed to make a quality decision (Simon, 1947). Thus it is understandable that organizations have contributed large amounts capital and resources to help manage expertise and have turned to decision support technologies to fill this gap.

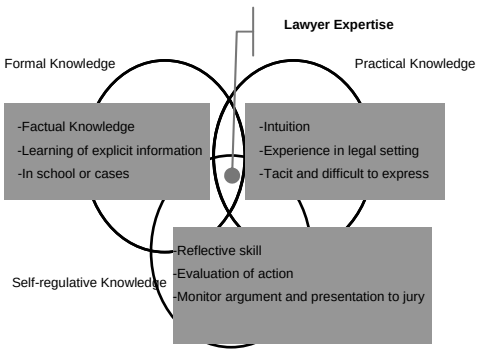

Figure 1: Components of Expertise of a Lawyer.

In Table 1 a human to technology relational approach is presented showing the comparison of the prevailing human and decision support technology used in organizations. On a human level, organizations can turn to a centralized human expert for decision-making or participants can congregate for a group meeting to make a decision if no one individual has complete knowledge of the problem. Organizations can also collect the availing opinions, feelings, and needs using a decentralized method of surveying, polling, or voting. These methods are used in organizations, however have limitations that are extensively addressed in decision theory research (Simon, 1947).

On the technology level, organizations have used ESs to replicate human experts and knowledge in narrow domains of decision-making. GDSSs systems facilitate group meetings by enhancing communication between its participants and recently, organizations are turning to capture distributed knowledge of employees and customers through CI tools.

Table 1: Human to Technology Relational Approaches.

Human	Human expert	Group meeting	Survey/ Polling
Technology	ESs	GDSSs	CI tools

Considering expertise is not only restricted to human beings- rather technology's capacity to posses "expert" ability to influence decision-making through the transfer of knowledge, organizations have allocated significant resources to leverage expertise using technology. Each technology or system has been built to better capture knowledge or represent expertise in the cognitive process of the decision-maker(s) for effective decision-making to occur (Liou, and Nunamaker, 1990; Smith, 1994). Expertise captured and managed from the support systems embody why each system is important for organizations to have. In re-examining the literature, organizations have cultivated different support technologies to support their expertise needs when human experts can not be found or no one person has complete knowledge of the problem.

4 CULTIVATING EXPERTISE THROUGH DECISION SUPPORT TECHNOLOGY

One method used by organizations to capture expertise is to employ expert systems. Currently, expert systems are playing a critical role for many organizations and are a source of competitive advantage (Gill, 1995). Expert systems, a branch of artificial intelligence are contributing to decision-making through their representation of knowledge and reasoning of human experts for its users (Weiss and Kulikowski, 1984). By mimicking and replicating the cognitive process of a human expert, novice users can be supported to perform as well as experts (Cascante et al., 2002) while expert users can have their expertise further refined. By emulating an expert's problem-solving ability, knowledge and reasoning are transferred to a user through the use of ESs for faster learning and decision-making than would occur when developing these skills over time. Organizations use ESs because they represent expertise to its users for decision-making when a human expert cannot be found or is in short supply.

Although many organizations have successfully implemented expert systems to address particular problems in a narrow domain, changing external factors impacting competitiveness and sustainability have forced organizations to approached critical decisions differently. Studies indicate (Gannon, 1977) the more complex organizations become the fewer decisions are made by any single individual (or expert system). Rather than rely on expertise from one individual or system for an important decision, organizations turn to groups or teams of experts in the decision-making process. Furthermore, groups of experts may be necessary when diverse subsets of knowledge are required and no single expert has complete knowledge of the problem.

One technology supporting organizational change and group decision making is group decision support systems (GDSS). GDSS use has shown to reduce time, costs (Gallup, 1985), and foster collaboration, communication, deliberation, and negotiations (Kull, 1982). Research in group decision support system theory suggests; that through the communication, collective knowledge, and interaction of participant's better solutions can be reached over any single individual. When a GDSS is used in decision-making it aims to improve the process of group decision-making for opinion

convergence, group consensus, and better outcomes in decision-making. Designed using the rationale theory of decision-making, GDSSs optimizes the

decision-making process by following what is referred to as intelligence, design, and choice (Simon, 1947). GDSS use enhances decision outcomes by leveraging the cognitive knowledge of participants by supporting the behavioural and social needs of the group to resolve uncertainty in the group decision making process. GDSSs possess expertise in the cognitive decision-making process using techniques developed within the support system.

Technologies embedded within the GDSS contribute to the different components of expertise. For instance, a database or information repository is one component of GDSS and offers the formal or documented knowledge of expertise. Practical knowledge of expertise can be viewed through the heuristics used in the GDSSs to analyze judgments or techniques in decision-making. Communication technologies such as email, instant messaging, and video conferencing allow for interaction to occur representing the self-reflective knowledge of expertise to arrive at a decision.

As a result of the different technologies that support the components of expert knowledge, GDSSs are able to capture the knowledge and contribution from the individual users collaborating to arrive at a better solution or create a greater sum than the individual parts. In addition to the cognitive expertise, GDSSs occupy the center point for the aggregation of information and expertise from each participant. GDSSs impact on the decision-process outcome depends on the degree of change in communication of the users and when used effectively better outcomes can occur. Though GDSSs have failed to build traction as an effective support system, they are continuing to used and have adapted to the market's organizational and technological needs of the 1990's by moving primarily to a web-based software allowing for anytime, anyplace meeting, and decision-making.

Though GDSSs have supported organizations by utilizing the expertise of the group and providing structure for effective decision-making (White et al., 1980), decision-makers are still constrained by the information they receive to make a decision. Since the quality of group discussion is greatly contingent upon the quality of information brought to the session by the group members, having tools with capabilities to increase available information internally and externally to the organization would be beneficial (Aiken et al., 1991). In hindsight, what is alluded to, is a changing organizational paradigm, away from a half century of support system development and research that centralized decision-making for experts, to a decentralized model of managing external capabilities, resources, and information of the organization. In organizations, decision-makers do not have access to all the information they need when making a decision (Simon, 1947) and thus, effective decisions can be compromised. Three potential reasons why critical information is not accessed by decision-makers could be: conventional methods and technologies insulate information flow to only a select group of people, decision-makers do not ask for all the information accessible to them, or those who have it do not share because of political or social reasons.

As Friederich von Hayek (1945) expresses in his well known article: The Use of Knowledge in Society, regarding the economic problem of society "…is to secure the best use of resources known to any of the members of society, for ends whose relative importance only these individuals know. Or, to put it briefly, it is a problem of the utilization of knowledge not given to anyone in its totality." Through the use of collective intelligence tools (CI tools), constraints and limitations to collect information and knowledge in its totality can be addressed.

Based on the premise that the collective judgment of a large group is better at predicting and forecasting future events than individual experts or small groups of experts (Hanson, 1999; Berg et al., 2001) collective intelligence offers a substitute to traditional experts and solution providers. CI tools that support information aggregation offer an alternative to the constraints of information flow in decision-making, knowledge work, and complexity in forecasting uncertain events. Moreover, the primary goal of CI tools is to facilitate the summative body of knowledge, information, and resources of its users.

Contrasting sharply to traditional decision support tools, CI tools democratize decision-making by including many people in and outside the organization into the information gathering and decision-making process. Diverging from traditional thought where high levels of expertise are seen as the best source of decision-making, CI tools have the ability to harness lower levels of expertise for peak solutions in decision-making (Page, 2007).

Prediction markets, a CI tool can be defined as markets that are designed for the purpose of collecting and aggregating information that is scattered among the traders (users) who participate

through trading. When a user participates by trading, information can be reflected in the market values in order to make predictions about specific future events (Wolfers and Zitzewitz, 2006). Instead of independently-derived individual predictions, predictions markets enable a collaborative evaluation process where many participants make small contributions with a granularity effect. Derived from the efficient markets hypothesis, markets are expected to be the best predictor of unknown future events and should be seen as a complement to executives and experts to aid in information flows to make decisions more quickly and accurately. Much like a real market, traders are rewarded monetarily or through visibility with in the organization based on the accuracy of the information they provide by participating. When individuals buy or sell contracts based on the information they have, they will be rewarded by being the first mover to reflect this new information into the market before others.

Since CI tools are in their formative stages of development and use, their robustness is yet to be demonstrated (Diasio and Agell, 2009). For instance, depending on the type of CI tool organizations implement they may or may not have a component of formal knowledge. Currently, prediction markets do not contain a formal knowledge moiety, however in the near future it is possible the addition of linked database, knowledge repositories, or automated market monitoring software is conceivable. As with formal knowledge, prediction markets do not possess practical knowledge but as usage grows heuristic trading components will facilitate trading virtually. The market mechanism within prediction markets act as the self-regulative knowledge that create this reflection in the market price through buying and selling.

Seeking to push decision-making down the corporate ladder and information up toward the top to those who need it, CI tools incubate the hidden information that is scattered around the organization or network to be discovered that allows non-experts to produce expert like results when collectively mobilize. By including a large number of people such as rank and file workers or the public into the decision-making process, organizations can create opportunities to augment their expertise needs. Organizations that effectively mobilize a diverse group of people and tap a new reservoir for problem-solving, transform individuals with a low level of expertise for a given problem into an additional method for forecasting, decision-making, and problem-solving. Companies that choose to use CI tools leverage resources of knowledge, information, and problem-solving ability far beyond what they could afford to deploy internally. CI tools help link and manage the external information, knowledge, and expertise of the organization and enable organizations to apply outside knowledge and expertise towards improving decision-making and problem-solving in the organization.

5 DISCUSSION AND FUTURE WORK

Today the internet has made it easier and more cost effective for organizations to implement CI tools to guide information flow. However, it is organizations choice and ability to effectively manage and leverage the collective intelligence of its resources. Uses of CI tools by organizations have had some success (Ho and Chen, 2007) however; much is still unknown about these tools. Future challenges may include using CI tools not as a replacement for experts but as an additional tool in decision-making. Traditional roles of experts may change and represent a mindset shift from answer givers to inquiry mediators in effort to harness the knowledge of the masses in decision-making.

The limitations of existing expertise locating methods have forced organizations to rethink where knowledge and expertise can be found. As the use of CI tools grow, opportunities exist to apply far greater knowledge resources to a wide spectrum of problems then any individual or group of expert could employ. CI tools support hard to find information that would not be included in problem-solving, create an efficient method for aggregating large amounts of information, and incorporates new and diverse perspectives giving organizations a greater opportunity to find solution providers.

6 CONCLUSIONS

Our review has shown how organizations use decision support technology to support their expertise needs in decision-making. The study has indicated a shift from the existing IT literature that reflects a changing paradigm where organizations can find and leverage expertise. As a result of the permeable boundaries of the organization, new technologies that bridge the external environment to organizations are emerging. These changes have significant impacts on organizations, where experts

and non-experts may find themselves playing new roles within the organizational structure.

Companies who take the necessary steps to integrate these technologies which utilize legacy support systems and emerging decision support technologies will be rewarded with a competitive advantage through accuracy in forecasting and problems-solving with more robust support systems.

Finally, this paper lays a foundation for a research stream in understanding the role decision support technologies play supporting expertise in organizations by: (i) showing a perspective of expertise supported by decision support technologies that organizations currently use and (ii) in structuring how organizational expertise in short supply can be augmented using CI tools from outside the organization.

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