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Coordination in Distributed Collaborative Environments: a Key to Better Decisions

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ABSTRACT

Distributed, collaborative decision making is becoming more common in many organizations. It occurs for a multitude of decision types, and is enabled by IT support. However no systematic study of the use and impact of such IT-based environments on decision outcomes has been done. In this research I develop a taxonomy of information environments and the information and coordination mechanisms made available in a distributed collaborative environment (DCE). I will use this taxonomy to study the fit between use of the DCE and the information environment in which decisions are made. I hypothesize that use of appropriate coordination mechanisms for inputs and processes improves decision outcomes. I will test the model in an empirical field study of two different operational decision types made with and without a DCE in offshore oil production.

Keywords

Collaborative decision making, information technology, coordination, ambiguity, uncertainty, complexity, urgency

INTRODUCTION

In a wide variety of business situations decisions are made collaboratively but expertise is distributed over space and time. Although these situations have been around for years, information technology can support such decision making, with low cost, high bandwidth communication technologies, real time data capture and analysis tools, and a variety of communication mechanisms. However, experience suggests that more than technology is needed to create effective distributed decisions.

In this research I characterize a distributed collaborative environment (DCE) as a combination of processes, skills, technologies, governance mechanisms, and physical environment characteristics designed to support distributed decision making, and ask the question: "For what decisions is use of a distributed collaborative environment effective?" To understand why and how DCE use is effective, I focus on the impact of both the information environment (characterized in terms of urgency, uncertainty, ambiguity, and complexity) and of use of the DCE on decision success. I take the perspective that coordination of distributed knowledge assets (data, information, knowledge and people), along with coordination of the workflows used by decision makers, are key to collaborative decision making success, and that DCE use facilitates this coordination. I empirically analyze the decision processes used, and outcomes obtained, across DCE's of varying maturity for two specific decision types.

The model below shows the overall decision framework.(Figure 1). The information environment is specific for each decision, and consists of degree of urgency, uncertainty, ambiguity, and complexity. The environment characteristics result in DCE use characteristics. DCE use then impacts decision success.

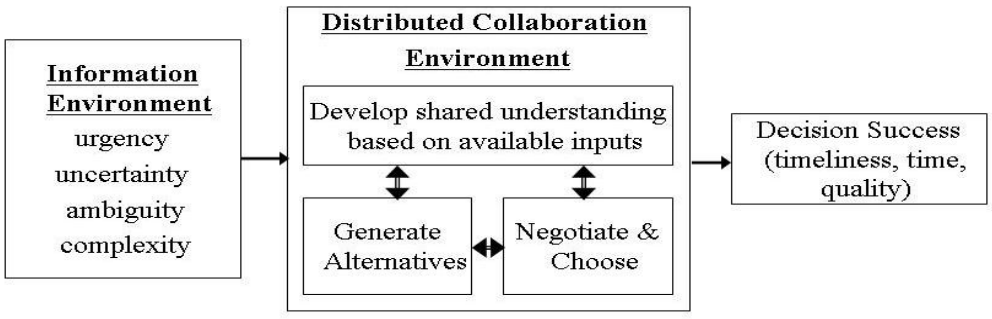

Figure 1: Overall Decision Framework

LITERATURE REVIEW

Decision Processes, Inputs, and Coordination

Collaborative decision making can be studied from multiple perspectives. The traditional individual cognitive analysis by Simon of decision making as intelligence, design, choice (Simon 1977) has been extended to, for example, strategic decision making by groups. (Mintzberg, Raisinghani and Theoret 1976; Nutt 1984). Group decision support systems have focused on supporting these types of decision processes, mainly by focusing on changing communication patterns and capabilities (Dennis and Garfield 2003; DeSanctis and Gallupe 1987). In this perspective, the environment is generally exogenous and decision processes are relatively structured. A second stream of analysis focuses on a social/cognitive framing in which a decision maker enacts the environment (Weick 1995). Orlikowski (2000) uses this perspective to show how individuals enact their environment through the use of information technology. Here the environment is endogenous: it is shaped by the decision maker. A third major perspective is the political/organizational. Goals are based on organizational or political drivers, and processes are difficult to characterize. Examples include Pfeffer and Salancik's (1978) work on power, as well as nonrational (garbage can) decision processes (Cohen, March and Olsen 1972). Most decisions these researchers focus on are unstructured and nonroutine.

In my research I will use the cognitive stream as a basis, as the decisions I focus on are relatively structured, with clear, agreed upon goals. Although technically complex, they are not routine (Gorry and Scott Morton 1971). As the decisions are made by groups, not individuals, I adapt Simon's model of the decision process to include building shared awareness (intelligence), shared alternatives generation (design), and consensus building via negotiation (choice) (Carlile 2004; Lawrence and Lorsch 1969; Nutt 1993; Nutt 1998; 2002; 2005). I focus on individuals collaborating, rather than on teams, as not all members in a group work on all decisions, and decisions may include outside experts.

Another stream of literature focuses more on managing inputs, especially knowledge. The communities of practice literature explores the relationship of tacit knowledge and knowers on each other, as well as organizational learning (Brown and Duguid 1991; Cook and Brown 1999). The knowledge management literature describes processes for managing (explicit) knowledge within organizations over time, but is not specific to decision situations (e.g., Alavi and Leidner 2001). In this research I view knowledge management through the lens of knowledge coordination (Iyer, Shankaranarayanan and Wyner 2006).

The third stream of literature I draw from is coordination. The coordination literature tries to capture the relationship between inputs and processes. At a high level, Thompson described the types of coordination between processes as sequential, reciprocal, or pooled (Thompson 1967). Nutt has analyzed coordination at this level for strategic decision making (Nutt 1998; 2000; 2002; 2005). In the decision processes I study, the coordination requirements are more specific. Distributed expertise (experts and information) need to be coordinated for a specific decision situation (Simon 1947). Coordination theory summarizes this requirement as "bringing the right resources at the right time to the right location" (Malone, Crowston and Herman 2003; Simon 1947).

Information Environment and Coordination Requirements

In this research the information environment is a key contingency leading to variation in the type and extent of coordination of the inputs and workflows. The information environment consists of different levels of urgency, uncertainty, ambiguity, and complexity. Multiple authors have described how these dimensions differentially impact business processes. Urgency (Nutt 2002), implies severe time constraints, such that the first apparently feasible solution is accepted. Edwards (1954) defines uncertainty as a situation in which there is known set of outcomes, but those outcomes have unknown probabilities. Thus this can be resolved by additional information (Hirschleifer 1973). Ambiguity is defined in at least two ways relevant to this research: first, as a situation in which outcomes, and perhaps inputs and relationships, are unknown, (Pich, Loch and De Meyer 2002; Schrader, Riggs and Smith 1993). Knowledge, in the form of experience or insight may help resolve this. Second, when information is ambiguous it is subject to multiple interpretations that are qualitatively different. That is, it may produce conflicting results for different stakeholders due to completely different world views, assumptions, or goals (Daft and Lengel 1986). This type of ambiguity (equivocality) must be reduced through negotiation or other processes. Thus ambiguous environments will lead to different information gathering processes, resolution processes, and coordination mechanisms among stakeholders, than will uncertain environments. Complexity is described by (Pich et al. 2002; Simon 1981) as due to two factors: a high number of variables (size) and/or a high number of interactions among variables. Filtering, or more compact descriptions of the situation (Simon 2003 (1962)) supports complex environments.

Toward a taxonomy of the relationship between information environment and Use of a DCE

Taking the coordination perspective of "right things, right time, right location", it is possible to detail requirements for use of a DCE in specific decision situations (See Table 1). Differences in the information environment lead to different ways of using the DCE, in terms of resources accessed, what is done with those resources, and coordination of decision subprocesses.

The key ingredients for issue resolution are people (experts with knowledge, and decision makers), along with data and information describing the issue, prior solution attempts, similar potential solutions, etc. Thus key questions about people availability are: do we know who they are, can they be contacted as needed, and will they respond? (Faraj and Sproull 2000). Data, information, and knowledge need to be available, in an interpretable form. "Raw data" may be desirable, but information, in the form of summaries, analyses (e.g. models or expert systems), or visualizations may be easier to use (e.g., Card, Mackinlay and Shneiderman 1999; e.g., Holsapple and Whinston 1996). In addition, some types of information artifacts may be created to coordinate between decision subprocesses or across experts' disciplines (Carlile 2002).

Timing is important in decision making (Cohen et al. 1972), especially in urgent situations. In general, the most effective way to resolve an issue is through simultaneous interaction of the "right things": synchronous interaction. Delays due to unavailability of resources can be costly. This also implies a need for timely conversion of data to information (rapid analysis and visualization), as well as timely data collection (e.g. real-time data availability).

Having all people interact face to face is known to speed up issue resolution (Webster and Trevino 1995). However, given the constraints of distributed decision making, telecommunications and information systems infrastructure must substitute for "being there" (Hollan and Stornetta 1992). Right location thus implies that all parties have access to each other as needed: synchronous interaction. The communication channel must appropriate for the issue (Sussman and Sproull 1999), possibly with rich media such as video.

	More use of:								
	Data	**Information**			**Knowledge**		**Asynch media & communications (sequential/ reciprocal)**	**Synch media & communications (pooled)**	**Rich media (Video)**
Environment characteristic:	**Raw Data Acquisition**	**Aggregation**	**Analysis**	**Visualization**	**Experts' input**	**Real Time Inputs**			
High urgency		**yes**		**yes**	**yes**	**yes**		**yes**	**yes**
High uncertainty	**yes**		**yes**				**yes**		
High ambiguity				**yes**	**yes**			**yes**	**yes**
High complexity		**yes**	**yes**		**yes**		**yes**		

Table 1: Expected Use of DCE Inputs and Coordination Mechanisms in different Information Environments

RESEARCH SETTING

I plan to study use of a DCE developed by a major oil company to improve management of offshore oil platform operations from onshore. The DCE is an integrated combination of processes, people characteristics (roles, skills), technologies, organizational structures, and physical environment characteristics designed to enable "better decisions faster".

Specifically, I will study two distinct operational decision processes in three settings, resulting in six sets of specific decisions. The first, well optimization, is an issue resolution process in which a group of technical experts determines causes and solutions to production losses for each well on a platform. They use real time information, analyses, and cross-disciplinary knowledge to propose solutions, which typically require capital or operational investment (e.g. a new type of pump). The environment is complex and sometimes urgent. The second decision, management of change review, is a prioritization and allocation process, in which proposed investments (including those from well optimization) are evaluated, budgeted for, and scheduled. It requires more management knowledge and negotiation, making it ambiguous and complex. Both decisions occur frequently enough to sample a statistically relevant number, and are made in all three settings.

The settings are all offshore oil platforms that have been in operation for several years. Personnel are familiar with both operations and each other. The main difference is the maturity of DCE use. One platform has been using its DCE for over two years. The second has just begun to implement a DCE, so has the technology and environment, but may not have adapted its processes, roles, and organizational structure. The third platform has no plans to implement a DCE.

EMPIRICAL MODEL

Based on the above taxonomy and conceptual framework, I will empirically test the model shown in Figure 2. For a given decision type (and thus information environment), the fit between environment and DCE use improves decision outcomes.

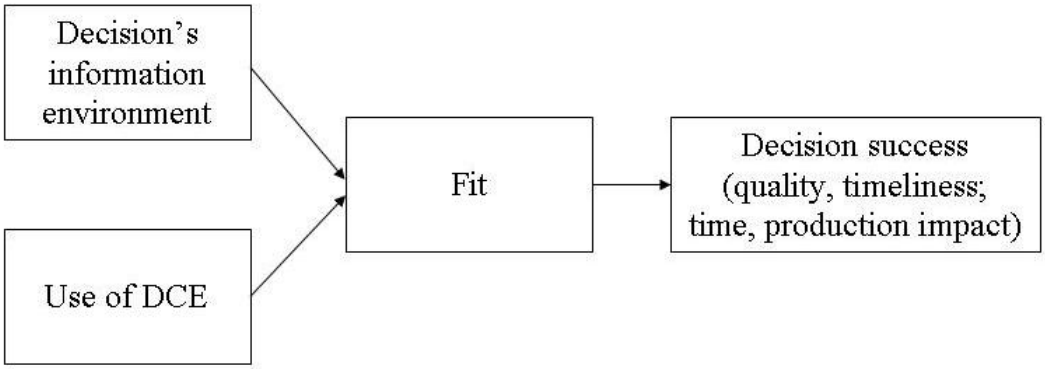

Figure 2: Empirical Model: Fit Between DCE use and Information Environment impacts decision success

HYPOTHESES

1. The DCE is used differently for different types of decisions. This is due to differences in information environment, which leads implicitly to different actions.
2. The decision processes will vary with the setting. That is, whether a DCE is used impacts how the decision process occurs, as the available inputs and coordination mechanisms are different.
3. The fit of coordination mechanism (use of the DCE) and the information environment, as predicted by the taxonomy, results in better decisions. This hypothesis will decompose into specific versions of "in information environment x, use of a, b, c (the measurable functions, inputs, or coordination mechanisms) leads to better decisions".

METHODS

I will approach this problem via field analysis of multiple instances of each decision type in each environment. Independent variables include use of various types of data, applications (e.g. for analysis or visualization), experts, and coordination mechanisms such as different types of media, all of which can be measured unobtrusively. In addition a survey will be used to determine the information environment for each decision.

Dependent variables will include perceived decision quality and timeliness, as well as time required to make the decision and a measure of production impact.

All work is done within with oil platforms that are technically similar, with teams experienced in both the technology and working together, reducing the need for explicit controls.

EXPECTED RESULTS AND IMPLICATIONS

I expect that use of the DCE improves both perceived and actual decision outcomes vs. a non-DCE environment. In addition I expect that the more mature DCE will show both greater use and a concordant improvement in outcomes over the less mature DCE.

I may find that certain coordination mechanisms and inputs are used more than others across decision types, and others are adapted for different decisions. I do not hypothesize about this but it will open up fruitful avenues of further research to confirm and explain these types of findings.

If I find that DCE use does not impact decision success, this implies that DCE's do not matter and that investment in sophisticated technology may be better spent elsewhere. This analysis will then help me suggest why this may be so and lead

to further research to try to determine which (unmeasured or unvaried) factors might matter in improving distributed collaborative decision outcomes.

LIMITATIONS AND FUTURE WORK

The research site allows for a natural experiment, but not a controlled experiment in which availability of coordination mechanisms can be manipulated. Thus it may be hard to isolate the impact of use vs. availability. In addition, the context makes it difficult to generalize findings across different types of DCE's. Results of use may be different for new groups, or those in which goals are less clear. Finally, I have limited myself to two decisions, in only two of the possible information environments suggested by the taxonomy. These limits can be overcome by both experimentation as well as field studies across multiple types of firms and environments.

EXPECTED CONTRIBUTION

Contributions for both research and practice will include a taxonomy relating environments and use of inputs and coordination mechanisms via DCE capabilities. This research will show theoretically how and why coordination matters in distributed collaborative systems. It will also derive appropriate measures for assessing DCE use, and show when, why and how DCE use is beneficial for various types of decisions.

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