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Supporting decision making process with "ideal" software agents – What do business executives want?

Yanqing Duan [a,*], Vincent Koon Ong [a], Mark Xu [b], Brian Mathews [a]

[a] Business School, University of Bedfordshire, Park Square, Luton LU1 3JU, Bedfordshire, UK
[b] Business School, University of Portsmouth, Portland Street, Portsmouth PO1 3DE, UK

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ABSTRACT

According to Simon's (1977) decision making theory, intelligence is the first and most important phase in the decision making process. With the escalation of information resources available to business executives, it is becoming imperative to explore the potential and challenges of using agent-based systems to support the intelligence phase of decision-making. This research examines UK executives' perceptions of using agent-based support systems and the criteria for design and development of their "ideal" intelligent software agents. The study adopted an inductive approach using focus groups to generate a preliminary set of design criteria of "ideal" agents. It then followed a deductive approach using semi-structured interviews to validate and enhance the criteria. This qualitative research has generated unique insights into executives' perceptions of the design and use of agent-based support systems. The systematic content analysis of qualitative data led to the proposal and validation of design criteria at three levels. The findings revealed the most desirable criteria for agent based support systems from the end users' point view. The design criteria can be used not only to guide intelligent agent system design but also system evaluation.

1. Introduction

As the business environment becomes more volatile, unpredictable and competitive the appropriate handling of information and making sense of it has become a distinct core competence of business executives. The capability for managers to know their company, its competitors, and the business environment and make informed decisions, can significantly affect business competitiveness and success. There is an increasing complexity and dynamism of operational and strategic information in electronic and distributed environments. Executives are constantly seeking assistance for continuous, proactive and self-adaptive approaches to acquiring, synthesising and interpreting information for business intelligence with a view to determining a course of action. Executive information systems (EIS) originally emerged as computer-based tools to provide executives with easy access to strategic information and to support and enhance their information processing activities; however, EIS as a standard alone application have started to disappear since the mid-1990s. It is reported (Averweg & Roldán, 2007; Basu, Poindexter, Dorsen, & Addo, 2000) that EIS in most organisations have moved on to Internet-based systems, and some of the key functions have merged with the latest enterprise systems, for example, the ERP and business intelligence (BI) systems that embed executive dashboards, scorecards to present/ report synthesised information to senior management (Simons, 2008). Past studies on EIS have established a range of views and guidelines for developing systems for executives, but these guidelines largely failed to develop robust and intelligent systems to meet emerging challenges.

The emergence of the intelligent software agent, as a concept and a technology, has been put forwarded as one of the solutions for reducing information overload problems faced by contemporary business organisations (Belfourd & Furner, 1997; Edmunds & Morris, 2000) and supporting business executives' intelligence activity for decision making in the more integrated and distributed environment of the Internet. However, there has been strong criticism that "*there is a truly dearth of such work in the literature that reports on real users' views on specific personal agents*" (Nwana & Ndumu, 1999, p. 136). Not much progress appears to have been made to address this criticism since. One of the factors contributing to the lack of interests in users' viewpoint in information systems (IS) is due to the factor that "*IS are often developed and studied from an organisational viewpoint . . . rather than how they support individual users, their characteristics, preferences and actions*" (Iivari, Isomäki, & Pekkola, 2010). Arnott and Pervan (2005) pointed out that one of the fundamental issues that needs to be addressed by DSS researchers is a crisis of professional relevance. Many IS researchers also stress that both technical and human factors should be considered in the

* Corresponding author. Tel.: +44 (0) 15832743134; fax: +44 (0) 158273926.
E-mail addresses: yanqing.duan@beds.ac.uk (Y. Duan), vincent.ong@beds.ac.uk (V.K. Ong), mark.xu@port.ac.uk (M. Xu), brian.mathews@beds.ac.uk (B. Mathews).

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IS design and development process (e.g. Avison, Fitzgerald, & Powell, 2001; Kling, 2007; Mumford, 2006). In examining the relationship between user participation and decision support systems (DSS) outcomes, Lynch and Gregor (2004) found out that much previous research focused on whether users were involved in development without the detailed consideration of the degree of their influence on system design features. Users, i.e. business executives, in this research context, should have their views considered and be able to influence agent design features. Therefore executives' desires and views on agent-based support should be investigated in order to design and develop agent–based support systems that will be accepted by and workable for them.

This research aims to explore the potentials of agent based systems for supporting the intelligence phase of decision making and contribute to a better understanding of users' expectations and requirements of designing and developing intelligent software agents from business executives' perspective. The research adopted a qualitative method from the system client perspective with an interpretative data analysis approach, therefore, the outcomes would motivate agent support system researchers to focus on issues of current importance and relevance to business executives (Arnott & Pervan, 2005).

This paper first examines the theoretical underpinning for supporting executive intelligence activities, which involves information processing and sense making, and the need for designing agent based support systems that are capable of responding and adapting to executives' decision making needs. It also reviews the literature on software agents and its potential for supporting executives' intelligence activities. The research adopted a qualitative approach to achieve its aims by using an agent interface prototype as a tool to help executives to understand the agent concept. Opinions were generated through focus group discussions and personal face-to-face interviews. Based on a rigorous content analysis using qualitative data analysis software, Nvivo, a set of design criteria was generated from focus group findings and confirmed with interviews. The design criteria has three-levels, comprising a "usability-adaptability-autonomy" trichotomy for supporting executive intelligence activities. The emphasis of this agent system design model is an intelligent and executive-centred system which can be used not only to guide agent support system design, but also the evaluation of the intelligent support systems.

2. Literature review

2.1. The decision making process

Effective decision making is the most important part of a senior manager's job. However, it is also the most challenging task they face in their managerial responsibilities. A number of scholars have contributed to the field of understanding the nature and the process of decision making, One of the most notable is Simon's (1977) work on the "*new science of management decisions*".

Simon (1977) proposed a generic decision making process which follows *intelligence-design-choice* phases. In his theory, he states that decision makers spend a large fraction of their time surveying the organisational environment to identify new varieties that call for new actions in the "*intelligence*" phase. In the "*design*" phase they individually, or with their subordinates, design and develop possible courses of action for handling situations where a decision is needed. In the "*choice*" phase, they select from those available courses of actions to meet and solve an identified problem.

The intelligence phase entails scanning the environment, either intermittently or continuously (Turban & Aronson, 1998). It is argued that the support for the "*intelligence*" phase is of particular importance and critical, because the intelligence phase is the first principal phase, which emphasises the search for variety, occasions, or conditions that call for decisions. In the intelligence phase, the environment is examined and problem areas, as well as opportunities, are identified. Besides the identification of problems or opportunities, the intelligence phase also involves classification of the opportunity or problem from the business environment. The intelligence phase, however, has often been neglected in DSS design and development.

2.2. Executives' intelligence activities

Business executives are senior managers who are responsible for strategic decision making in an organisation. Therefore, their decisions are critical and have profound human, financial and organisational impact. With the increasing availability of electronically distributed information, managers suffer from information overload, especially an over abundance of irrelevant information (Eppler & Mengis, 2004; Maes, 1994; Shapira, Shoval, & Hanani, 1999). As a result, senior executives are facing increasing complexity, diversity and uncertainty in processing information for making decisions. Senior executives simply cannot relate simultaneously to all of the information available to them. They have to select and then make sense of what is selected. Ackoff (1967) foresaw this dilemma with the introduction of management information systems (MIS). He strongly believed that the emphasis of an executive support system should shift from supplying relevant information to eliminating irrelevant information. He argues, "Unless the information overload to which managers are subjected is reduced, any additional information made available by an management information systems cannot be expected to be used effectively" (Ackoff, 1967, p. 148).

Simon's (1977) intelligence phase requires executives to carry out a number of core activities in order to identify opportunities, problems and needs, which call for decisions. The key activities carried out in the intelligence phase are information acquisition through environment scanning, information synthesis and sense making. These core activities are defined as "Intelligence Activities" in this paper. Support for executive intelligence activities is essential for them to better cope with the increasingly dynamic and unpredictable environment.

In order for executives to understand their internal and external business environment and to attend to signals and messages generated from those environments, they need a system that is capable of providing a broad range of relevant information. Although companies have little control over external events, information acquisition activity can reduce remoteness and increase the predictability of future possibilities. Information synthesis in executive intelligence activities involves information filtering and refining. Information synthesis acts as a "variety reducer" by screening out irrelevant information and refining information through relevance feedback for their relevancy. Finally, sense making is pertinent to executive intelligence activities. Synthesised information is further processed to resolve the equivocality of information and to give meaning and understanding. Explanations are key functions in sense making activity, in which explanations help provide adequate justification on information such as the meaning of data, the justification for a particular piece of information and the reasons for advising a particular course of action. Identified opportunities and problems in the intelligence phase trigger the phase two and three activities.

2.3. Intelligent agents

Intelligent agents, or software agents, are "software entities that carry out some set of operations on behalf of a user or another