REVITALISING EXECUTIVE INFORMATION SYSTEMS
FOR SUPPORTING EXECUTIVE INTELLIGENCE
ACTIVITIES

by

Koon Y (Vincent) Ong

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of the University of Bedfordshire

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"The fear of the LORD is the beginning of wisdom, and the knowledge of the Holy One is understanding. Blessed is the man who finds wisdom, and the man who gains understanding."

(Proverbs 9:10; 3:13)
Executive Criteria of Agent-based EIS for Supporting Executive Intelligence Activities

Koon Y (Vincent) Ong

ABSTRACT

With the increasing amount, complexity and dynamism of operational and strategic information in electronic and distributed environment, executives are seeking assistance for continuous, self-reactive and self-adaptive activities or approaches of acquiring, synthesising and interpreting information for intelligence with a view to determining the course of action – executive intelligence activities. Executives Information Systems (EIS) were originally emerged as a computer-based tool to help senior executives to manage the search and process of information. EIS was popularised in 1990's but EIS study have not advanced to a great extent in either research or practice since its prevalence in the mid and late 1990's. Conventional EIS studies have established some views and guidelines for EIS design and development, but the guidelines underpinned by preceding research have failed to develop robust yet rational EIS for handling the current executive’s information environment. The most common deficiency of traditional EIS is the static and inflexible function with predetermined information needs and processes designed for static performance monitoring and control. The current emergence of the intelligent software agent, as a concept and a technology, with applications, provides prospects and advanced solutions for supporting executive’s information processing activities in a more integrated and distributed environment of the Internet. Although software agents offer the prospective to support information processing activities intelligently, executive’s desires and perception of agent-based support must be elucidated in order to develop a system that is considered valuable for executives.

This research attempts to identify executive criteria of an agent-based EIS for supporting executive intelligence activities. Firstly, four focus groups were conducted to explore and reveal the current state of executive’s information environment and information processing behaviour in the light of Internet era, from which to examine the validity of the conventional views of EIS purpose, functions and design guidelines. Initial executive criteria for agent-based EIS design were also identified in the focus group study. Secondly, 25 senior managers were interviewed for deeper insights on value-added attributes and processes of executive criteria for building agent-based EIS. The findings suggest a “usability-adaptability-intelligence” trichotomy of agent-based EIS design model that comprises executive criteria of value-added attributes and processes for building a usable, adaptable and intelligent EIS.
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Chapter 1

Introduction

1.1 Introduction

This chapter provides an overview of the research. Firstly, the research background is discussed in Section 1.2. Section 1.3 presents the research scope and working definitions for this study. Section 1.4 states the research objectives of the thesis and Section 1.5 outlines the research phases, including methodological setting for this study. Finally, an overview of the thesis structure is presented in Section 1.6.

1.2 Research Background

As the business environment becomes more volatile and competitive, appropriately handling information and knowledge has become a distinct core competence in the company. The capability to know itself, know its 'enemies', and know its business environment affects a company's success or failure. The challenge is that organisations and environments are systems that continually pose a variety of disturbances to managers. As a result, managers are facing vast amount and complexity of operational and strategic variety. Individual managers or executives are seeking assistance in their search of variety that can cope with the organisational environment that continually creates disturbances to them. In addition to this, the process of searching for more variety relating to a specific situation or condition needs to be done much quicker than
ever before due to the proliferation of data and information. Here, the search for more variety (information) suggests the need for "intelligence" processing activities, which is the ability to respond and adapt to environmental changes through a self-reactive and self-adaptive approach in information processing, such as information scanning and filtering.

The business environment continually and rapidly creates signals and messages that senior executive should attend to (Draft et al. 1988; Auster & Choo 1994). With the increasing availability of electronically distributed information, senior executives suffer from information overload, especially an over abundance of irrelevant information (Maes 1994; Shapira et al. 1999). Senior executives simply cannot relate simultaneously to all information available to them, they have to select and make sense of what is selected. Ackoff (1967) has foreseen this dilemma since the introduction of management information systems (MIS). He strongly believed that the emphasis of a manager support system should shift from supplying relevant information to eliminating irrelevant information. He argued, "Unless the information overload to which managers are subjected is reduced, any additional information made available by an MIS cannot be expected to be used effectively" (Ackoff 1967, p. 148).

Senior executives are individuals whose works are characterised as brevity, variety and discontinuity governed by different managerial roles and agenda (Mintzberg 1973; Ackoff 1967; Kotter 1982, 1999). According to Mintzberg, executives are considered as the "nerve centre" in the processing of information, in which informational roles tie all managerial work together, linking status and the interpersonal roles with the decisional roles. However, executives' information processing activities are typically unstructured with a wide variety of conflicting and equivocal considerations and inputs based on internal and external information, as well as hard and soft information (Mintzberg 1973; Jones & McLeod 1986; Watson et al. 1997). Ackoff (1974) also stresses that managers do not conform to formal problem-solving or decision making models, instead, they are sporadically "managing a mess" due to a dynamically changing agenda or network of "concerns". Further, senior executives' information processing behavior is heterogeneous and has often been governed by the complexity of each senior manager's innate mental models (Mintzberg 1973, McKenney & Keen 1974; Isenberg 1984; Agor 1984; Kuo 1998).
Simon's (1965) intelligence-design-choice model states that executives spend a large fraction of their time surveying the organisational environment to identify new varieties that call for new actions. They probably spend an even larger fraction of their time, individually or with their subordinates to design and develop possible courses of action for handling situations where a decision is needed. They then spend a small fraction of their time in selecting from those available courses of actions to meet and solve an identified problem. According to Simon (1965), the three fractions sum up most of what executives do. Any information systems that can support the above three phases of activities will reduce the fraction of time needed for information processing. The support for intelligence activity is of particular importance, because intelligence activity precedes design, and design activity precedes choice.

As senior executives are compelled to respond to their changing and unpredictable environment continuously by seeking variety (information) and for decision making, an advanced information support system is needed that can help or support executives in the following three aspects of intelligence processing. First, to reduce the amount of information from the environment as to capture only relevant information. Second, to capture and process information according to individual executives' specific needs and interests. Third, to learn and adapt to information changes in order to cope with the environment better, as well as to anticipate future changes.

Many management information support systems have been developed to support executives' information processing activities, such as Management Information Systems (MIS), Decision Support Systems (DSS), Executive Information Systems (EIS), or Executive Support Systems (ESS). EIS, in particular, emerged as a computer-based tool to provide executives with easy access to strategic information with the goal to support and enhance executives' information processing activities (Rockart & Treacy 1982; Millet & Mawhinney 1992; Watson et al. 1991, 1997). Since the early 1990s, many studies have been conducted on EIS as companies and researchers foresaw the great potential of EIS (Watson et al. 1991; Wetherbe 1991; Millet & Mawhinney 1992; Warmouth & Yen 1992; Watson & Frolick 1993; Belcher & Watson 1993; Jordan 1993; Edwards & Peppard 1993). Conventional EIS studies have established some
consensus on guidelines for EIS design and development. However, the guidelines underpinned by preceding research have failed to develop robust yet rational EIS. What is often reported is EIS failure (Rainer & Watson 1995; Bussen & Myres 1997; Lehaney et al. 1999; Xu et al. 2003). For example, executives tend to seek current, trigger and speculative information (Mintzberg 1973), but the formal EIS tend to provide largely aggregated, precise and historical information based on existing internal databases and predefined information needs, which is predominantly used for communication, performance monitoring and control (Edwards & Peppard 1993; Nord & Nord 1995; Vandenbosch & Huff 1997). Conventional EIS are also inflexible enough to adapt and meet changing information needs due to the predefined rules for exception manipulation, reporting and control (Young & Watson 1995; Bajwa et al. 1998; Salmeron, 2002). Therefore, it is important to revisit conventional views of EIS purpose, functions and design guidelines in responding to the increasing availability of electronic and distributed information in current information communication technology (ICT).

Despite the integration of data manipulation and decision support tools into current management support systems, the key deficiency is still the intelligent functions in information processing (Liu 1998a,b; Montgomery & Weinberg 1998). For instance, systems that actively and continuously scan the business environment, automatically filter through the irrelevant data and information, and constantly provide signals or warning of potential opportunities and threats. The advent of Artificial Intelligence (AI) (or sometimes called soft computing) techniques, such as fuzzy logic, neural networks and genetic algorithms gives the possibility to develop intelligent support systems, such as expert systems (ES) and knowledge-based systems (KBS). However, ES and KBS are mainly adopted to support operational and tactical decision, rather than strategic decision (Wong et al. 1994; Eom 1996). Most of the ES are not successfully adopted and implemented due to the limited functions, high cost of development and organisational resistance (Wong & Monaco 1995; Watson et al. 1997; Grove 2000).

Recent progress in understanding the theoretical basis for intelligence has gone hand in hand with advancements in the capabilities of intelligent software agents. The current emergence of the Intelligent Software Agent (or Software Agent), as a concept and a technology, with applications, provides intelligent support for information processing
activities. The intelligent software agents offer the potential for supporting intelligence processing activities because these agents have become more integrated in the distributed environment of the Internet. With the overwhelming flow of distributed information produced for the executives from an increasing number of sources, intelligent agent-based systems are becoming a key potential to fulfil the following three key functions in intelligence processing. First, the ability to screen and filter an increasing amount of data and information in real environments with continuous input from both internal and external environments. Second, the ability to personalise information gathering and processing according to individual users. Third, the ability to learn and adapt to information changes.

1.3 The Research Scope and Working Definitions

The basic argument of this research is whether the conventional views and guidelines of EIS are still applicable in supporting current executive’s information environment and information processing activities, and, whether the current emergence of the intelligent software agent can provide intelligent support for intelligence processing activities.

The scope of this research, hence, falls into the following domains:

- **Executive information** – refers to the executive’s information environment with regard to information sources and needs.
- **Strategic intelligence** – refers to critical and relevant information relating to a specific situation or condition that could alter the business plan of an organisation.
- **Executive’s information processing behaviour** – refers to those activities an executive may engage in the search of potentially critical and relevant information, and using or transferring that information. The notion of mental models that affect executive’s thinking and behaviour is beyond the scope of this study.
- **Executive intelligence activities** – refer to continuous, self-reactive and self-adaptive activities or approaches of acquiring, synthesising and interpreting information for executives to obtain strategic intelligence with a view to
determining the course of action. This concept of ‘intelligence’ is taken from the first phase of Simon’s (1965) intelligence-design-choice model, which means the search of occasions for making decision.

- **Executive criteria** – refer to critical requirements for an agent-based support system based on executive’s desires and perceptions in judging the usefulness of the agent’s functions or attributes.

- **Executive information systems (EIS)** – refers to systems that are designed to support and enhance executive’s information processing activities.

- **Intelligent software agents or software agents** – refer to software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in doing so, employ some knowledge or representation of the user’s goals or desires.

The term ‘executive intelligence activities’ is sometimes used interchangeably with ‘executive’s information processing activities’. And the term ‘intelligent software agents’ is used interchangeably with ‘software agents’ or just ‘agents’.
1.4 Research Objectives

The overall aim of the research is to examine the conventional views and guidelines of EIS in responding to the current executive's information environment and information processing activities, and to identify executive criteria of an agent-based EIS for supporting executive intelligence activities with a view to propose an an agent-based EIS design model. To achieve this aim, the study intends:

1. To develop a better understanding of executive intelligence activities by reviewing the literature background and preceding empirical works associated with executive's works, information environment and information processing behaviour.

2. To explore and reveal the current state of executive information and information processing behaviour in the light of the Internet era, from which to examine the validity of the conventional views of EIS purpose, functions and design guidelines.

3. To identify executives' perceptions and desires of agent-based EIS for supporting executive intelligence activities.

4. To elucidate value-added attributes and processes of executive criteria for building agent-Based EIS, from which to propose an agent-based EIS design model for system developers, managers and researchers in the field of EIS.
1.5 Research Phases and Methods

Based on the above research aim, this study entails, first, the exploration of the current state of executive information and information processing behaviour in the light of Internet era. Second, this study involves the examination of executives’ perceptions on the adoption of software agents in EIS design and development. The research objectives are achieved through a four-stage process as below.

Stage 1 Literature review – to review theoretical literature pertinent to executive intelligence activities and empirical literature on EIS studies and software agent applications. The theoretical literature review outlines the notion of executive intelligence activities, and the need for supporting executive intelligence activities. The empirical literature review revisits the preceding empirical studies of EIS, and explores the potential of intelligent software agents for intelligent EIS design and development. The aim is to generate research questions and lay the foundation and direction for empirical studies.

Stage 2 Prototyping – an interface prototype is designed and used as a demonstration of some of the agent attributes in order to stimulate executives’ thinking and imagination. The prototype is used to support the empirical studies in order to aid understanding, thus, generate more insights on executives’ perception on the design of agent-bases EIS. It is not used for methodological setting, but methodological support. Therefore, this interface prototype is not built for technological implementation, evaluation or experimentation.

Stage 3 Focus group study – to explore current state of executive information and information processing behaviour, followed by executives’ perception and concerns on agent-based solutions for supporting executive intelligence activities. The findings of this stage examine the validity of the conventional views of EIS purpose, functions and design guidelines and gain useful insights for improving EIS design and development. Executive criteria of agent-based system for supporting executive intelligence activities and executives’ concerns about the adoption of software agents are identified.
The focus study also enables an initial agent-based EIS design model to be proposed for in-depth exploration in the semi-structured interviews. In total, four focus groups discussion were conducted with a total of 41 middle towards top-level managers, who attended the Executive MBA (part time) at Luton Business School.

Stage 4 Semi-structured interview – to gain deeper insight on agent-based solutions for supporting executive intelligence activities. This stage identifies factors that influence executive’s information processing activities and elucidates value-added attributes and processes of the executive criteria in the agent-based EIS design model. In total, 25 participants with majority senior executives took part in the semi-structured interviews.

1.6 The Structure of the Thesis

This thesis comprises seven chapters. The first chapter provides an overview of the study. It presents the research background, research questions, the research scope and working definitions, research objectives and research methods used for this study.

Chapter two offers the theoretical review of previous research pertinent to executive intelligence activities. Prior literature and research pertinent to executive intelligence activities such as interaction between organisational environment and executives, executive works, executive information and needs, executive thinking and information processing behaviour are critically reviewed to constitute a theoretical base that underpins this research. The notion of executive intelligence activities and the need for supporting executive intelligence activities is presented at the end of this chapter.

Chapter three reviews and reports existing literature and preceding empirical studies on EIS studies and software agents. The chapter presents the evolution of management information support systems, followed by the impact of Internet technologies on management information support systems. Conventional studies of EIS are reviewed and challenged, followed by outlining the need for revitalising EIS design and
development. The notion of software agents is outlined, reviewed and considered. Finally, research questions for empirical studies on executive intelligence activities with intelligent agent-based support are proposed.

Chapter four details the methodology for this study. The chapter begins by presenting the general issues on research methodologies and philosophy in research, followed by reviewing research methods employed in IS research. The chapter then outlines the interface prototype as methodological support tool and the focus group study and semi-structured interviews as primary research methods. The chapter describes in details the techniques of design and analysis, as well as validity and reliability issues in each primary research method. Research methodology is reflected at the end of this chapter.

Chapter five presents the findings of the focus group study. The findings are interpreted and discussed in detail. The discussion suggests implications for the study, and enables the proposal of an initial agent-based EIS design model for further examination in the semi-structured interviews.

Chapter six presents the findings from the semi-structured interviews. The findings are analysed with the qualitative data analysis software, NVivo. The interpreted findings suggest deeper insights and implications on the agent-based EIS design model.

Chapter seven provides overall conclusions to the study. Contribution to knowledge is outlined. Challenges and limitations of the research are also presented together with future development of this study suggested for further research.
Chapter 2

Literature Review

2.1 Introduction

This chapter offers the theoretical review of previous research pertinent to executive intelligence activities. Firstly, Section 2.2 outlines the structure of the chapter through a theoretical map for literature review. Prior literature and research pertinent to executive intelligence activities such as interaction between organisational environment and executives, executive works, executive information and needs, executive thinking and information processing behaviour are critically reviewed from Section 2.3 to Section 2.7 to constitute a theoretical base that underpins this research. Section 2.8 outlines the notion of executive intelligence activities and the need for supporting executive intelligence activities in EIS.
2.2 Structure of the Chapter

A theoretical map for literature review is outlined in Figure 2.1. This diagram provides guidance for reviewing literature backgrounds that are relevant to executive intelligence activities.

- **Organisational environment** The literature review in this field intends to reveal the interaction between organisational environment and managers. General system theory such as organisational cybernetics, the Law of Requisite Variety and the Viable Systems Model (VSM), as well as decision making process model are closely related to this study and thus are reviewed in the following section. The purpose of this review is to provide a theoretical underpinning for designing mechanism for supporting executive intelligence activities.

- **Executive information and needs** This literature reviews the nature of executive information and prior approaches for identifying needs for executives. The intention of this review is to provide implication on how computer-based system can support intelligence processing.

- **Executive work** Characteristics of managerial work and processes are reviewed. This establishes an understanding of the relationships between managerial works and processes and their impacts on executive intelligence activities.
• **Executive thinking** This literature review serves to reveal the influence of executive’s mental models on intelligence processing activities.

• **Information processing behaviour** Literature backgrounds of information processing behaviour is reviewed. This helps reveal the relationships between information processing behaviour and intelligence processing activities.

### 2.3 Interaction between Organisational Environment and Managers

As the business environment becomes more volatile and competitive, the handling of information and knowledge has become a distinct core competence in the company. The need for a company to know itself, know its 'enemies', and know its business environment determines its success or failure. Sun Tzu's *The Art of War* stated strongly:

"Know the enemy and know yourself; in a hundred battles you will never be in peril. When you are ignorant of the enemy but know yourself, your chances of winning or losing are equal. If ignorant both of your enemy and of yourself, you are certain in every battle to be in peril”,

and

"We are not fit to lead an army on the march unless we are familiar with the face of the country – its mountains and forests, its pitfalls and precipices, its marshes and swamps.”

(Sun Tzu, *The Art of War*, 5th Century BC)

An organisation is capable of having full knowledge of itself as organisation has full access to the internal information that is available and of high relevance variables. However, the external environment continually creates new signals and messages that an organisation should attend to (Auster & Choo 1994). The challenge is that information about competitors and the external environment is complex and dynamic in each respective organisational context, and usually scattered in different locations and not readily available (Duncan 1972; Draft et al. 1988; Stoffels 1994; Xu & Kaye
The question is how senior executives can operate and manage in such a complex and dynamic organisational context.

Simon (1965) argues that organisations can adapt to their environment or adapt the environment to organisation if they are to remain effective. He says, "If we want an organism or mechanism to behave effectively in a complex and changing environment, we can design into it adaptive mechanisms that allow it to respond flexibly to the demands the environment places on it. Alternatively, we can try to simplify and stabilize the environment. We can adapt organism to environment or environment to organism" (p. 40). However, the environment has become increasingly complex and dynamic for organisation to simplify and stabilise. The focus is, hence, not to adapt the environment to organisation but to design adaptive mechanisms that can operate in a complex and changing environment. Here, appropriate approaches are needed to allow analysis of complex societal problems and intervention to resolve such problems. General system theory such as organisational cybernetics, the Law of Requisite Variety (Ashby 1956) and the Viable Systems Model (VSM) (Beer 1979), as well as decision making process model are closely related to this study and thus are reviewed in the following section. The following reviews provide a theoretical underpinning for the rationale of designing mechanism for supporting executive intelligence activities.

2.3.1 Review of General System Theory

System thinkers suggest approaches such as system dynamics and organisational cybernetics to tackle complex societal problems. (Jackson 2001). System dynamics focuses on capturing the underlying characteristics of complex systems by means of quantitative modelling and simulation. The key perspective of system dynamics is on modelling and simulating organisational issues based on continuous processes, by means of differential equations (Schwaninger et al. 2004). The integration of systems dynamics methodology with the development of software packages has mainly produced practical information system applications for operational purposes (Ashayeri et al. 1998). Hence, the system dynamics approach is not pertinent to this study because this study aims to understand executive intelligence activities that are strategic-oriented.
Organisational cybernetics is relevant to this study as the focus is on continual adaptation and learning of organisation. Cybernetics was defined as the "science of control and communication in the animal and the machine" (Wiener 1948). Ashby (1956) in his celebrated 'An Introduction to Cybernetics' demonstrates that cybernetics could impact on many different areas of sciences – between machine, brain and society. The purpose of cybernetics is to deal with randomly varying input from the environment in order to maintain stability under exogeneous disturbances (Schwaninger et al. 2004). The cybernetic view on socio-technical systems has bred models and approaches for management in general and for the design of organisations in particular.

**Law of Requisite Variety**

From the notion of cybernetics, Ashby (1956) formulates the "law of requisite variety" that had contributed significantly in the management and organisational studies. The variety of a system is defined as the number of possible states it is capable of exhibiting. It is a measure of complexity and a subjective concept depending on the observer. Ashby's "law of requisite theory" states that the variety of control measures must match the variety of disturbances. In other words, only variety can destroy variety. It needs to have as much variety available as the system itself exhibits in order to control a system. In another formulation of his Law of Requisite Variety, Ashby states that the capacity of the channels of communication to be used for perceiving the disturbances and for transmitting the control measures must match the capacity of the disturbance generator. Ashby's law suggests the way of managing the response function of an organisation on changing (internal and external) environments.

From the viewpoint of managers, organisations and environments are systems that possess variety. The business environment continually poses a variety of disturbances to managers. The Law of Requisite Variety applies to the situation where managers have to learn to live with probabilistic systems as they are continually confronted by new and unexpected events. Managers have to exhibit enough variety in order to counteract the variety of disturbances. The challenge is that managers are facing vast amount and complexity of operational and strategic variety. The capacity of the channels of communication to be used for perceiving the disturbances and for
transmitting the control measures suggests the concept of intelligence support in this study. Managers are seeking assistance in the search of variety that can cope with the organisational environment that continually creates disturbances to them. The search of variety allows managers to have a better understanding of how to manage in a complex and dynamic organisational context. In this case, the better a manager is capable of perceiving disturbances and exhibiting control or action, the better a manager is capable of reducing or removing disturbances.

According to Beer (1979), the father of organisational cybernetics, managers or organisations can either reduce the variety of the system they are confronting (variety reduction) or increase their own variety (variety amplification). This process of balancing varieties is known as “variety engineering”. As Jackson (1991) further explained that managers have to learn how to use variety reducers, filtering out the vast complexity of operational and strategic variety and capturing only that of relevance to themselves and the organisation. And they have to learn how to use variety amplifiers, amplifying their own variety vis-à-vis the operations and the organisation’s variety vis-à-vis its environment. Variety engineering enables a system to achieve requisite variety within the complex environment and remain viable.

**Viable System Model**

Beer (1979) believes that a system is viable if it is capable of responding and adapting to environmental changes even if those changes could not have been foreseen at the time the system was designed. The principle of viability can be explained through the nervous systems in the human body, which are capable and flexible in responding to the body environment. He introduced the “Viable System Model” (VSM) that comprises of five subsystems that are responsible for operations, coordination, control and monitoring, intelligence and policy. The VSM can be considered as a framework for the restructuring of organisations as viable systems, which deal with complexity continuously and adaptively.

System One refers to those units that are to be controlled, such as departments or subsidiaries in the organization. System Two to System Five are the channels for controlling those units in System One. System Two coordinates according to a prescribed routine, such as formal reporting systems and networks of contacts. System
Three is referred as "Here and Now" element that deals with current operations. System Four, the "Changes and the Future" element deals with the interaction between the organisation and the external environment, thus, initiates changes and development work. System Five represents the policy-formulation that determines the overall purpose of the organisation. With its emphasis on engineering variety, the VSM can legitimately be seen as a sophisticated working out of the implications of Ashby's law of requisite variety in organisational terms. The VSM identifies the necessary and sufficient communication and control systems that must exist for any organisation to remain viable in a turbulent environment.

It is not the intention of this thesis to elaborate fully the organisation of the VSM. However, System Four in Beer's VSM provides a theoretical basis for intelligence support because it is concerned with planning the way ahead in the light of external environmental changes and internal organisational capabilities. Hence, it is relevant to this study on using computer-based systems to support executive intelligence activities. System Four comprises an overview of the organisation's environment as it captures information directly from the general environment. It can, therefore, act as a "scanner" that scans all unidentified relevant information from the overall environment. The scanning process in System Four allows the organisation to adapt its internal environment to meet its external environment. As top managers can easily be overloaded with irrelevant information, System Four can also act as a "filter" that captures only strategic information for top managers. The information scanning and filtering process put senior managers in a better position to react to threats and opportunities, as well as to anticipate future changes despite the turbulent environment. Carvalho (1998) has used the VSM to describe the role of computer-based systems in organisations. They suggest that Executive Information Systems (EIS) should aim to provide intelligence support of System Four in the VSM.

2.3.2 Review of Simon's Decision Making Process Model
Simon's (1965) work on decision making process has been influential in designing management support system, in particular, decision support systems (Sprague 1980; Huber 1981; Turban & Aronson 1998). The 'intelligence-design-choice' trichotomy is the most well-known model for understanding decision making process (see Figure 2.2). This model distinguishes three major decision making phases. The first phase is
called the *intelligence* activity (the term is borrowed from the military meaning of intelligence), which focuses on the search of occasions for making decision. The second phase is called the *design* activity, which is to invent, develop and analyse possible courses of action. The third phase is called the *choice* activity, which is to select a particular course of action from those available courses.

![Decision Making Process Model](image)

**Figure 2.2** The decision making process model (adapted from Simon 1965)

Simon (1965) states that executives spend a large fraction of their time surveying the organisational environment to identify new situations that call for new actions. They probably spend an even larger fraction of their time, individually or with their subordinates to design and develop possible courses of action for handling situations where a decision is needed. They then spend a small fraction of their time in selecting from those available courses of actions to meet and solve an identified problem. According to Simon (1965), the three fractions sum up most of what executives do.

Having information systems that can support the above three phases of activities will reduce the fractions of time needed for information processing. The support for *intelligence* activity is of particular importance, because intelligence activity precedes design, and design activity precedes choice. The phase of *intelligence* activity provides a theoretically support to intelligence processing support for this study. In the intelligence activity phase, the environment is examined and problem areas as well as opportunities are identified. Often, this phase is triggered by dissatisfaction with problems and organisational objectives. Besides the recognition of problems or opportunities, the intelligence activity phase also involves classification of the opportunity or problem in terms of the level of structuredness involved in the issue. Simon (1965) differentiates between two extreme forms in the level of structuredness, programmed problems and non-programmed problems. Programmed problems are simple, repetitive problems, which can be solved easily with computer support using standard and structured solutions. Non-programmed problems are complex and unstructured in nature, which are not easily solved with computer support. According
to Simon (1965), non-programmed decision making on non-programmed problems can be improved by training in orderly thinking. For example, the military's "estimate of the situation" comprises a checklist of things to consider in analysing a military decision problem.

Simon's (1965) model implies that intelligence activity support is critical for intelligence processing activities. An advanced information systems that can provide intelligence activity support will assist executives in the recognition and classification of environmental conditions. However, the challenge lies with the non-programmed problems. In the military context, intelligence can possibly be obtained through the estimation of complex situations. Likewise, the design of advanced information systems can possibly obtain intelligence by estimating as many as the non-programmed situations based on previous experiences or records. This would save some fractions of executives' time in supporting intelligence processing activities.

The design activity phase in Simon's (1965) model is also relevant to the intelligence processing support for this study. In this phase, possible courses of actions or alternatives are analysed, designed and developed. These alternatives are evaluated by predicting the outcomes of each alternative. When it is necessary, assumptions and simplifications are made in order to make the problem easier to understand and solve. Since executives spend a larger fraction of their time in this design phase, an information system that can support the design activity will improve the overall intelligence processing activities. For instance, an advanced information system that automatically and proactively analyses, evaluates and develops courses of actions for executives. The choice activity phase is less relevant to this study because the selection of alternatives for decision making involves largely on the innate ability of executives. Besides, the choice activity requires only a small fraction of time to select from alternatives for decision making.

The above review of general system and decision making theory provides a theoretical support to the design and development of intelligent support systems that are capable of responding and adapting to environmental changes as it captures information about the environment through scanning and filtering process. The self-reactive and self-adaptive approaches in information process suggest the notion of
intelligence processing. As senior managers need to respond to their changing and unpredictable environment continuously for decision making, an advanced information support system is needed that can help or support managers in the following three aspects of intelligence processing. First, to reduce the amount of information from the environment as to capture only relevant information. Second, to capture and process information according to individual executives’ specific needs and interests. Third, to learn and adapt to information changes as to cope with the environment better, as well as to anticipate future changes.

2.4 Review of Executive Work

2.4.1 Mintzberg’s Managerial Roles

The traditional view of managerial work as rational, scientific, reflective and regulated has long been challenged by Mintzberg’s (1973) work on managerial roles. In the attempt to know what managers actually do, Mintzberg (1973) conducted an in-depth study of the nature of managerial work, he soon realized that executives are committed to activities that are characterised by brevity, variety and discontinuity. Mintzberg (1973) identified ten distinct managerial roles that influence the way manager works in order to cope with these activities. Mintzberg’s ten observable roles are divided into three categories: interpersonal, informational, and decisional. More importantly to note, the three interpersonal roles (figurehead, leader, liaison) that derive from the manager’s formal authority and unique position give rise to the three informational roles (monitor, disseminator, spokesman), and in turn enable manager to perform the four decisional roles (entrepreneur, disturbance handler, resource allocator, negotiator). These ten roles are be summarised in the following Table 2.1.

Table 2.1 Managerial roles (adapted from Mintzberg 1973)

<table>
<thead>
<tr>
<th>Roles</th>
<th>Description</th>
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<tbody>
<tr>
<td>Interpersonal Roles</td>
<td></td>
</tr>
<tr>
<td>Figurehead</td>
<td>A symbolic role that requires him to fulfil social, inspirational, legal and ceremonial duties.</td>
</tr>
<tr>
<td>Leader</td>
<td>A political role that gives him power for motivation and mobilization of subordinates, as well as staffing, training and promoting.</td>
</tr>
<tr>
<td>Liaison</td>
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</table>
A relational role that develops network of contacts for information, favours and mutual benefits.

<table>
<thead>
<tr>
<th>Informational Roles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monitor</strong></td>
<td>Continually seeks and receives information from multiple sources to use information for different purposes and to develop understanding of the business and environment.</td>
</tr>
<tr>
<td><strong>Disseminator</strong></td>
<td>Transmits information from external and internal information sources into organisation and to one another.</td>
</tr>
<tr>
<td><strong>Spokesman</strong></td>
<td>A public relation role that communicates information, i.e. performance, plans and policies to various external groups.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decisional Roles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entrepreneur</strong></td>
<td>Searches for threats and opportunities and initiates and designs necessary change for improvement in his organisation.</td>
</tr>
<tr>
<td><strong>Disturbance Handler</strong></td>
<td>Resolves unexpected stimulus, i.e. loses, conflicts.</td>
</tr>
<tr>
<td><strong>Resource Allocator</strong></td>
<td>Allocates organisational resources of all kinds, i.e. money, manpower, goodwill.</td>
</tr>
<tr>
<td><strong>Negotiator</strong></td>
<td>Engages and represents the organisation in important negotiation activity with other organisations.</td>
</tr>
</tbody>
</table>

From the above, the interpersonal roles place the manager in a unique position to get information. His external contacts bring special external information and his leadership activities serve to make him a central point for organisational information. The informational roles allow manager to monitor, control and disseminate information from and to the internal and external organisation environment. The manager’s unique access to information and his special status and authority enable him to make organisational and strategic decisions.

The manager’s roles in the processing of information are important to take note as they are relevant to this study. Mintzberg (1973) suggests that managers serve as the “nerve centre” in the processing of information. Figure 2.3 shows that it is the informational roles that tie all managerial work together, connecting the interpersonal roles with the decisional roles. The interpersonal roles ensure the accessibility and provision of information; the decisional roles make the most significant use of it.
Mintzberg’s (1973) findings have sometimes been mistaken as an opposition to the support of information systems. The manager as “information nerve centre” implies that the information processing applies to virtually all the roles. In fact, Mintzberg (1973) indicates that the successful cooperation of managers and system analyst or planner is feasible to reprogram and automate some of the managerial activities.

Mintzberg suggested seven possible areas where managers can work together with analyst or planner for a successful reprogramming of the strategy-making system. The areas discussed include finding problems and opportunities, evaluating costs and benefits of proposed projects, building models, planning for contingent events, analysing in real-time, monitoring improvement projects and developing adaptive plans. Although Mintzberg thinks that not many areas can be easily reprogrammed, some of these areas are now being supported by computer-based support systems. For examples, analytical tools for costs and benefit analysis, real-time monitoring systems
and analytical models for decision aids. Nevertheless, Mintzberg’s “planning dilemma” remains applicable in managerial work. Basically, the management scientists (i.e. information system designer, system analyst) lack formal knowledge of the manager’s working process and are unable to access much of the manager’s information. On the other hand, managers have the information and the understanding of the dynamics of the business environment but they are severely time constrained to do the systematic analysis that complex strategic decisions require.

2.4.2 Kotter’s Managerial Work Processes

While Mintzberg (1973) presents an activities view of executive work, Kotter (1982, 1999) presents a process view of managerial work. Kotter (1982, 1999) believes that managers are facing two fundamental dilemmas in their work: 1) figuring out what to do despite uncertainty and an enormous amount of potentially relevant information; and 2) getting things done through a large and diverse group of people despite having little control over most of them. Kotter (1982) conducted an in-depth interviews and structured observation of 15 general managers, he concludes that managers centre their works on two key processes: agenda setting and network building.

Kotter’s (1982, 1999) findings suggest that the effective senior executives rely actively on agenda setting and network building in order to tackle those challenges. Executives acquire information continually to develop, connect and complete their agendas consciously and unconsciously. Although the agendas usually address a broad range of hard information, such as financial, product and market issues, they often contain lists of goals or plans that are not explicitly connected and expressed. In addition to setting agendas, executives spend significant time and effort to developing relationships with the internal and external people. According to Kotter (1982, 1999), the network building involves a wide range of interpersonal tactics and informational roles. As a result, executives spend most of their time with people in addition to their direct subordinates and their bosses, actively involve in a wide range of discussion topics (often short and disjointed conversations), aggressively seek information (including bad news), skillfully ask questions and seek out programmes and projects that can help achieve their multiple objectives.
Kotter’s work suggests the increasing impact of information process and use in the process of agenda setting and network building. In the process of connecting agendas, the access to hard, structured information is extremely useful and efficient for information monitoring, thus, help setting and completing manager’s agendas. The network building involves heavily on formal and informal communication. With the advance of information technology, such as the Internet and email system, information can be monitored and disseminated much quicker than never before. It is also found that executives are using these technologies more and more for monitoring and disseminating information.

2.5 Review of Executive Information and Needs

2.5.1 Executive Information

According to Mintzberg (1973), executive information tends to conform to the following characteristics: 1) Current information – the rapid access to information; 2) Trigger information – the availability of information in the form of concrete stimuli or triggers instead of aggregations; 3) Verbal information – the reliance of verbal media for speculative information. As a result, soft information from informal sources such as hearsay, phone calls and meetings constitute a large share of executive’s information diet. This is confirmed as the following:

“Managers seem to cherish soft information ...A great deal of the manager’s inputs are soft and speculative – impressions and feelings about other people, hearsay, gossip, and so on” (Mintzberg 1973, p.49).

“Evidence suggests that managers identify decision situations and build mental models not with the aggregated historical abstraction that a formal management information system (MIS) provides but with specific tidbits of informal or soft data” (Jones & McLeod 1986, pp.220-221).

“Soft information enhances the understanding of past, current, and future events, often by adding value to factual data. ...It can be conveyed in multiple
forms – text, graphics, image and voice – and through multiple channels – formal and informal and internal and external to the organisation” (Watson et al. 1997, p. 219)

Soft information is considered as valuable to executives for the two reasons. First, an executive can act on soft information immediately. Executives with little time to spare would want to process and use information effectively. Second, soft information provides richer information due to the immediate feedback and the simultaneous observation of multiple cues, i.e. body language, facial expression, and tone of voice (Jones & McLeod 1986). According to Daft & Lengel (1984), the “richness” of information is more desirable because it has the ability to reduce uncertainty and ambiguity. Richness is the potential of information from data and is dependent on the use of feedback, multiple information cues and language variety in a specific context.

Ackoff (1974) also stresses that managers do not conform to formal problem-solving or decision making models, instead, they are sporadically “managing a mess” due to a dynamically changing agenda or network of “concerns”. This “mess management” process typically uses a very small amount of hard information. Based on this “mess management” concept, Young (1987) identifies the following characteristics of mess-processing related information:

- **News-valued and highly temporal** – relevant executive information tends to be temporal and quickly outdated, and its value depends largely on dimensions of newsworthiness (new and significant development of an issue or concern).
- **Informed-speculation and interpretation** – speculative information that explains other information or help to interpret the meaning of some hard information.
- **Organised in smaller “chunks”** – information is typically less than typical data files (measured in words or characters or bytes).
- **Source-dependent** – the impact or assessed value is often highly dependent on its source.
- **Partial and externally ambiguous** – cognitive information that requires understanding of data and knowledge from experience
- **Natural language formatted** – information is text-based and may conform to general rules of grammar.
The above review indicates that the nature of executive information is soft-oriented and mess-processing related. This poses a direct conflict with most of the formal and conventional EIS. Executives tend to seek current, trigger and speculative information (Mintzberg 1973), but the formal EIS tend to provide largely aggregated, precise and historical information. Besides, the conventional EIS provide largely internal-oriented information, yet executives hunger for more external information. Little attention has been paid to the executive information consisting of both hard and soft information. As a result, executives often ignore the formal EIS. In many cases, executives remain rely on informal networks for information search and process. The challenge is whether a computer-based support system is able to process soft and mess-processing related information. With the increasing amount of electronic information, a considerable amount of soft information exists in text-based documents such as e-mails, reports and news. Using the advanced computing technology, this soft information can possibly be manipulated and converted into enriched information for intelligence processing.

2.5.2 Executive Information Sources

Executives manage information to some extent by controlling the selection of sources and media. Information sources can be categorised as human (personal/ informal), documentary (impersonal/ formal) and electronic sources. Most studies found that executives obtained most of the information from human (personal) sources through informal networks of communication (Ives & Olson 1981; Keane 1998), whereas other studies found the frequent use of impersonal sources more than personal sources (Jones & McLeod, 1986; Subramanian et al. 1993). Certainly, personal sources are preferred more by the executives because of the high information richness (Mintzberg 1973; Daft et at. 1988). Information is transmitted through rich media, such as face-to-face meeting and telephone conversations, that allow executives to seek instant feedback and simultaneous observation of multiple cues, i.e. body language, facial expression and tone of voice. Surprisingly, most studies show that electronic sources are less frequently used (Auster & Choo 1992, 1993; Keane 1998).

However, the proliferation of Internet applications, such as electronic messages and online databases may have changed the managers' information acquisition behaviour in recent years. There is also a debate about whether personal (formal) versus
impersonal (informal) sources of information provide better input to the organisational information processing. The results from Daft et al.’s (1988) study suggest that both personal and impersonal sources are valued and that both internal and external sources are used. Most importantly, the use of all sources increased as strategic uncertainty increased, suggesting that multiple sources are the appropriate information systems for chief executives.

2.5.3 Executive Information Needs

Information needs are strongly related to a person’s cognitive needs – gap or deficiencies in the state of mental knowledge or understanding that may be represented by questions or topics that could be posed to an information system or source (Choo 1998). The satisfaction of these cognitive needs depend on the successful retrieval of information that matches the gap or deficiencies. Information needs do not form as a pattern but grow, evolve and change over time. Taylor (1968) suggests that information needs emerge through four levels of needs – visceral need, conscious need, formalised need, and compromised need. A person moves from the gap or deficiencies in knowledge or understanding (visceral need) to a mental description of the area of unknown or ambiguity (conscious need). He or she will then consult people or seek more information to reduce the ambiguity (formalised need) by interacting with an information system or source, either directly or through an intermediary. The questions or topics posed to an information system or source will be modified or rephrased in a form that could be understood or processed by the information system (compromised need).

The emerging nature of information needs suggests that satisfying goes beyond finding information that matches the queries or questions expressed by individuals. Individuals will feel that the information is relevant, meaningful or useful in a personal way if the information retrieved is able to connect with the visceral needs and conscious needs. These visceral needs and conscious needs suggest that it is virtually not feasible to identify executives’ actual information needs due to the unknown of executives’ mental models. Conventional EIS studies have attempted to identify executives’ information needs, but they merely identify executive information attributes, such as information sources and types (McLeod et al. 1984; Wetherbe 1991; Watson & Frolick 1993; Watson et al. 1997; Keane 1998; Salmeron 2002). If a
system is somehow able to intelligently identify some of the emerging needs as mentioned earlier, more value-added information will be processed and retrieved for individual user. In this case, the formalised need and compromised need as suggested by Taylor (1968) are easier determined than the visceral need and conscious need.

Hitherto, research has attempted to identify executive information needs via different approaches as discussed in the following section.

Rockart (1979) examined four different approaches or procedures of determining executive information needs – the by-product technique, the null approach, the key indicator system, and the total study process. Table 2.2 describes the procedures and their relative strengths and/or weaknesses.

Table 2.2 Procedures of determining executive information needs (adapted from Rockart 1979)

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By-product technique</strong></td>
<td>Focus on getting paperwork (routine information) processed inexpensively.</td>
<td>Little attention paid to the real information needs.</td>
</tr>
<tr>
<td>Information by-products generated from transaction-processing systems, i.e. payroll, billing, inventory etc.</td>
<td>Useful for routine information processing.</td>
<td>Information is prepared based on executives’ predetermined interests or requests.</td>
</tr>
<tr>
<td></td>
<td>Available to all interested executives.</td>
<td>Information is mostly aggregated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information is single functional related</td>
</tr>
<tr>
<td><strong>Null approach</strong></td>
<td>Focus on changeability, soft and speculative information, i.e. hearsay, gossip</td>
<td>Too much emphasis on executive’s strategic and person-to-person roles.</td>
</tr>
<tr>
<td>Executive information is dynamic and impossible to be predetermined, hence, the use of information systems is considered useless.</td>
<td></td>
<td>Overlook the management control role.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard and analytical information is ignored.</td>
</tr>
<tr>
<td><strong>Key indicator system</strong></td>
<td>Information provided is objective, quantifiable and computer stored.</td>
<td>Highly focus on hard and analytical information.</td>
</tr>
<tr>
<td>3 concepts of information provision – selection of key indicators of the health of the business,</td>
<td>Data are available in full by exception and</td>
<td>Tends to be financially all-inclusive rather</td>
</tr>
</tbody>
</table>
exception reporting, expanding availability of value-added information display techniques.

<table>
<thead>
<tr>
<th>Total study process</th>
<th>Managers' total information needs are queried and compared with the existing information systems for improvement.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Comprehensive and able to spot missing systems.</td>
</tr>
<tr>
<td></td>
<td>• Top-down process of information needs identification is highly useful.</td>
</tr>
<tr>
<td></td>
<td>• Expansive in terms of manpower and data collection.</td>
</tr>
<tr>
<td></td>
<td>• Highly difficult to determine the correct level of analysis.</td>
</tr>
<tr>
<td></td>
<td>• Biased information needs from users.</td>
</tr>
<tr>
<td></td>
<td>• Difficult in devising reporting systems that serves all executives.</td>
</tr>
</tbody>
</table>

Rockart (1979) sees some shortcomings of these approaches, he offers a new approach of determining executive information needs – critical success factors (CSF) that aims to overcome some of those shortcomings. CSF approach focuses on individual executives and their current hard and soft information needs. It takes into consideration that executive information needs will vary from manager to manager and that these needs will change with time. This approach is based on the concept of the “success factors” raised by Daniel (1961), a managing director of McKinsey & Company. Daniel (1961) stated, “... a company’s information system must be discriminating and selective. It should focus on “success factors (p.116).” Anthony et al. (1972) expanded this concept in their work on the design of management control system. They emphasized three critical features for a management control system, “The control system must be tailored to the specific industry in which the company operates and to the specific strategies that it has adopted; it must identify the ‘critical success factors’ that should receive careful and continuous management attention if the company is to be successful; and it must highlight performance with respect to these key variables in reports to all levels of management (p.148).” Rockart (1979) in MIT has identified four key sources of CSF: 1) structure of the particular industry; 2) competitive strategy, industry position, and geographical location; 3) environmental factors; 4) temporal factors. The benefits of CSF approach is summarised by Rockart (1979) as below:

• Helping executives to channel their attention to factors identified.
• Forcing executives to develop good measures for those CSFs.
• Allowing clear definition of the amount of information needed.
• Focusing on data that are not "easy to collect", for example, soft information
• Acknowledging the need for designing information systems that accommodate changeable and temporal issues.
• Acknowledging the need for designing information systems for executive specific.
• Emphasise vehicles of communication for management and thus improve management planning process

In the process of determining the CSFs, Rockart (1979) identified that the process of determining CSFs require information external to the organisation, coordinating pieces of information from different sources and subjective assessment of information value. The design of information systems must consider the need for designing information systems that accommodate changeable and temporal information, and the need for designing information systems that are customised for specific individual executives. Therefore, the design of EIS should not just serve as reporting facilities for CSFs as such EIS are used for static performance monitoring and control. As CSF approach takes into consideration of soft information and that executive information needs will vary from manager to manager and that these needs will change with time, a static and generic EIS for all managers is impractical.

Conventional EIS related studies tend to perceive executive information attributes (sources, types and contents) as executive information needs. Researchers believe that the identification of executive information attributes would contribute to the successful design and development of EIS (McLeod et al. 1984; Watson & Frolick 1993; Jordan 1993; Watson et al. 1997; Salmeron 2002). In this thesis, executive information needs is believed to be strongly influenced by an individual's cognitive needs, which grow, evolve and change over time. It is feasible for information system developers to identify executive information attributes, but it will be very difficult for them to identify an exclusive pattern of executive information needs due to the emerging and heterogeneous nature, in particular the visceral need and conscious need.
It is potentially possible and useful to understand how executives use information systems or sources to seek more information to reduce the ambiguity (*formalised need*) and how executives translate their information needs into a form that can be understood and processed by the information systems (*compromised need*). The goal of EIS design and development is to support and enhance executives’ emerging needs, in particular the formalised need and compromised need. The focus should be placed on designing personalised EIS that are capable of accommodating changeable and temporal information.

### 2.6 Review of Executive Thinking

In everyday decision making processes, executives are not passive choice makers but are active sense-makers who rely on perception, action, and mental models to arrive at solutions to problems (Kuo 1998). This intuition function or mental model enables executives to obtain the meaning and significance without explicit reliance on analytical tools, hence, it can synthesise disparate ideas which did not appear to be related in the past (Isaack 1978). As a result, executive’s information processing behaviour is complex due to the heterogeneity and innate state of mental models (Mintzberg 1973, McKenney & Keen 1974; Isenberg 1984; Agor 1984; Kuo 1998).

McKenney and Keen (1974) conducted research on executive’s cognitive style, with the purpose of bridging the gap between management scientists and senior managers. The study revealed implications concerning executive thinking process for the implementation of analytic models for the general manager. McKenney and Keen (1974) proposed a model of managerial cognitive style that comprises two dimensions that determine problem solving and decision making style: *information gathering* (acquisition) and *information evaluation* (interpretation), as shown in Figure 2.4. Information gathering may be *perceptive* or *receptive*. The *perceptive* individual looks for concepts, cues, and relationships in a data set to gather, filter and catalogue the data they find. The *receptive* individual disregards relationships but focuses on detail and thorough analysis of data. In *information evaluation*, a person may be intuitive or systematic. The *intuitive* individual uses a trial-and-error approach, jumping from one method to another method in problem solving. The *systematic* individual uses a
structured method in problem solving. Their findings depict distinct differences in the ways in which individuals of particular styles respond to problems. Their implications for the implementation of analytic models are rather unclear but they suggest the following considerations: the classification of problems and tasks, the identification of specialised styles of individual users and the different approaches available for different individuals.

In Isenberg’s (1984) study of what senior executives think about and how they think, he found that most successful senior executives’ decision making process are rather less rational and often bypass rigorous and analytical planning, especially dealing with ambiguity, novelty, inconsistency and surprise. According to Isenberg (1984), senior executives use affective intuition in at least five distinct ways: (1) they intuitively sense the existence of problem or opportunity, often based on a vague gut feeling; (2) they rely on intuition to perform well-learned behaviour patterns rapidly without conscious effort, often based on years of painstaking practice and experience; (3) they synthesise isolated bits of data and experience into an integrated picture, often in an “aha!” experience; (4) they use intuition as an evaluation tool on the results of more rational analysis; (5) they use intuition to bypass in-depth analysis and move rapidly to come up with a plausible solution. These approaches are more affective-oriented because they involve the feelings and judgment through intuition and experience. In conclusion, Isenberg (1984) stresses the need for creating effective organisational processes, “One
alternative to the vain task of trying to rationalize managers is to increase the rationality of organizational systems and processes. Although organizational behaviour is never completely rational, managers can design and program processes and systems that will approach rationality in resource allocation and employment (p.88)." The reason is that "rational systems free senior executives to tackle ambiguous, ill-defined tasks that the human mind is uniquely capable of addressing (p.89)." This implies that the computer-based support systems are important to save time for more unstructured activities. In other words, the development of EIS can be perceived as an attempt to rationalize as many information search and process activities as possible, with the help of automation or even intelligent systems.

The above review on executive thinking suggests that the concept of mental models is critical to understanding executive work and behaviour (Rockart & De Long 1988). It seems to be very difficult to study and identify executive’s implicit mental models and to model the EIS to cope with each individual mental model. However, executives can at least benefit from information systems in two areas. First, it saves time for the highly uncertain and unstructured activities as implied by Isenber (1984). Second, it enhances executive’s model-building processes and helps them think about their business. Rockart and De Long’s (1988) interview study indicates the significant EIS use to support, test, or communicate their cognitive maps. It is evident that executive’s information processing behaviour is linked to mental models, likewise, organisational systems are linked to mental models. However, it is beyond the scope of this study to examine executive’s mental model. The reason is that to understand the implicit mental models of executives would require significant amount of time in the study, such as ethnography research that examines carefully the lives of the people studied and seeks to place the phenomena studied in their social and cultural context. Senior executives who have time constraint issues with frequent interruption are unlikely to commit to it.
2.7 Review of Information Processing Behaviour

Information processing is related to the study of information behaviour. Information behaviour, or information processing behaviour is "those activities a person may engage in when identifying his or her own needs of information, searching for such information in any way, and using or transferring that information (Wilson 1999, p.249). Information processing behaviour involves information seeking, information gathering and information manipulating activities. It is defined as the process in which the individual searches for information in order to change his or her state of knowledge (Marchionini 1995). During this process, the individual identifies and selects information sources; articulates a query, question or topic; extracts the information; evaluates the information retrieved; filters the irrelevant information, and interprets the information. The individual might go back and repeat the processes till his information needs are met. Research suggests that information processing behaviour exhibits different activities and processes. Predominant information processing behaviour models are summarised in Table 2.3.

Table 2.3 Predominant information behaviour models (adapted from Detlor 2003)

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choo (1998)</td>
<td>A general model of information use consisting of information needs, information seeking and information use.</td>
</tr>
<tr>
<td>Dervin (1992)</td>
<td>A sense-making framework comprising four elements: (1) a situation in time and space defining the context in which information problems arise; (2) a gap which identifies the difference between the contextual situation and the desired situation; (3) an outcome; and (4) a bridge involving some closing of the gap between the situation and outcome.</td>
</tr>
<tr>
<td>Ellis (1989a,b); Ellis et al. (1993)</td>
<td>A process-oriented model consisting of a series of eight stages: (1) starting; (2) chaining; (3) browsing; (4) differentiating; (5) monitoring; (6) extracting; (7) verifying; and (8) ending.</td>
</tr>
<tr>
<td>Ingwersen (1996)</td>
<td>A cognitive model comprising: (1) information objects; (2) an information system and (3) a cognitive space between the system interface and a user's social or organisational environment.</td>
</tr>
<tr>
<td>Kuhlthau (1991, 1993)</td>
<td>An affective orientation to the information search process comprising six successive stages of gradual refinement of a problem area: (1) initiation; (2) selection; (3) exploration; (4) formulation; (5)</td>
</tr>
</tbody>
</table>
Taylor (1986, 1991) A model refining: (1) the information use environment as the contextual space in which information behaviour occurs; and (2) a value-added approach towards information systems design to facilitate the resolution of information-based problems.

Wilson (1999) A problem-solving model of the information seeking and searching process. Key stages are: (1) problem identification; (2) problem definition; (3) problem resolution; and (4) solution statement. Transition between these stages involves uncertainty resolution.

The above studies suggest that information processing behaviour is shaped by multiple factors, such as the individual’s work situations and organisational contexts, the affective feelings of individuals, the thinking efforts of individuals, and the systematic stages of process. Choo’s (1998) general model of information use indicates that the information processing behaviour is influenced and shaped by situational, affective and cognitive dimensions.

Choo (1998) categorised the individual’s work situations and organisational contexts as the situational dimensions based on Taylor’s (1991) proposal of information use environments (IUEs). Basically, Taylor (1991) groups the work situations and organisational contexts into four categories: sets of people (the nature of their work), problem dimensions (typical concerned problems), work settings (organisational culture, style and structure) and problems resolution assumptions (perceived and anticipated ways to problem resolution). Each category contains attributes, such as training backgrounds, typical problems, organisational structure and culture, and resolution assumptions that influence and shape individual information processing behaviour.

The affective responses or feelings influence information processing behaviour by channelling attention to certain issues or information, pointing out doubt and uncertainty, indicating likes and dislikes, and motivating effort (Choo 1998). For instance, information gathering is influenced by the user’s mood or attitude towards the search task. A user in an invitational mood would tend to explore further, whereas a user in an indicative mood would tend to cease exploration quickly (Kelly 1963). Kuhlthau’s (1991, 1993) affective-oriented model describes that the affective
responses could ease the uncertainty, increase confidence in the course of information search and motivates individual’s information processing experience. For example, as the information search progresses, feelings will shift toward increased confidence and satisfaction if the search has been successful.

The thinking efforts (cognitive) of individuals shape information processing behaviour by attempting to find information in order to bridge the situation gaps (cognitive gaps) when he or she recognises an inability to act or understand a situation because of a lack of information (Dervin 1992; Choo 1998). Dervin’s (1992) sense-making framework identifies a number of generic information gaps, called situation stops, and suggests ‘help categories’, such as getting support or confirmation, getting connected to others, in order to bridge those gaps. The way individual perceives a gap is a good indicator of how the individual will go about bridging the gap and wanting the help (Choo 1998).

The systematic stages of process indicate that information processing behaviour takes place by following through a series of activities systematically. Ellis (1989a,b) and Ellis et al. (1993) derive a process-oriented model of information process from an analysis of the information-seeking patterns of social scientists, research physicists, and chemists. The model describes eight categories of information process activities: starting, chaining, browsing, differentiating, monitoring, extracting, verifying and ending. In fact, most of the information processing behaviour on web browser is influenced by Ellis’ process-oriented model.

For a better information systems support on information processing behaviour, it is important to understand the different dimensions that shape and influence the behaviour. If information processing behaviour were merely systematic stages of process activities, it would be much easier to programme those activities with computer-based information systems. However, it is a complex process that involves the situational, affective and cognitive dimension of individuals. The situational dimension is more likely to be identified and understood, but the affective and cognitive dimension will be much harder to identify and understand. The way human think and learn in complex situations are still mysterious for information systems designers to design and develop mechanisms to cope with these issues. However, it
does not mean that researchers can ignore this aspect of study. Current research in affective computing begins to study user’s affect and emotion in information process (Picard 1997; Tanaka et al. 2005). An affective support in information processing will help reduce uncertainty and increase confidence, thus increase user’s ability to construct meaning or make sense of the information (Choo 1998). It may be a long way to go, however, the immediate need is to design a personalised information support systems that at least take into some of those factors in the situational, affective and cognitive dimension. For example, by building specific user profile with specific categories, like work settings and problems resolution assumptions.

Theoretical backgrounds pertinent to information processing behaviour are discussed in the following section.

2.7.1 Environmental Scanning
The first notable study of environmental scanning was carried out by Aguilar (1967), that is concerned with “scanning for information about events and relationships in a company’s outside environment, the knowledge of which would assist top management in its task of charting the company’s future course of action” (Aguilar 1967, p.7). The environmental scanning effort is directed toward strategic decisions and strategic planning. The process of strategic management starts with environmental scanning, followed by strategy formulation, strategy implementation, evaluation and control (Wheelen & Hunger 1992). According to contingency theorists, organisational performance is dependent on the organisation’s ability to align or match its strategies, structures, and processes to its environment (Burns & Stalker 1961; Lawrence & Lorsch 1967; Duncan 1972). As the external environment becomes more volatile and unpredictable, environmental scanning becomes more critical to the organisations. Stoffels (1994) defines environmental scanning as a methodology for coping with external competitive, social, economic and technical issues that may be difficult to observe or diagnose but that cannot be ignored and will not go away. And Hambrick (1982) defines environmental scanning as the managerial activity of learning about events and trends in the organisation’s environment, and conceives it as the first step in the ongoing chain of perceptions and actions leading to an organisation’s adaptation to its environment. Environmental scanning is however not to control and predict the environment, but to learn and understand about the
external environment and to enhance the organisation adaptability to its respective environment.

Environmental scanning is a key mean for obtaining the knowledge about the past, the intelligence about the present and the foreknowledge about the future. It helps organisations understand the external forces of change. Companies can therefore develop and modify strategy to meet changing external environment. Environmental scanning can be conceived of as a key step in the process of organisational adaptation (Hambrick 1982; Lozada & Calantone 1996). Scanning also provides early signals from potential threats and opportunities that are identified. For instance, companies can become more competitive advantage by knowing their competitors, as they need improved understanding of the extent to which competitors in an industry has unequal mastery of environmental trends (Hambrick 1982). Members of the organisations will be able to make sense of the environmental happenings through scanning in order to develop a shared interpretation that can serve as a context for organisational action (Liu 1998a). Stoffels (1994) suggests that the purpose of scanning the environment is to learn, to increase responsiveness and to enhance the adaptability of decision-making systems. Scanning also enables organisations to learn about the future and to be able to envision and shape the future to its advantage (Liu 1998a). Hamel and Prahalad (1994) introduced the need of developing industry foresight through gaining a deeper understanding of the forces that will draw the competitive space of the future trends and discontinuities in technology, demographics, government regulation, as well as social lifestyle, etc. Although companies have little control over external events, scanning process can reduce the remoteness and increase the predictability of the future possibility.

2.7.1.1 The Modes of Scanning
Aguilar (1967) characterizes scanning activities into four modes as undirected viewing, conditioned viewing, informal search, and formal search, as depicted in Table 2.4. Managers employ different modes for different scanning purposes. However, managers may need to employ both viewing and focus search activities in order to generate better scanning output.
### Table 2.4 Modes of scanning (adapted from Aguilar 1967)

<table>
<thead>
<tr>
<th>Modes of Scanning</th>
<th>Definition</th>
<th>Purpose</th>
<th>Characteristics of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undirected Viewing</td>
<td>the general exposure to information where the viewer has no specific purpose in mind with the possible exception of exploration</td>
<td>provides viewer the general awareness of emerging issues</td>
<td>wide sources, unrefined, distantly and tentatively related</td>
</tr>
<tr>
<td>Conditioned Viewing</td>
<td>directed exposure to a more or less clearly identified area or type of information</td>
<td>serves to signal a warning that more intensive scanning is required</td>
<td>particular sources, ready and refined</td>
</tr>
<tr>
<td>Informal Search</td>
<td>a relatively limited and unstructured effort to obtain specific information or information for a specific purpose (strategic information)</td>
<td>to &quot;keep an eye&quot; on the business environment; to uncover new desired information</td>
<td>specific, actively being sought</td>
</tr>
<tr>
<td>Formal Search</td>
<td>a deliberate and structured effort to secure specific information or strategic information</td>
<td>for major decision making and strategic planning</td>
<td>specific and strategic</td>
</tr>
</tbody>
</table>

The above modes of scanning can be depicted by the following diagram (Figure 2.5) as to show the difference between viewing and searching. Viewing activity is to have an exposure view at information, but searching activity aims to keep an eye on information. Searching is therefore requires more attention and time than viewing. Information obtained from searching activities is more strategic than viewing activities as it entails more effort, time and resources.

![Figure 2.5 Modes of scanning](image-url)
2.7.1.2 The Scanning Process

According to Aguilar (1967), scanning activity is a process of viewing information and searching strategic information from the business environment. The intensity of scanning activity grows as more strategic information is needed. The choice of scanning modes is essential to obtain strategic intelligence. A number of variables have to be taken into consideration in the scanning process as scanning activity can be costly while information tends to be boundless. Aguilar (1967) suggests three scanning rules which comprise of different variables. Firstly, the *issue-related rules* look into (1) the scope or magnitude of the issue; (2) the urgency or timeliness of the issue; (3) the extent to which an issue constitutes a problem; (4) the extent of readily definable issue; and (5) the relationship of the issue to long term plans. For example, the greater the scope, the more clearly goal-related the issue is, the more urgent, problematic or definable it is, the greater will be the benefits from the intensive scanning for information. Secondly, the *information-related rules* pertaining to (1) the adequacy of existing information; (2) the availability of additional data; and (3) the predictability or regularity of information appear. For instance, an informal search would be appropriate for executive who would not know the information sources nor the availability of information. Lastly, the *capacity-related rules* deal with (1) the time, energy and other resources devoted by executives; (2) the number and nature of important issues; (3) the types and levels of scanning skills available; and (4) the interests and values of individual towards scanning. In practice, the decision to scan often results from the integration of different rules in response to a number of variables. The rules may also interrelate differently in each specific company or industry setting.

Aguilar’s (1967) work is evidently the pioneering effort for the research of environmental scanning. Many information behaviour researchers have applied his model to different studies of information behaviour (Weick & Daft 1983; Choo et al. 1999; Choo 2001). However, as agreed with Kourteli (2000), Aguilar’s (1967) scanning process relates little with the level of the dynamic characteristics of the external environment and the level of the heterogeneous and complex characteristics of individual. Both *issue-related rules* and *information-related rules* must consider the changeable nature of information. As discussed earlier, the nature of executive
information is soft-oriented and mess-processing related. The human-related rules pertaining to the heterogeneity and complexity of individual business environments is needed as they demand different ways and processes of scanning the environment.

The notion of environmental scanning underlies the understanding of information acquisition in this study. Based on Aguilar's work, information acquisition can be in the "reactive" (searching) or "proactive" (viewing) mode (El Sawy & Pauchant 1988; Vandenbosch & Huff 1997; Choo 1999). In the reactive mode, also termed "problemistic" or "decision-oriented" search, information is acquired to solve a specific problem (Choudhury & Sampler 1997). For this study, executives are searching and looking for specific information to enhance their understanding of a specific issue. It serves as "probes and detectors" that provide a microscopic view to search for detailed and specific information (Liu 1998a). In the proactive mode, also referred to as environmental scanning, sensing or surveillance (Aguilar 1967; Hambrick 1982), the purpose of the information is exploratory, to detect potential threats and opportunities (Choudhury & Sampler 1997). For this study, executives are viewing and looking at information in a broad way with no specific informational need in mind. It serves as a "radar" that sweeps the total environmental horizon widely, captures early warning signals and identifies areas that require managerial attention (Liu 1998).

2.7.2 Information retrieval

The theory of Information Retrieval (IR) is focused on the science of data gathering and management, often in association with mechanisms and technologies that provide efficient data search and process (van Rijsbergen 1979). The goal of IR is to support efficient information searching and browsing activities. IR is a discipline in its own right, served by a range of journals and conferences. IR has been characterised in a number of ways, ranging from data retrieval, document retrieval, information retrieval, and text retrieval, natural language processing and each of these have their own theories, models and technologies. Although there may be differences and disagreement in these different approaches, the commonality can be depicted in the following general model of information retrieval, from Belkin & Croft (1992), as depicted in Figure 2.6.
In this model, Belkin and Croft (1992) argues that when a person's goals, tasks and intentions can not be attained due to limited and inadequate resources and knowledge, the person would be in an anomalous state of knowledge or in need for information. The person would engage in active information-seeking activities, such as submitting a query. This expressed query represents the person's information need. On the other side, texts are produced, collected and organised into databases. The databases will be processed and turned into meaningful representation of the texts. The process of representing the meaning of texts in a form that can be processed by computer is a key process in IR, i.e. indexing. The representation of texts or surrogates and the query will be compared, or in some cases, direct interaction between the user and the surrogates. This will then lead to the selection of relevant retrieved texts. The retrieved texts will either be used or evaluated by the user or the system. The evaluation will lead to some modification of the query, information need or the surrogates. The process of query modification through user evaluation is known as relevance feedback in IR (Salton & McGill 1983). Relevance feedback by the user
provides an evaluation of the actual relevance of a document to a query. The relevance feedback in IR is rather focusing on query reformulation.

This model suggests that the acquisition of accurate descriptions of information needs is essential in IR system. However, the query, or rather the person's information needs must be expressed in a language that is understood by the IR system. This poses two challenges in the executive information study. First, executives may not be able to express fully their complex and dynamic information needs due to the cognitive and innate state of mental models in executives. Second, the information needs may not be expressed in the right context and in a language understood by the system. Hitherto, many IR systems are still mainly supporting keyword-based searching and browsing. Nevertheless, many efforts have been made in developing retrieval models, building document and index spaces, extending and refining queries for IR system (Crestani et al. 1998; Fidel 1994; Frakes & Baeza-Yates 1992). Recent efforts have also been made in building content-aware (semantic) and context-aware information through merging information retrieval with ontological models (Velardi et al. 2001; Sebastiani 2002; Cesarano et al. 2003; Brown & Jones 2001; Chanana et al. 2004; Kirsch-Pinheiro 2005).

2.7.3 Information filtering

The concept of information filtering (IF) is closely related to information retrieval (IR). Belkin and Croft (1992) consider both IR and IF as two sides of the same coin. They both have the goal to support efficient information processing activities by retrieving information relevant to user interests. However, the goal of IF is to screen through large volumes of dynamically generated information from dynamic data streams and to present users with information likely to satisfy their information interests. Figure 2.7 shows the general model of information filtering as proposed by Belkin and Croft (1992).
According to Belkin and Croft (1992), the above general model of information filtering begins with people (users) or group of users who have relatively periodic or long term goals or work tasks. The users have regular information interests that may change over time as new conditions, goals and knowledge occur or change. Such regular information interests will be converted into representation of texts, which then turned into profiles that can be put to the IF system. In another word, these profiles are specifications of the users' information interests. On the left side, the focus is on producers of texts, such as newspapers, individuals who distribute the texts as they are generated, so that they can be brought to users' attention. The representation of texts or surrogates will then be represented and compared to the profiles. The comparison results in some of the texts to be retrieved for users' attention, and some to be discarded. The retrieved texts are used and/or evaluated based on how well they respond to the information interests, which lead to modification of the user profiles and information interests. The modified entities will be used in subsequent comparison or filtering process. The process of profiles modification through user
evaluation is known as relevance feedback as in IR's query modification. In comparison to general model of IR, IF differs from IR in the following ways: (1) IR is concerned with single uses of the system based on one time goal and one time query, but IF is concerned with repeated uses of the system based on long term goals or interests, which are described in the user profiles; (2) IR is concerned with the extraction and categorisation of texts from relatively static database, but IF is concerned with the distribution and comparison of texts from dynamic data streams; (3) IR is concerned with responding to the user's interaction with texts with the purpose to retrieve matching texts, and IF is concerned with long term changes of information interests with the purpose to eliminate irrelevant data from incoming data streams.

Belkin and Croft's (1992) model suggests that the identification of information interests and the building of representations are essential in IF system. User profiling, or sometimes known as user modeling aims at determining representations of the user preferences and interests (Shapira et al. 1997; Balabanovic & Shoham 1997). In other words, it aims at modeling the user and presenting his or her information needs and interests in a form of a profile. Balabanovic and Shoham (1997) believes that "the construction of accurate profiles is a key task—the system's success will depend to a large extent on the ability of the learned profiles to represent the user's actual interest" (p.68). Most of the work on IF focuses on the user profiling research that considers profiles as user models. User profiling enables elimination of irrelevant information and personalisation of information delivery according to user preferences. If IF is concerned with long term changes of information interests as suggested by Belkin and Croft (1992), this will require a continuous improvement of user profiles building and modification. This determines the basis for the performance of IF systems. Hence, user profiling is often related to user relevance feedback.

User relevance feedback is used to create and refine user profiles in IF. Initially, the process of profiles modification through user evaluation is done directly by the user, which is known as explicit relevance feedback (Salton & Buckley 1990; Belkin et al. 1996). This increases the cognitive load on the users, as they need to explicitly feedback into the system on the relevance of retrieved documents. This poses the challenges for users, especially executives to find time and engage in expressing their
personal relevance judgments explicitly into the system. However, recent research in user relevance feedback has been working on gathering relevance feedback automatically and unobtrusively by monitoring user behaviour in information processing. This helps reducing the user effort. This approach is called *implicit relevance feedback* (Morita & Shinoda 1994; Kelly & Teevan 2003; White et al. 2004). Some of the unobtrusive behaviours (surrogates) monitoring include user reading time, scrolling and interaction with documents.

If IF is concerned with the comparison and matching of users' long term information interests with the texts from dynamic data streams, as suggested by Belkin and Croft (1992), this poses the challenge to provide relevance feedbacks in the right user context because they are subjective, dynamic, cognitive, situational and multidimensional (Schamber 1994). In the executive context, we have learned that executive information is soft-oriented and mess-processing related. In terms of executive's information needs, executive will only feel that the information is relevant, meaningful or useful in a personal way if the information retrieved is able to connect with the *visceral needs* (the gap or deficiencies in knowledge or understanding) and *conscious needs* (the area of unknown or ambiguity). In everyday decision making process, executives are not passive choice makers but are active sense-makers who rely on perception, action, and mental models to arrive at solutions to problems (Kuo 1998). Nevertheless, recent studies have looked into the cognitive, situational and interactive feedback models, that emphasise the important role of context in IF's user relevance feedback (Quiroga & Mostafa 2002; White et al. 2004).

In the process of acquiring relevant information, there is also a need for eliminating irrelevant information through relevance feedback (Maes 1994; Shapira et al. 1999). The notion of IR and IF underlies the understanding of information synthesis in this study. Ackoff (1967) states that "*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.*" IF has not been taken into consideration in the conventional study of EIS. However, the need is increasingly high as executives are coping with the external massive information from the business environment. Information synthesis acts as "*variety reducer*" *(from Beer's (1979) "variety engineering" concept)* by screening out irrelevant information.
and refining information through relevance feedback for their relevancy. Information synthesis should involve the selection of information from a dynamic datastream, rather the selection, collection and organization of information, mainly texts, from a relatively static database. A continuous creation and modification of user profiles through user relevance feedback (both explicit and implicit) must be well in place in information synthesis process.

2.7.4 Information Interpretation

Information interpretation involves making sense of the information. It is often viewed as an individual level process wherein people attend to and make sense of incoming information (Thomas et al. 1993). It entails the analysis, evaluation and creating of information into some structure for understanding and action (Gioia 1986; Taylor & Crocker 1981). In the model of sense making developed by Weick (1995), organisations are loosely coupled systems in which individual managers have great latitude in interpreting equivocal information from the environmental change and establishing their own representations of external reality. The goal of sense making is to create and identify events that recur to stabilise the organisational environment and make it more predictable. In this case, information interpretation involves the process of translating the viewed and searched events, the process of developing models for understanding, the process of bringing out of meaning, and the process of assembling conceptual schemes (Liu 1998a; Daft & Weick 1984).

Intelligent information systems or knowledge-based systems are in principle capable of explaining their reasoning or justifying their behaviour. Here, explanations are important and valued features that serve to clarify and justify the meaning of information, and resolve any misunderstanding of information (Gregor & Benbasat 1999). In other words, explanations help provide adequate justification on information such as the meaning of a data, the reasons for advising a particular course of action, and the justification for a particular piece of information. This is similar to the objectives and processes of information interpretation as mentioned earlier. In view of the lack of understanding on the benefits of explanation function, Gregor and Benbasat (1999) propose a theoretical base that combines a cognitive effort perspective, cognitive learning theory and argumentation model for the design and use of explanation function. For example, the cognitive effort perspective states that there is limitation in
human cognitive capacities (Payne et al. 1993; Gregor & Benbasat 1999). Hence, there is need for explanation. Gregor and Benbasat's (1999) empirical studies conclude that explanations are important to users, in particular, when the user perceives an anomaly, when they want to learn, or when they need a specific piece of knowledge to participate properly in problem solving. Gregor's (2001) study also shows that benefit did arise from the use of explanations. For instance, problem-solving performance increased with frequency of using an explanation function, particularly with problems that required collaboration between system and user. However, it appears that explanations will not be used if the user has to put too much effort to get them. Hence, explanations should be provided automatically in an unobtrusive manner.

The concept of organisational learning also provides some understanding on information interpretation. Choo (1994) described the organisational learning process as a continuous cycle of activities that include sensing the environment, developing perceptions and generating meaning through interpretation, using memory about past experiences to help perception and interpretation, and taking action based on the interpretations developed. According to Liu (1998a), perception and interpretation depend heavily on the norms, frames, rules, schemes and shared mental models that managers use as lenses to view trends and developments. In addition, the interpretation of the data or information is often influenced by executives' hidden assumptions, blind spots and taboos from the company's past successes. Hence, this poses a challenge to develop an interpretation process that is capable of converting information into meaning for understanding and action.

2.8 The Notion of Executive Intelligence Activities

In summary, information processing behaviour that involves information seeking, information gathering and information manipulating activities is strongly related to the intelligence processing activities. The study of information processing behaviour indicates that activities that a person engages in information search and process are influenced and shaped by situational, affective and cognitive dimensions, or simply by following systematic stages of process. Understanding these dimensions will help
information systems designers design and develop advanced information systems that take into consideration of relevant factors, such as building user profiles based on the situational dimension.

The ability to search the business environment for conditions calling for decision (as in the intelligence activity phase of Simon's (1965) decision process model) through continuous, self-reactive and self-adaptive activities or approaches in executive information process suggest the notion of executive intelligence activities (see Figure 2.8). Executive intelligence activities support is essential for senior executives to cope better with the increasingly dynamic and complex executive information through value-added information seeking, information gathering and information manipulating activities. The theory of information retrieval (IR) suggests that efficient information search and process can achieve through a closed-loop process that involves evaluation and modification either through the user's explicit relevance feedback or the implicit relevance feedback from the system itself. Hence, there is a need to support executive intelligence activities through a closed-loop process, whereby actions could be suggested and/or taken continuously in order to process information on behalf of senior executives.

![Figure 2.8 Executive intelligence activities](image)

The study of environmental scanning suggests the key mean for obtaining intelligence about the past, the present and the future. The concept of environmental scanning underlies the understanding and the need for information acquisition in executive intelligence activities (see Figure 2.8). In order for executives to understand their internal business environment and to attend to signals and messages generated from the external business environment, they need a system that is capable of providing a broad range of information, and that is typically spread across several computer
systems within the organisation as well as the external information on markets, customers, suppliers, competitors and the remote external information on politic, economic, social and technological issues. It is more than just providing historical data through basic query and reporting mechanisms. It involves sophisticated information scanning and searching activities through macroscopic viewing (radar) and microscopic search (search) of potentially relevant information. Scanning activities provide early signals from potential threats and opportunities and help executives understand the external forces of change. Searching activities provide specific information on newly arising issues and help executives understand the detailed information of issues. Although companies have little control over external events, this acquisition activity can reduce the remoteness and increase the predictability of the future possibility.

The concept of information filtering (IF), originated from the theory of information retrieval suggests the understanding and the need for information synthesis in executive intelligence activities (see Figure 2.8). The goal of IF is to screen through massive of dynamically generated information through user profiling and relevance feedback (explicit and implicit) and to present users with information likely to satisfy their information interests. Similar to the goal of IF, information synthesis acts as "variety reducer" by screening out irrelevant information and refining information through relevance feedback for their relevancy. Information acquired is synthesised to increase its relevancy and reliability. Irrelevant information will be eliminated and relevant and useful information will be extracted through filtering activities. Key activity in information filtering is user profiling. User profiling enables elimination of irrelevant information and personalisation of information delivery according to user preferences. Information refining activities involve both explicit and implicit relevance feedback of user. User relevance feedback is used to create and refine user profiles. A continuous creation and modification of user profiles through user relevance feedback (both explicit and implicit) will gradually improve the results of information search and process.

Finally, information interpretation is pertinent to executive intelligence activities (see Figure 2.8). Information interpretation involves making sense of the incoming information. It entails the process of translating the viewed and searched events, of
developing models for understanding, of bringing out of meaning, and of assembling conceptual schemes. In other words, synthesised information is further processed to resolve the equivocality of information and to give meaning and understanding about the organisation’s events. Explanations are key functions in information interpretation activities, in which, explanations help provide adequate justification on information such as the meaning of a data, the reasons for advising a particular course of action, and the justification for a particular piece of information. However, these activities pose challenges because executives are cognitively complex individuals who tend to use their innate mental models to perceive and understand the viewed and searched events.

The next chapter reviews the current management information support systems and examines the potential of intelligent software agents for supporting executive intelligence activities in EIS. The preceding empirical studies of EIS with regards to EIS purpose, design guidelines and functions are studied and reviewed. The concept and applications of intelligent software agents are studied and considered for supporting executive intelligence activities.
Chapter 3

Executive Information Systems (EIS) and Intelligent Software Agents

3.1 Introduction

This chapter reviews the current management information support systems and examines the potential of intelligent software agents for supporting executive intelligence activities in EIS. Firstly, Section 3.2 presents the evolution of management information support systems, followed by the impact of Internet technologies on management information support systems in Section 3.3. Section 3.4 revisits and reviews prior empirical studies of EIS. Conventional views on EIS purpose, design and function are challenged and Section 3.5 outlines the need for revitalising EIS design and development. Section 3.6 and Section 3.7 reviews and considers intelligent software agents for supporting executive intelligence activities in EIS. Section 3.8 reviews preceding conceptual development of agent-based frameworks for intelligent information processing. From the theoretical literature and empirical literature review, empirical questions for empirical studies on executive intelligence activities with intelligent agent-based support are proposed in Section 3.9.
3.2 The Evolution of Management Information Support Systems

The evolution of computer-based systems that support managerial work can be summarised in the following diagram (Figure 3.1).

![Diagram showing the evolution of management information support systems]

**Figure 3.1 The evolution of management information support systems**

### 3.2.1 Management Information Support Systems

The emergence of management information support systems begins with the introduction of management information system in the 1960s, followed by decision support system in the 1970s, and executive information system in the late 1980s. The ultimate purpose of these systems is to develop a solution that can assist a manager in decision making. Often, it is the development of computing technologies that causes different terms being coined. Hence, EIS is conceptually similar to an MIS or DSS in terms of the purpose. In fact, many EIS include MIS and DSS as part of the total system. Nevertheless, the similarities and differences are important for understanding, communicating and developing an executive system. The following provides a comparison of MIS, DSS and EIS as presented in Table 3.1.
Many management information support systems have been increasingly developed and implemented in business, yet their applications are still limited and often do not support executive intelligence activities. Management Information Systems (MIS) are used to serve managers at organisational levels, which lack the degree of customisation and focus required by senior executives. Decision Support Systems (DSS) focus on specific decision problem or a collection of related problems that are related to middle managers.

The distinction between EIS and other decision support systems is a specifically designed system that provides executives with easy access to internal and external information that is relevant to their critical success factors (Watson et al. 1997). Back in 1988, Rockart and De Long (1988) states three key reasons for growth in EIS. First, the use of information systems to support executives does make good managerial
sense in their complex, unstructured and unpredictable nature of works because there are many logical applications of IS which can effectively support executive tasks. Second, the information technology is rapidly improving with the integration of easier-to-use software and the lower cost of implementation. Third, computer-based executive support will continue to spread as more and more senior executives are becoming more computer literate. The theoretical and empirical literature of EIS is revisited and discussed in Section 3.5.

3.2.2 Decision Support Infrastructure

Data warehouse, data mining and online analytical processing (OLAP) are tools for decision support. They are integrated into management information support systems, such as DSS and EIS for exploratory information retrieval and data management of organizations (Inmon 1996). Devlin (1997) defined the data warehouse as a single, complete, and consistent store of data obtained from a variety of sources and made available to end users in a way they can understand and use in a business context. The goal of data warehousing is to better analyse the massive amounts of data that companies are collecting and accumulating to make better business decisions. Data warehousing consists of data importing and exporting components, which are responsible for accessing, transforming, distributing, storing and exporting the data and information (Ma et al. 2000). The data warehouse structure includes integrated data, detailed and summarised data, historical data and metadata.

Data mining is the utilisation of data stored in the warehouse to find new, hidden, or unexpected patterns of information in data through software technology (Bose & Sugumaran 1999). Data mining is often referred as knowledge data discovery (KDD) as it is the process of looking in a database to find patterns without a predetermined hypothesis of the patterns. The goal of data mining is to find potential goal mines of valuable information from the data warehouse. The concept of data mining can be seen as exploratory analysis of data through the process of scanning a massive amounts of data to extract valuable information.

Online analytical processing (OLAP) is an architectural extension of the data warehouse. As data warehousing focuses on the data collection, data cleansing, data integrating and data storing, the OLAP tools provide the means needed to manipulate
and analyse the data. OLAP is basically a means of exploratory data analysis. OLAP displays multidimensional view of data summaries in a rapid and interactive fashion, in which it enables the efficient browsing of large amounts of data, empowering its users to search for patterns, trends and relationships. However, OLAP is mainly used for data aggregation and data summarization (Ma et al. 2000). There is a lack of statistical inference tools within OLAP software packages. Second, OLAP performs exploratory rather predictive or deductive analysis. The users must determine the significance of relationships, trends and patterns.

Many vendors in the commercial world have coined the term of *business intelligence* by using the data warehousing, data mining and OLAP tools. It is, after all, about getting the right data, analysing the data for insights, and using the insights to make better decisions. The terms such as data mining, OLAP and business intelligence are becoming popular in the beginning of 2000s. As a matter of fact, these terms practically eliminated the term EIS from most vendors’ web sites and product lists. In summary, data warehouse, data mining and OLAP are basically improved database technologies. These technologies aim to transform data into valuable information for better decision making process. However, data extraction in these technologies is usually based on existing databases and predefined information needs. As a result, information collected is internal and historical oriented.

Despite the integration of decision support infrastructures, such as data warehouse, data mining and online analytical processing (OLAP) into current management information support systems, the key deficiency is still the intelligent functions in information processing. For instance, systems that actively and continuously scan the business environment, automatically filter through the irrelevant data and information, and constantly provide signals or warning of potential opportunities and threats.

### 3.2.3 Intelligent Support Systems

The advent of Artificial Intelligence (AI) (or sometimes called *soft computing*) techniques, such as fuzzy logic, neural networks and genetic algorithms gives the possibility to develop intelligent support systems, such as expert systems and knowledge-based systems. Zeleznikow and Nolan (2001) suggest using fuzzy logic and neural networks for building intelligent support systems that provide reasoning in
the presence of uncertainty. Zadeh (1994) states that principal constituents of soft computing are fuzzy logic, neural network theory and probabilistic reasoning with the latter subsuming belief networks, genetic algorithms, parts of learning theory and chaotic systems. Zadeh (1994) claims that soft computing offers the potential to mimic the ability of the human mind to effectively use different modes of reasoning that are approximate (Zadeh 1994). The ability to mimic knowledge and distribute knowledge to users with good reasoning constitutes the essence of an Expert Systems (ES) or Knowledge-based Systems (KBS).

To a certain degree, ES or KBS are an extension of DSS with intelligent support, in which they are developed to give reason and automate decision-making support in order to assist users in particular problem domain. ES are one of most commercially successful branches of AI (Metaxiotis & Psarras 2003). Many organisations remain enthusiastic about the ES applications (Wong 1996; Kunnathur et al. 1996). However, ES are mainly adopted to support operational and tactical decision, rather than strategic decision. More surprisingly, Wong et al.'s (1994) and Eom's (1996) survey of the use of ES indicates that half of the ES were used in the production and operations areas. In fact, most of the ES are not successfully adopted and implemented due limited functions, high cost of development and organisational resistance (Wong & Monaco 1995; Watson et al. 1997; Grove 2000). Grove (2000) raises several problems and limitations associated with current ES/ KBS applications: (1) Experts are often unable to express explicitly their reasoning process; (2) ES tends to perform poorly due to the limitations in its coded expertise, which relates to a narrow domain; (3) The standalone, based on mainframe, AI workstations or PC platforms causes the limited use of ES and the difficulty in information sharing, as well as difficulty in software installation and upgrades.

Internet technologies have offered new opportunities for enhancing current or traditional ES or KBS. Grove (2000) argues that the Internet is an ideal base for KBS delivery. Duan et al. (2005) use three web-based ES to examine the benefits and challenges of using the Internet as a base for intelligent support. Their findings conclude that the process of knowledge engineering can be enhanced significantly by using the Internet. For examples, online knowledge acquisition and updating by domain experts can save travel costs and expert's time, online community provides
the potential source of knowledge, and effective online user feedback and evaluation. Section 3.4 discusses more fully the impact of the Internet on management information support systems.

With the overwhelming flow of distributed information produced for the executives from an increasing number of sources, intelligent support systems are becoming key to fulfil the following three functions in information processing. First, the screening and filtering of an increasing amount of data and information. Second, the personalisation of information gathering and processing according to individual users. Third, the learning and adaptation of system to information changes. The emergence of intelligent software agents offers the capability to fulfil these three key functions. The Internet serves as the most important environments for intelligent software agents, whereby information is processed in real environments with continuous input from both internal and external environments. Section 3.7 will review the literature background and potential of intelligent software agents in detail.

3.3 The Impact of Internet Technologies on Management Information Support Systems

The current explosion of the hypertext-oriented information service of the Internet, the World Wide Web, provides an enormous option for systems developers to create applications that are appropriate to the managerial works and information needs. A Web-based solution can quickly overcome some of the drawbacks of current management information support systems, especially with regard to cost, geographically distributed location, ease of use, development cycle, architecture, and even added features such as intelligent agents (Basu et al. 2000, Gopal & Tung 1999).

Shim et al. (2002) examine the development of the DSS concept since its inception in the 1960s and early 1970s until today. They conclude that the advent of the Internet technologies has enabled inter-organisational decision support systems, and has given rise to numerous new applications of existing as well as many new management decision support systems due to lower cost and increased functionalities. The Internet
has in fact become the global infrastructure for supporting information acquisition and retrieval from heterogeneous data sources, including high-speed text and rich multimedia images, audio and video (Shaw et al. 2002). Hence, there is a vast array of potential for using Internet technologies or web-based solutions to enhance current management information support systems. Basu et al. (2000) propose specific functions that can be included in web-based management information support systems:

- Collaboration, communication, and exchange of documents/information, along with video conferencing, online training, and seminars
- Generation of basic reports in text, 3-D graphics, and interactive forms with database queries
- Drill down to more detailed information via links on Web pages
- Modeling capabilities for forecasting and manipulation of data/information, in part with downloadable spreadsheets or databases that users obtain from Web pages
- Monitoring and comparative analysis, online analytical processing (OLAP) that can extract and present multidimensional data from different points of view.
- Access to relevant and environmental information with links to consultative, professional and financial services, or news/trend-related Websites
- Extranets permitting data input and sharing with external corporate partners, customers and suppliers

The Internet technologies have also led to the emergence of portal solutions through Intranet, Extranet and Enterprise Information Portal (EIP). Intranet, a corporate-wide Web that uses Internet standards and protocols to empower information sharing and foster efficient communication and collaboration between users within an organisation. Using the same Internet-based open standard protocols that form the basis of an Intranet, Extranet bridges communication and collaboration between organisations or business partners. The new wave of web technology is the Enterprise Information Portal (EIP), modeled after Yahoo or Excite on the public Internet. The concept of EIP is a single point of access, where it gives users a unified view of all corporate knowledge assets using the new universal interface, the web browser. The differences between EIP and Intranet or Extranet is the integration of other
with the computer’s ability to store, retrieve, manipulate and compute internal and external data’ (Warmouth & Yen 1992).

With these definitions, the following characteristics of EIS are provided by researchers as depicted in Table 3.3 (Rockart & De Long 1988; Watson et al. 1991; Edwards & Peppard 1993; Young & Watson 1995; Nord & Nord 1995):

Table 3.3 Characteristics of EIS (adapted from Young & Watson 1995)

- Direct, hands-on usage by senior executives
- Easy to use and require minimal or no training to use
- Tailoring the EIS to individual executive users
- Focusing on the information needs of individual executives
- Monitoring key performance indicators/ critical success factors
- Depiction of organisational health indicators
- Scanning, filtering, organising and delivering data
- ‘Drilling down’ to examine details of data
- Reporting exception conditions to highlight variances
- Combining text, graphics, and tabular data on one screen user interface
- Statistical analysis tools for summarising and structuring data
- Accessing to both internal and external data
- Providing current and online status access to performance data
- Incorporating both hard data (e.g. figures) and soft data (e.g. opinions)
- Integrated capabilities for data access, security and control
- Integrated office support functions, e.g. email, calendar
- Integrated decision support functionalities, e.g. what-if analysis

3.4.2 EIS Functions and Capabilities

When the concept of EIS was firstly introduced, Rockart and De Long (1982) saw EIS as data-retrieval systems designed to provide information for executive use to improve managerial planning, monitoring and control. The functions of EIS focus on data retrieval and analysis. In the mid and late 1980s, Levinson (1984) and Rockart and De Long (1988) emphasised the need for personal support and communications tools, as well as “business-oriented” systems to improve user effectiveness. The
functions of EIS were integrated with limited DSS tools. In the early and mid 1990s, Watson and his team (Watson et al. 1991) added the importance of acquisition of internal and external information via user-friendly functions and interface. In summary, the EIS functions evolve as the following: (i) Generation I, in the early 1980s, which functions focus on monitoring and control; (ii) Generation II, in the mid and late 1980s, with the additional of limited decision-making functions; (iii) Generation III, in the early and mid 1990s, comprises monitoring and control function, decision-making function and acquisition of internal and external information function.

The conventional model of EIS functions and capabilities developed by Rockart and De Long (1988) is reviewed. This model comprises three key functions supported by different capabilities (as depicted in Figure 3.2).

<table>
<thead>
<tr>
<th>Office support applications</th>
<th>Planning and control process</th>
<th>Enhanced modelling</th>
</tr>
</thead>
</table>

Figure 3.2 Conventional model of EIS functions (adapted from Rockart & De Long 1988)

The *office support applications* aims to support and enhance informational roles of executives and to increase executive efficiency so that more time can be devoted to other managerial activities. Three standard application categories are suggested:
- Support for electronic communication (e.g. email, word processing, news feeds)
- Data analysis capabilities (e.g. spreadsheets)
- Organising tools (e.g. electronic calendars, automated filing)

The *planning and control process* is rather similar to MIS applications. The aim is to support and enhance decisional roles of executives. The following capabilities are suggested to facilitate planning and control activities:
- Retrieval capabilities – to improve existing corporate or divisional information provision
• Reporting capabilities – to monitor and report new information streams and critical information
• Planning and forecasting tools – to improve control processes and planning for the future
• Customised information databases – to give the flexibility to manipulate performance information
• Electronic communication capabilities – to tighten communication links between executive and the rest of the organisation
• Programme management capabilities – to support and monitor project-related information

The *enhanced modelling* aims to enhance executives' mental models through improved access to external data, integration of data from multiple sources, meaningful presentation of data, improved analysis of data and off-hours data access. These capabilities are suggested to enhance mental models:

- Query language tools
- Analytic and modelling capabilities
- Graphical tools
- Online capabilities

Conventionally, the design of EIS focuses on office support applications, planning and control process, and improved analytic and modelling capabilities (Rockart & De Long 1988). Key functions of earlier EIS design are mainly standard office automation packages and management reporting facilities on company’s KPI (Key Performance Indicators) and CSF (Critical Success Factors) (Rockart & Treacy 1982; Millet & Mawhinney 1992). The improved analytic and modelling capabilities are mainly developed to provide status and trends of internal and historical information (Millet & Mawhinney 1992). Hence, it is rather a management control and planning system with performance measures based on critical success factors. This has failed to meet the primary purpose of EIS, that is to provide executives with easy access to internal and external information that is relevant to their critical success factors (Watson et al. 1991, 1997).
3.4.3 Previous Empirical Studies on EIS Applications and Adoptions

The application and adoption of EIS in practices has been widely reported in the mid and late 1990s. The findings and implications of the previous key empirical studies surrounding EIS applications and adoptions are summarised in the following Table 3.4.

### Table 3.4 Summary of findings and implications of EIS applications and adoptions

<table>
<thead>
<tr>
<th>Research Scope</th>
<th>Findings Summary</th>
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</table>
| 1. Edwards and Peppard (1993)                                                | • 4 distinct groups which shared the similar characteristics have been clustered: (1) *Conglomerate EIS* – reporting subsidiary companies’ information to parent company to enable senior managers to manage their portfolio (i.e. financial information);  
  (2) *Control and Monitoring EIS* – automating the traditional management accounting reports to the top management for performance monitoring (include non-financial information);  
  (3) *Competitive and Intelligence EIS* – collect and assemble industry and competitive environment information from a variety of sources for top management in order to identify opportunities and threats;  
  (4) *Communication and Control EIS* – providing users a variety of tools to manage personal information (i.e. e-mail, e-diary, etc.) |
| Research Scope: Characteristics of EIS                                                                                          |                                                                                                                                                                                                                  |
| A case study of 7 organisations using EIS at the senior management level                                                       |                                                                                                                                                                                                                  |
| 2. Nord and Nord (1995)                                                       | • About one third (30.8%) of the respondents used EIS for decision support, and/or for communication.  
  • Users: top management and middle management  
  • 87.5% respondents believed that EIS improved their communication.  
  • 62.5% respondents indicated that EIS increased their confidence in decision making and access to other unavailable information.  
  • 20% said that EIS helped increase their profits.  
  • Other benefits found: improved responsiveness, timely decision making, reduced inventories, better control of sales and manufacturing.  
  • Important EIS functions by executives: ease of use, followed by decision support tools, then graphics, minimum number of keystrokes, mouse or touch screen, electronic briefing book modules, electronic mail packages. |
| Research Scope: usage of EIS, benefits of EIS, desired EIS characteristics                                                      |                                                                                                                                                                                                                  |
| A survey of Fortune 500 companies (n=152)                                                                                      |                                                                                                                                                                                                                  |
| 3. Watson et al. (1995)                                                       | • The function of EIS concentrated on the ease of use and graphic data presentation.  
  • The top problems of EIS development is “getting accurate data and keeping abreast of executives’ changing information requirement”  
  • Successful EIS factors by executives: timely information, improved efficiency, accurate information, status access, convenient information, relevant information are ranked on |
| Research Scope: critical success factors of EIS development, desired EIS functions or features, problems and failures of EIS     |                                                                                                                                                                                                                  |
| Development | The top.
| --- | ---
| • In contrary to Nord and Nord's findings, “ease of use” was perceived less important by executives. | 
| • The key motivating factor for EIS is related to internal information needs. External information needs were perceived less important. | 
| • The critical factor of EIS development: acquisition of meaningful and relevant information | 
| • EIS failures: fail to provide strategic information, internal information focused, repetitive information, inflexibility in data extraction | 


| Research Scope: keys to successful EIS development and ongoing operation | Top keys to successful EIS development are executive sponsorship, definition of information requirements and management of data.
| --- | ---
| A structured interview with 48 persons comprised three constituencies (executive users, EIS professionals & vendors and consultants), and a questionnaire survey (n=149) | For ongoing EIS operation, executives placed relatively greater importance on the EIS improving their efficiency and receiving information that is accurate, relevant, current and convenient to access through ease of use functions. The EIS professionals gave relatively high marks to ease of use, access to current status information, and adapting to changing information requirements.
| Information quality, impact on executive work, EIS functions, ease of use and information delivery issues are identified as five key operational EIS factors in relation to the executive users and EIS. |

5. Rai and Bajwa (1997)

| Research Scope: current EIS Adoption in US organisations, adoption level, critical success factors of EIS Adoption | EIS have not been widely adopted – only a third of the respondents had adopted EIS either for collaboration support (EIS^sub c^) or decision support (EIS^sub d^). |
| --- | ---
| A survey of 70 EIS-adopted companies (n=210) | EIS for collaboration support (EIS^sub c^) is relatively standardize and replicable. EIS for decision support (EIS^sub d^) has to be developed in situ given the specific characteristic of the user and task.
|  | The adoption of EIS^sub c^ (59 firms) is slightly greater than EIS^sub d^ (54 firms).
|  | No significant differences in firm size were detected between adopters and non-adopters of either EIS^sub c^ or EIS^sub d^.
|  | Increase in environmental uncertainty promotes the adoption of both EISs.
|  | No differences are observed in IS department (ISD) size between adopters and non-adopters of EIS^sub c^, but it is found that adopters of EIS^sub d^ had larger ISD size than non-adopters.
|  | There is a significant relationship between environmental uncertainty and the level of adoption of EIS^sub d^, but not with the adoption level of EIS^sub c^. |
### 6. Vandenbosch and Huff (1997)

**Research Scope:** (1) the relationship between information retrieval behaviour and perceptions of organisational performance; (2) the relationships between information retrieval behaviour and individual differences, system characteristics, and organisational context.

* A field study of 7 organisations using EIS at the senior management level

<table>
<thead>
<tr>
<th>Points</th>
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<tbody>
<tr>
<td>A significant relationship between top management support and level of adoption of both EISs were detected.</td>
</tr>
<tr>
<td>IS support is positively related to the adoption level of EIS sub d but not EIS sub c.</td>
</tr>
</tbody>
</table>


**Research Scope:** the relationship between top management support, IS support, vendor/consultant support and EIS success.

* A survey of 69 firms (n=238)

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<th>Points</th>
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<tbody>
<tr>
<td>30 of 36 interviewees (83%) exhibited focused search (searching mode) behaviour, 9 (25%) exhibited scanning behaviour (viewing mode).</td>
</tr>
<tr>
<td>EISs were found to contribute to gains in efficiency (25, 69%) much more frequently than to gains in effectiveness (6, 17%).</td>
</tr>
<tr>
<td>Scanning is found more likely than focused search to lead to gains in effectiveness. But both scanning and focused search seem to have the potential to lead to gains in efficiency.</td>
</tr>
<tr>
<td>Focused search is found to be more frequent used than scanning. 75% of the executives did not use EIS to scan information; instead, they used EIS to monitor performance through focused search.</td>
</tr>
<tr>
<td>The degree of innovativeness and tolerance for ambiguity, but not locus of control were strongly linked to a predisposition toward scanning generally.</td>
</tr>
<tr>
<td>3 identified system characteristics (differentiation, integration, flexibility) and social influences affected the way in which an EIS was used and the impact upon perceptions of organisational performance.</td>
</tr>
<tr>
<td>Those executives with divergent jobs were more likely to have a predisposition towards scanning than those with convergent jobs.</td>
</tr>
</tbody>
</table>

Conventional EIS studies indicate that most EIS were used predominantly for communication, performance monitoring and control (Edwards & Peppard 1993; Nord & Nord 1995; Vandenbosch & Huff 1997). This implies the inability of
conventional EIS in managing strategic information due to the internal focused of EIS use. However, EIS were found to increase executives’ confidence in decision making (Nord & Nord 1995), and improve executives’ efficiency through successful information acquisition (Rainer & Watson 1995; Watson et al. 1995; Vandenbosch & Huff 1997). This suggests the need for supporting information search and scan in EIS.

Conventional views on EIS design also imply that value added presentation of data via user-friendly interface such as graphical, tabular, and/or textual information presentation is essential in EIS design (Nord & Nord 1995; Watson et al. 1995). Data should be processed (i.e. summarised, aggregated, analysed), prepared and reported to executives using friendly and colourful interface. Ease of use is considered relatively importance in EIS design and development (Nord & Nord 1995; Rainer & Watson 1995; Watson et al. 1995).

Other EIS studies also attempt to explore factors contributing to the success of EIS adoption and implementation. Most of the studies imply that there are relationships between EIS success and support from top management, IS or vendor (Rai & Bajwa 1997; Bajwa et al. 1998) and between EIS adoption and environmental uncertainty (Rai & Bajwa 1997). However, these studies do not provide useful implications on guidelines for successful EIS design and development.

3.5 The Need For Revitalising EIS Design and Development

Many EIS failures have been reported from the study of the adoption of EIS and keys to EIS success (Millet & Mawhinney 1992; Watson & Frolick 1993; Rainer & Watson 1995; Young & Watson 1995; Rai & Bajwa 1997; Bajwa et al. 1998; Koh & Watson 1998). Conventional EIS’s data extraction is usually based on existing internal databases and predefined information needs, which is predominantly used for communication, performance monitoring and control (Edwards & Peppard 1993; Nord & Nord 1995; Vandenbosch & Huff 1997). It is not sufficient to address the significance of business problems for strategic decisions. The predefined information needs also cause the inflexibility in data extraction (Liu 1998a,b; Chen 1995).
Information retrieval becomes inflexible and reactive, whereby executives have to initiate information search only from the databases that contain predetermined information. This suggests the need for an effective implementation of intelligence on the business environment, such as the ability to monitor and analyse the internal and external information continuously and proactively in real time business environments.

Conventional EIS is also inflexible enough to adapt and meet changing information needs (Young & Watson 1995; Bajwa, et al. 1998; Salmeron 2002). Most EIS have predefined rules for exception manipulation, reporting and control. These embedded rules were pre-determined by IS professionals based on what executives specified in the initial development of EIS. However, executives’ information needs and requirements are individual specifics and changing over different issues and time, thus could not be pre-specified beforehand. Hence, there is a need for a dynamic information infrastructure that is capable of adapting and meeting specific and dynamic information needs of executives (Koh and Watson, 1998).

Most EIS are designed with the assumption that the critical deficiency is the lack of relevant information; as a result, executives are supplied with more information than they can possibly absorb. This leads to information overload. There is a need to filter information so that it is manageable by the executives because any additional information made available by an EIS cannot be expected to be used effectively unless the information overload to which executives are subjected is reduced. On top of that, conventional EIS often provide information that has already existed in other forms (Wheeler et al. 1993). For example, information acquired from EIS is already available on paper reports. Therefore, there is a need to eliminate the redundancy of information as to reduce the amount of time needed for executives to process the information.

Information can easily become stale in a conventional EIS due to the limited and static presentation of data (Watson et al, 1995). Despite the over emphasis on ease of use and user-friendly interface (Nord & Nord 1995; Watson et al. 1995), the information infrastructure and context of executive is often neglected. There is little insight on how executive information should be structured, manipulated and presented for supporting executive intelligence activities (Xu et al. 2003). Recent empirical
studies of EIS imply that advanced information acquisition and reporting functions will be useful for managing executive information (Xu & Kaye 1995 1997; Koh & Watson 1998; Kumar & Palvia 2001). For examples, using scanning, filtering and reporting function to collect and synthesise information from multiple sources and proactively report brief and aggregated information to executives.

Despite the integration of data manipulation and decision support tools into current management support systems, the key deficiency is still the lack of intelligent functionality (Liu 1998a,b; Montgomery & Weinberg 1998). For instance, intelligent functionality that continuously scan business environment, automatically filter irrelevant data and information, and proactively provide signals or alerts of potential opportunities or threats. Recent progress in understanding the theoretical basis for intelligence has gone hand in hand with advancements in the capabilities of intelligent support information systems. The intelligent software agents, subfields of AI offer the potential for supporting executive intelligence activities because these agents have become more integrated in the distributed environment of the Internet. The next section reviews the theoretical basis of intelligent software agents and explores the potential of intelligent software agents for supporting executive intelligence activities in an intelligent EIS.
3.6 Intelligent Software Agents

3.6.1 Definitions and Characteristics
The concept of an agent originates from the domains of Artificial Intelligence (AI) and Distributed Artificial Intelligence (DAI) (Nwana 1996). Agents are now widely explored and discussed by researchers in the mainstream of computer science, as well as in network communications, robotics, and user interface design (Wooldridge & Jennings 1995; Nwana 1996; Wooldridge & Ciancarini 2001). The rapid growth of research interests has led to a variety of definitions and descriptions of the term agent. Wooldridge & Jennings (1995) and Nwana (1996) have made efforts to clarify the essence of the agent concept. It is, however, still quite contentious due to the proliferation and diverse use of the term in many domains. Wooldridge & Jennings (1995) distinguish two general usages of the term agent, summarised in the following tables (Table 3.5 & Table 3.6). Table 3.5 depicts the weak notion of agent, which means that agents could possibly act intelligently or act as if they were intelligent. The weak notion of agent is, therefore, less contentious. Table 3.6 depicts the strong notion of agent, which means that agents that do so are actually thinking. This strong notion of agent is more contentious. Nevertheless, central to the notion of an agent is its autonomous and goal-directed behaviour. This study reviews and explores the weak notion of agent, as most preceding empirical studies did (Liebermann 1995, 1997; Liebermann et al. 2001; Rhodes & Starner 1996; Moukas & Maes 1998; Budzik 2002).

Table 3.5 Weak notion of agent (adapted from Wooldridge & Jennings 1995)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy</td>
<td>Agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state.</td>
</tr>
<tr>
<td>Social ability</td>
<td>Agents interact with other agents (and possibly humans) via some kind of agent-communication language.</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Agents perceive their environment, (which may be the physical world, a user via a graphical user interface, a collection of other agents, the INTERNET, or perhaps all of these combined), and respond in a timely fashion to changes that occur in it.</td>
</tr>
<tr>
<td>Proactivity</td>
<td>Agents do not simply act in response to their environment, they are able to exhibit goal-directed behaviour by taking the initiative.</td>
</tr>
</tbody>
</table>
Table 3.6 Strong notion of agent (adapted from Wooldridge & Jennings 1995)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Agents are able to move around an electronic network.</td>
</tr>
<tr>
<td>Veracity</td>
<td>The assumption that an agent will not knowingly communicate false information.</td>
</tr>
<tr>
<td>Benevolence</td>
<td>The assumption that agents do not have conflicting goals, and that every agent will therefore always try to do what is asked of it.</td>
</tr>
<tr>
<td>Rationality</td>
<td>The assumption that an agent will act in order to achieve its goals, and will not act in such a way as to prevent its goals being achieved — at least insofar as its beliefs permit.</td>
</tr>
</tbody>
</table>

In this study, we use the term agent as intelligent software agent, or simply software agent. The definition of software agents is similar to Maes’s (1994) definition. Software agents are “software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in doing so, employ some knowledge or representation of the user’s goals or desires” (Maes 1994). Other synonyms of software agents are knowbots (i.e. knowledge-based robots), softbots (software robots), taskbots (task-based robots), userbots, robots, personal agents, autonomous agents and personal assistants (Nwana 1986).

Key characteristics of intelligent agents are (1) responsive – able to perceive their environment and respond in a timely fashion to changes that occur in it; (2) proactive – able to exhibit opportunistic, goal-directed behaviour and take the initiative where appropriate; (3) social – able to interact, when they deem appropriate, with other artificial agents and humans in order to complete their own problem solving and to help others with their activities (Jennings & Woolbridge 1996, 1998). In another word, agents allow us to delegate our work to the software agents, and thus simplify and reduce our workload. This helps reduce complexity and increase efficiency such as automating tasks, finding and filtering information, intelligently summarising complex data and providing explanations to data. Intelligent software agent is probably one of the latest developments that have potential for making great contributions to knowledge systems or intelligence systems (Sycara et al. 1996; Janca & Gilbert 1998).

Nwana (1996) proposes a typology of agents based on their mobility, functionality and attributes (Figure 3.3). Seven types of agents are classified: collaborative agents,
interface agents, mobile agents, information/Internet agents, reactive agents, hybrid agents and smart agents (Figure 3.4). Different types of software agents are deployed for different applications, such as systems and network management, mail messaging, business process management, electronic commerce and information management. For the purpose of this study, we will focus on Interface agents and Information (Internet) agents as they are found to be relevant and suitable for supporting executive intelligence activities.

3.6.2 Interface Agents
Interface agents emphasise autonomy and learning in order to perform tasks for their owners. The key metaphor underlying interface agents is that of a personal assistant who is collaborating with the user or other agents in the same working environment (Maes 1994). Lieberman (1997) defines an interface agent as a program that can...
affect the visual representations of physical or conceptual objects in a direct manipulation interface, as well as without explicit instructions from the user. Interface agents support and provide assistance through the following four ways of learning (see Figure 3.5): (1) by observing and imitating the user; (2) through receiving positive and negative feedback from the user; (3) by receiving explicit instructions from the user; (4) and by asking other agents for advice. Hence, an interface agent is also referred as learning agent. The goal is to provide customised assistant to individual users over a period of learning. The autonomy behaviour allows users to delegate tasks to the interface agents, thus reduce the workload of users. The learning behaviour causes the interface agents to adapt, over time, according to user's preferences and habits.

![Figure 3.5 Interface agents (adapted from Maes, 1994)](image)

With the current growth rate of interactive interfaces, the user interfaces will run out of functionality for direct-manipulation. Hence, Lieberman (1995, 1997) and his team in MIT believe that interface agents provide a solution in the increasing complexity of user interfaces and the tasks which they are applied. Lieberman et al. (2001)'s autonomous interface agents suggest the ability to look ahead in the user's information searching and scanning activities and act as an advance scout to save the user needless searching and recommend the best paths to follow. They called these agents reconnaissance agents. In
terms of information processing activities, interface agents can act as personal assistant in daily administrative tasks such as calendar scheduling, information browsing, information watching, news filtering, recommendation of information, etc.

3.6.3 Information Agents

With the vast amount of heterogeneous information sources and the increasingly availability of distributed information on the Internet, the impacts of information overload are manifold. Web indices and search bots, such as Lycos and Alta Vista have been used to find relevant information on the Internet. However, they do not behave pro-actively due to their one-shot answering mechanism providing a rather simple query language in terms of regular expressions of phrases and keywords. Researchers of software agents are looking into ways to improve current information acquisition and processing activities from distributed information sources. Information agents emerge as a major domain in intelligent software agent technology.

Information agent (sometimes referred as Internet agent) is defined as “an autonomous, computational software entity (an intelligent agent) that has access to one or more, heterogeneous and geographically distributed information sources, and which pro-actively acquires, mediates, and maintains relevant information on behalf of users or other agents, preferably just in time” (Klusch 2001, p. 340). The goal of information agent is to perform the role of managing, manipulating or collating information from one or many different information sources through advanced information acquisition and retrieval in databases (Nwana 1996; Klusch 2001) (see Figure 3.6). It is found that information agent is relatively similar to interface agent. There is a significant degree of overlap. For instance, many of the software agents built at the MIT Media Labs are deployed in web-based environment, e.g. Letizia (Lieberman 1995, 1997).
Klusch (2001) argues that an information agent is supposed to satisfy one or more of the following requirements:

- **Information acquisition and management** – The agent is capable of providing transparent access to one or many heterogeneous information sources. It extracts, monitors, filters, analyses and updates relevant information on behalf of its users or other agents. The acquisition of information includes advanced information retrieval from both internal and external distributed information.

- **Information synthesis and presentation** – The agent is able to filter and refine heterogeneous data and to provide unified, multi-dimensional views on relevant information to the user.

- **Intelligent user assistance** – The agent can dynamically adapt to changes in user preferences, the information and network environment as well. It provides intelligent, interactive assistance for users. This is similar to interface agents that aim to increase user’s awareness based on its personal information needs.

As information agents are able meet the above requirements, they can assist users in information scanning and monitoring, extracting and filtering, manipulating and interpreting, recommendation and notification.
3.6.4 Approaches for Building Software Agents

The common approaches for building software agents are identified in the following:

- **User programming**

  User programming, or end user programming is a PBE (Programming by example) generated programme that allows user to manipulate information on the graphical user interface (GUI) level (Repenning & Perrone 2000). Such programming allows customised personal information processing. However, this approach demands user's insight and effort. The agent needs to be programmed explicitly by its user so that information processing in relation to a particular task can be carried out. In this case, a user has to recognise opportunity for employing an agent, take initiative to build the agent and endow it with explicit knowledge (Klusch 2001).

- **Knowledge engineering**

  Knowledge engineering provides methods and tools for building knowledge models in a systematic and controllable way. The notion of ontologies and problem-solving methods provide the backbone for constructing structured and reusable knowledge models (Studer et al. 2003). Problem-solving methods allow a more direct control of the reasoning process by making the implicit control knowledge more explicit (Benjamins & Fensel 1998). Ontology is a formal, explicit specification of a shared conceptualisation (Studer et al. 2003). Ontology is becoming widespread in fields such as intelligent information and reasoning services, natural language processing and knowledge representation. The main challenge with knowledge engineering approach is that it requires substantial efforts from knowledge engineers to encode implicit control knowledge using complex algorithms. As a result, the agent has to be highly user-specific as well as domain-specific with relatively fixed representation of knowledge (Klusch 2001).

- **Machine learning**

  Machine learning is a computational approach for making computer systems able to adapt and learn from their experience. It involves highly repetitive and different behaviours from different users in order for the agents to adapt to individual user preferences and behaviours (Klusch 2001). Langley and Simon (1995) describe and review five basic learning paradigms in machine learning approach. The five
basic learning paradigms consist of neural networks, instance-based or case-based learning, genetic algorithms, rule induction and analytic learning. In general, neural networks emphasise on analogies to neurobiology, case-based learning focus on human memory, genetic algorithms on evolution, rule induction on heuristic search, and analytic methods explore reasoning in formal logic. Adaptation of the agent to user preferences and behaviours allow customisation or personalisation in information gathering and processing.

3.7 Applications of software agents for intelligent information processing activities

Many software agents have been developed or are currently under development in academic and commercial research labs, but they are yet to be deployed in the real world (Nwana 1996; Wooldridge & Jennings 1998; Wooldridge & Ciancarini 2001; Wooldridge & Dunne 2005). Examples of software agents in relation to intelligent information processing support and enhancement are depicted in Table 3.7.

<table>
<thead>
<tr>
<th>Software Agents</th>
<th>Applications</th>
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</table>
| **Letizia** (Liebermann 1995, 1997; Lieberman et al. 2001) | ▪ An interface agent that consists of a keyword and heuristic-based search agent that assists in web browsing.  
▪ Letizia conducts a breadth-first search concurrently for other useful locations that the user may be interested in, by guessing the user's intentions via inferring from his/her browsing behaviour.  
▪ Letizia will then recommend some other useful serendipitous locations to the user. |
| **Remembrance Agents** (Rhodes & Starner 1996) | ▪ An interface agent that is memory-based, in which it recommends continuously and unobtrusively invaluable documents, emails or files to the user.  
▪ The agent proactively carries out keyword search and retrieve relevant documents for users by observing user's information behaviour. |
| **Amalthaea** (Moukas & Maes 1998) | ▪ A multiagent ecosystem that consists of information agents, like filtering agents and discovery agents.  
▪ The goal is to assist users in coping with information overload in the WWW.  
▪ Amalthaes tries to identify potential sites of interest to the user based on a model of his or her interests.  
▪ Amalthaes learns the user's interests and habits using... |
machine learning techniques, maintains its competence by adapting to the user’s interests which may change over time while at the same time exploring new domains that may be of interest to the user.

**Let’s Browse**  
(Lieberman et al. 1999)
- An extension to Letizia’s interface agent that allows a group to collaboratively browse together.
- The job is to recommend pages likely to be of interest to the group.
- Let’s Browse also features a visualization of the recommendation process.

**ExpertFinder**  
(Vivacqua & Lieberman 2000)
- An interface agent that assists with the problem of finding another user who is knowledgeable to answer a question or solve a problem.
- An agent that automatically classifies both novice and expert knowledge by autonomously analysing documents created in the course of routine work.
- When a user requests help it tries to match the help request with the user who has the most appropriate experience.

**Watson**  
(Budzik et al. 2002)
- A proactive information agent that proactively retrieves documents from online repositories that are potentially useful to the user in the context of a task.
- The goal is to improve user’s awareness of resources available to them, while minimising the effort required to discover them.
- When a user performs a task, the agent translates documents in an application into an abstract document representation. Watson analyses the document representation to automatically form queries to online repositories, which then retrieve potentially useful information for user’s action.

**121**  
(Budzik et al. 2002)
- An extension of Watson’s information agent that builds communities of practice on the fly, based on the work that its users do, so that users with similar goals and interests can discover each other and communicate both synchronously and asynchronously.
- A system that aimed at fostering opportunistic communication among users viewing or manipulating content on the Web and in productivity applications.

The notion and applications of software agents provide a great opportunity for developing agent-based systems that support executive intelligence activities. Software agents, like Remembrance Agents (Rhodes & Starner 1996), Letizia (Liebmann 1995, 1997; Liebermann et al. 2001) and Let’s Browse (Lieberman et al. 1999) adopt a strategy that is midway between the conventional perspectives of information retrieval and information filtering, in which efficient information search and process is achieved through a closed-loop process that involves evaluation and modification either through the user’s explicit relevance feedback or the implicit
relevance feedback from the system itself. Here, software agents gather implicit relevance feedback automatically and unobtrusively by monitoring or observing user’s information processing behaviour, thus, initiate and perform both retrieval and filtering behaviour autonomously. Hence, software agents offer the potential to automatically scan the distributed heterogeneous environment and proactively search information that best match a user profile learned through implicit relevance feedback. In many ways, information acquisition becomes more intelligent as software agents are capable to look ahead in the user’s information processing activities and act as an advance scout to save the user needless searching and recommend the best paths too follow.

Adaptive information agents, like Amalthaea (Moukas & Maes 1997) learn the user’s interests and habits using machine learning techniques, maintains its competence by adapting to the user’s interests which may change over time while at the same time scanning new domains that may be of interest to the user. The software agent can learn by itself, as well as learning from multiple agents. Learning among multiple agents may be collective, which means that the agents adapt themselves in order to improve the benefits of the system (Klusch 2001). Here, software agents offer the potential to personalise information acquisition through intelligent information filtering, and, to deal with uncertain, incomplete and ambiguous information through intelligent information refining. Hence, information synthesis that consists of information filtering and information refining can be intelligently supported and enhanced by software agents. In this case, software agents perform the information filtering process according to specific user’s interests identified and learned over a period of time. And, software agents perform the information refining process through learning from multiple agents.

Proactive information agents, like Watson (Budzik et al. 2002) and I2I (Budzik et al. 2002) proactively and automatically retrieve potentially useful information from online repositories to recommend to users in the context of the work they are doing. The goal is to foster an awareness of the relevant information resources available to users. In this case, software agents must be able to reason about the contents of a document in the right context in order to provide helpful recommendation. For examples, the meaning of the information, the reasons for advising a particular course
of action, and the justification for a particular piece of information. Using knowledge engineering, software agents offer the potential to make the implicit control knowledge more explicit. In this case, information interpretation could possibly be achieved through intelligent explanation and reasoning services, natural language processing and knowledge representation. However, the software agent has to be highly user-specific, as well as domain-specific with relatively fixed representation of knowledge because it requires substantial efforts from knowledge engineers to encode implicit control knowledge using complex algorithms (Klusch 2001).

Hitherto, many software agent applications are yet to be deployed in real applications due to the following challenges (Nwana 1996; Wooldridge & Jennings 1998; Wooldridge & Ciancarini 2001; Wooldridge & Dunne 2005):

- The identification of appropriate techniques for the development of useful software agents. Software agents are still very much limited by the current state of the art in machine intelligence.
- The development of software agents is too diverse. Researchers tend to suggest agent-based solution through what they seem fit in accordance to their own respective definitions and approaches.
- The ability to demonstrate that the knowledge learned with software agents can truly be used to help users and reduce users’ workload in a specific context and domain. Most of the conceptual architectures of agents are generic solutions that can be used for different range of applications.
- The infantry stage of software agents suggests that users do not actually have a clear vision of how agents can be deployed to assist them. This also leads to the acceptance of users in terms of using and trusting software agents to perform the tasks on behalf of them.
- The ability of software agents to negotiate with other peer agents. Software agents tend to be distributed by their very nature, working and collaborating with other agents under a multi-agent environment.

Although software agents and their applications are still in the early stage of development, they will advance increasingly as research and development in software agents have been mushrooming across different fields, such as intelligent information gathering and processing, personalised information acquisition and knowledge sharing.
3.8 Preceding Conceptual Development of Agent-based Frameworks for Intelligent Information Processing

The following section describes some of the preceding non-empirical studies on conceptual development of agent-based frameworks for intelligent information processing activities. These frameworks are reviewed to see whether they are relevant and appropriate for supporting executive intelligence activities.

3.8.1 Chi and Turban’s (1995) DIEIS Framework

Chi and Turban (1995) proposed a conceptual model framework for distributed intelligent executive information systems (DIEIS), as depicted in Figure 3.7. In the DIEIS framework, a decentralised group of agents cooperatively attempt to provide a solution to a complex problem through a coordinator. The DIEIS comprise seven independent but closely-related subsystems: Knowledge Processing Agents, knowledge bases (a case base, a rule base and a database), Knowledge Creating or Collecting Agents, user interface, multimedia agent, the environment and the coordinator.

The responsibilities of Knowledge Processing Agents (e.g. database management systems (DBMS), inductive reasoning agents, computational agents, deductive reasoning agents) are to retrieve and organise data from the knowledge and databases and refine them. The refined data is then sent to the presentation mechanism for executives. The user interface serves as a dialogue system for information input and output. If no existing knowledge is available, Knowledge Creating or Collecting Agents are triggered to gather information from the internal and external environments via environment scanning agents, learning agents and email agents. The coordinator is the focal point of DIEIS, it regulates all the activities among agents by checking the meta knowledge stored in the index.
Chi and Turban’s (1995) conceptual framework of DIEIS provides a brief representation of what software agents can possibly contribute to executive intelligence activities. Knowledge Creating or Collecting Agents are appropriate for information acquisition as they scan and search information from internal and external environment. Knowledge Processing Agents are fitting for information synthesis as they filter and refine information to match the knowledge bases, which represent the user profiles in the system. Although Chi and Turban’s (1995) use the terms, knowledge processing and knowledge creating or collecting, the model is rather considered as an improved information retrieval system. Basically, the model provides more alternatives for information retrieval, such as DBMS, computational agents, Email agents, etc. Their framework is based on the distributed problem solving approach that uses the concept of task sharing and result sharing. The autonomous and goal-directed behaviour of software agents are not clearly demonstrated in the framework.

Moukas and Maes (1998) propose a multi-agent architecture framework that assists user in coping with information overload in the WWW, as illustrated in Figure 3.8. The framework comprises the information filtering agents and information discovery agents. The information filtering agents are responsible for the personalisation of the information and for adapting to the user’s interests. The information discovery agents are responsible for information resources handling, gathering the actual information that the user is interested in. The text processing mechanism extracts keywords from the retrieved document and produces a keyword vector. The user gives feedback through a credit allocation mechanism that converts the rating into credit.

The above model is relatively similar to the notion of information retrieval and information filtering as proposed by Belkin and Croft (1992). Information Discover Agents perform the information acquisition process by scanning and searching information from the distributed information sources. Information Filtering Agents are responsible for information filtering as to extract information that matches user’s
interests. Information Discover Agents and Information Filtering Agents are relevant in supporting executive intelligence activities. However, the model requires users to explicitly rate the document in order to improve the clusters of interests of the user profiles. There is a lack of implicit learning mechanism of agents that are capable of responding and adapting to the changes of information needs and interests implicitly, without the explicit feedback from user.

3.8.3 Liu's (1998a,b) Agent-based Framework for Strategic Scanning and Interpretation
Liu (1998a,b) proposes a conceptual agent-based support framework that continuously engage in three types of activities: locating and choosing information sources, scanning and interpretation of relevant information, diagnosis of strategic issues and managing of the strategic issue agenda. Three types of agents are identified in the framework, as depicted in Figure 3.9: the information resource agent (IRA), the field intelligent agent (FIA), and the strategic issue attendant (SIA). The IRA is responsible for managing the sources of information, ensuring a match between user’s information needs and the available sources. The FIA is responsible for domain-specific scanning, analysing and interpretation of information. The SIA is responsible for capturing strategic issues, creating and maintaining sets of issue profiles, an issue repository, and a dynamic strategic issue agenda.
The User

IRA

SIA

FIA

The above model provides conceptual insight on agent-based support for information scanning and interpretation. The IRA evaluates information sources received and matches them with user's information needs. In tracking and probing specific issues, the SIA identifies new strategic issues and alerts managers to these issues. FIA continuously search for and sense signals and messages from the environment. The model focuses rather on the general way of information scanning and interpretation, little insights are found on how software agents learn, adapt and make sense of information. In addition, information filtering is only briefly discussed in this model. The strategic information process seems to skip the filtering and refining process of information that are critical for the retrieval of potentially relevant and targeted information. Nevertheless, the alert function in strategic issue attendant (SIA) suggests implication for information interpretation in executive intelligence activities.

3.8.4 Shaw et al.'s (2002) Agent-based Architecture for Intelligent Information Retrieval

Shaw and his team (2002) propose a general architecture for an intelligent retrieval system with distributed heterogeneous data sources. The architecture consists of five
software agents, data sources, and a user profile base, as illustrated in Figure 3.10. Five software agents are intelligent user information agent (IUIA), query enhancing agent (QEA), searching and routing agent (SRA), filtering agent (FA), and analysis and synthesis agent (ASA). The user profile base (UPB) is a knowledge base of user profiles so that the information retrieval is carried out in the right context. The feedbacks from the agents help populate the knowledge bases of the system in order to enhance the learning capabilities.

Figure 3.10 General architecture for an intelligent retrieval system with distributed heterogeneous data sources (adapted from Shaw et al. 2002)
With the proliferation of distributed heterogeneous information sources, this architecture contributes to knowledge in information retrieval system. The multi-agent architecture is potentially capable of providing autonomous and continuous information processing activities, such as searching, filtering, analysing and synthesising. The architecture suggests that the user profile base is the nerve centre of this intelligent retrieval system. Feedbacks from agents are essential in order to build and update knowledge bases and user profiles. This architecture can contribute knowledge in supporting executive intelligence activities. This architecture suggests that information acquisition and information synthesis can be supported by multi-agents, however, there is no evidence on how information interpretation can be supported by agents.

3.8.5 Implications From Preceding Conceptual Development of Agent-based Frameworks

The above agent-based frameworks or architectures suggest that the use of multiple software agents is key to building comprehensive intelligent systems for supporting executive intelligence activities. The collaborative efforts of multiple software agents can manage the complicated information process better and thus enable the processing of more complicated information. In fact, many executive tasks comprise various aspects of problem domains which can not be supported by a single software agent (Chi & Turban 1995). Multiple software agents are potential for supporting executive intelligence activities, like improving information scanning, synthesis and interpretation, and building knowledge-based user profiles.

A knowledge base of holistic user profiles is critical for building an agent-based system for supporting executive intelligence activities. The user profile can consist of executive’s personal profile, executive’s information needs and interests, executive roles, and organisational environment profile. The user profile can be built up explicitly through user’s feedback, or implicitly through monitoring and observing user’s information process behaviour. The user profiles enable software agents to perform domain-specific acquisition, synthesis and interpretation of information. As a result, information processing becomes more personalised to the executive. The
profile can also be used by software agents to predict user's needs thereby learning to take action proactively and autonomously.

A learning mechanism is important for building an agent-based support system, in which software agents are able to learn a user's preferences and habits over time, and adapt to the changing needs and interests of the user. Learning and adaptation can occur in individual software agents or among multiple software agents. A single software agent can learn by feedback, analogy and discovery (Klusch 1999). The popular technique is user relevance feedback, which can be done explicitly or implicitly. The feedback received will then be used to update the user profile. Learning among multiple software agents is collaborative, whereby the software agents adapt themselves in order to improve the benefits of the system. In other words, agents learn from agents. In an open and distributed information environment, an agent-based support system must be capable of coping the dynamic change of information.

The literature review and previous empirical studies of EIS and relevant software agents help to lay the foundation and direction for empirical studies. The next section outlines the research questions for empirical studies on executive intelligence activities and the adoption of software agents for supporting executive intelligence activities.
3.9 Empirical Research Questions

From the theoretical literature and prior empirical review, empirical research questions for empirical studies on executive intelligence activities with intelligent agent-based support are proposed. The first three questions are designed for focus group study because the questions are devised for exploratory purpose. Questions 4 and 5 are designed to gain deeper insight through one to one interview study.

3.9.1 Current Executive's Information Environment and Information Processing Activities

Research question 1: *What are the challenges of today's executive information processing activities?*

The design of an agent-based system for supporting executive intelligence activities has to be able to cope with the challenges of current executive's information environment and information processing activities. Executive information has always been characterised as soft-oriented and mess-processing related. However, there is an increasing amount of electronic information and a considerable amount of soft information available in electronic and text-based documents. Executives are facing new challenges in handling vast amount of electronic information due to the increasing amount of distributed information and heterogeneous information sources. The nature of executive information is, therefore, becoming more uncertain as organisation environment continually and dynamically generates information for executives to process. If value-added information is defined in terms of its ability to reduce uncertainty (Daft & Macintosh 1981), insights on characteristics contribute to that uncertainty will be useful for developing value-added information systems. Firstly, the empirical study will aim to identify challenges faced by executives in their current information environment. Understanding characteristics that contribute to the uncertainty of executive information would be useful to examine the validity of the conventional views of EIS purpose, functions and design guidelines, as well as suggest useful insights for improving EIS design and development.

Challenges faced by executives in their current information environment also contribute to the uncertainty of executive information processing. With the increasing
uncertainty of executive information, executive information processing behaviour is more likely to be complex, dynamic and heterogeneous. Executive information processing behaviour refers to activities an executive may engage in searching, scanning, filtering, refining, interpreting and understanding information for decision making. Secondly, the empirical study will aim to identify challenges faced by executives in their current information processing activities. Similar as above, the findings of this empirical study would be useful to examine the validity of the conventional views of EIS purpose, functions and design guidelines, as well as suggest implications for improving EIS design and development.

3.9.2 Perception on Agent-based Support in EIS

**Research question 2:** *If software agents can play a part, to what extent do executives desires and expect software agents to contribute in their current information processing activities?*

Although software agents offer the potential to support information processing intelligently, executive criteria of agent-based support must be made known in order to develop a system that is considered useful for executives. Executive criteria refer to critical requirements for an agent-based support system based on executive’s desires and perceptions in judging the usefulness of the agent’s functions or attributes. Using focus group method, the study will explore executives’ perceptions on agent-based solutions for supporting executive intelligence activities.

One of the challenges for this research question is that the concept of software agents may be completely foreign to the executives. Executives may find it difficult to understand the concept and foresee the potential application of software agents. Demonstration of relevant software agent applications would be useful to show the executives what software agents can offer. However, most of the software agent applications for intelligent information processing are yet to be deployed in real applications. Hence, an interface prototype will need to be designed to serve as a representation of some of the basic attributes of software agents for intelligent information processing. The prototype will be used to support the collection of empirical data of executive criteria of agent-based EIS.
Based on the literature review and the preceding conceptual development of agent-based frameworks, an agent-based environment for supporting executive intelligence activities has to be a cost-effective solution that provides individual executive with fast, easy and personalised access to timely and relevant internal and external information that is critical and strategically important to the organisation. With the vast amount of distributed heterogeneous information sources, the integration of Internet technologies and software agents into the current EIS might offer a huge potential for supporting executive intelligence activities. Hence, a web-based interface prototype will be designed to support the selected empirical studies.

3.9.3 Executive’s Concern on The Assistance of Software Agents

Research question 3: What would be executives’ concerns if software agents act as their ‘personal assistant’ in their information processing activities?

Resistance to information systems is best attributed to the interaction between human and technology (Markus 1984). Despite the possibility and potential of building an intelligent agent-based EIS, executives who are going to use the system may resist it. It is crucial to find out executives’ concerns on the applications of software agents, in particular, their concerns on having software agents to autonomously and proactively act on their behalf. One challenge for this empirical study is that executives who have not used any agent-based related applications will find it difficult to understand the extent of assistance that software agents can offer, as well as to foresee the drawbacks of software agents. Nevertheless, the empirical study will serve as an initial exploration on executives’ concern over the adoption of software agents in supporting executive intelligence activities.

3.9.4 Factors that Influence Executive’s Information Processing Behaviour

Research question 4: How do current executives collect and process their strategic information?

Executive works are characterised by brevity, variety and discontinuity, hence executives tend to seek current, trigger and speculative information (Mintzberg 1973). Their information needs are difficult to determine due to the emerging, exclusivity and heterogeneous nature, in particular the visceral need and conscious need (Taylor 1968). It is, therefore, virtually not possible to identify explicit patterns of executive’s information processing behaviour. However, factors that influence executive’s
information processing behaviour are more likely to be identified. For example, knowing the ways executives search and process information will suggest common factors that influence their behaviour. This further empirical study will aim to gain deeper insights on factors that influence executive’s information processing behaviour through one-to-one interview. Understanding factors that influence executive’s information processing behaviour could provide implications of the additional and/or complementary support on executive intelligence activities.

3.9.5 Value-added Attributes and Processes of Agent-based Support in EIS

Research question 5: What would be the executive criteria of agent-based systems for supporting their information processing activities?

The further empirical study for this study is to gain deeper insights on value-added attributes and processes of software agents that are considered to be useful for supporting executive intelligence activities. Value-added attributes are functional requirements needed for an agent-based system to assist executives in information processing activities. Value-added processes are specific activities performed by agent-based system that add value (i.e. enhance) to the executive intelligence activities. The implications gained from the preceding conceptual development of agent-based frameworks suggest that multiple software agents are useful to execute autonomous and continuous functions that intelligently help senior executives search, acquire, refine and process information from the business environment. The construction of user profile is critical for performing personalized and domain-specific acquisition, synthesis and interpretation of information. And, the learning mechanism is important for building an agent-based system for managing the dynamic change of information needs and interests through learning and adaptation.

The further empirical study will aim to gain deeper insights on value-added attributes and processes of software agents in the processes of information acquisition, information synthesis and information interpretation. The findings will suggest an agent-based EIS design model for supporting executive intelligence activities.

The next chapter outlines the research methodology employed for the empirical studies of this research. Focus group study and semi-structured interviews are the key research methods in this study.
Chapter 4

Research Methodology

4.1 Introduction

The research methodology for this study is described in this chapter. Firstly, Section 4.2 presents the general issues on research methodologies and philosophy in research. Secondly, Section 4.3 reviews research methods employed in IS research, followed by reviewing prior empirical studies of EIS. Thirdly, Section 4.4 outlines the methodological setting for this study. Section 4.5 describes the design of interface prototype that assists empirical data collection. Section 4.6 outlines the qualitative research method of focus group study for initial empirical data collection. Section 4.7 presents the semi-structured interviews for further qualitative data collection. Lastly, Section 4.8 reflects on the research methodology employed in this study.
4.2 Research Methodologies and Philosophy

4.2.1 Research Methodologies
Research methodology can be classified in various ways. The most common distinction is between qualitative and quantitative methods. Quantitative research methods were originally developed in the natural sciences to study natural phenomena. Examples of quantitative methods are survey research, laboratory experiments, formal methods and numerical methods. Normally, quantitative data sources are questionnaires, structured interviews and published statistics. Qualitative research methods were developed in the social sciences to study social and cultural phenomena. Examples of qualitative methods are case study research, action research and ethnography. Normally, qualitative data sources include observation, interviews and personal experience.

In general, the motivation for doing qualitative research is that qualitative researchers can get closer to the participant’s perception through detailed interviewing and observation. In many cases, qualitative researchers are more likely to examine the constraints of the participant’s everyday social work, which direct their attention to specific scenarios or cases (Denzin & Lincoln 1994). In this case, qualitative researchers see this world in action and look for findings in it directly. Hence, qualitative research methods provide richer descriptions of the social world. However, in comparison to quantitative research methods, qualitative research methods lack controllability, deductibility, repeatability and generalisability (Lee 1989).

Much discussion has been made on the strengths and weaknesses of both quantitative and qualitative methods (Benbasat et al. 1987; Lee 1989; Gable 1994; Denzin & Lincoln 1994; Claver et al. 2000). Researchers often adopt either quantitative or qualitative research method, however, more and more researchers are suggesting the use of multiple methods, or triangulation, in order to secure an in-depth understanding of a phenomenon (Ragin 1987; Kaplan & Duchon 1988; Lee 1991; Gable 1994).

According to Myers (1997), there are other classifications of research methodology that are commonly made. For examples, Burrell and Morgan (1979)’s objective-
subjective dimension is classified as being concerned with the discovery of general laws (nomothetic) versus being concerned with the uniqueness of each particular situation (idiographic), as aimed at prediction and control (determinism) versus explanation and understanding (voluntarism), as taking an outsider (etic) versus taking an insider (emic) perspective, and so on. However, these distinctions are beyond the scope of this study.

4.2.2 Research Philosophy

All research methods, whether quantitative or qualitative, are based on some underlying or hidden assumptions that constitute the validity and reliability of research (Myers 1997). Guba and Lincoln (1994) suggest four paradigms based on ontological (what is there that can be known about?), epistemological (what is the nature of the relationship between the knower or would-be knower and what can be known?) and methodological (how can the inquirer go about finding out whatever he or she believes can be known?) assumptions: positivism, post-positivism, critical theory, and constructivism. Each paradigm provides unique attributes for different purposes of scientific inquiry. For examples, positivism aims to use valid and reliable methods to describe, predict, and control human behaviour through objectively designed and applied research (Plack 2005). Post-positivism aims to discover cause and effect relationships and to predict and control future behaviour on the basis of present behaviour (Guba & Lincoln 1994; Plack 2005). Critical theory aims to critique and affect change over time through reflection and action. Constructivism aims to understand how social reality and social phenomena are constructed.

Orlikowski and Baroudi (1991) suggest three paradigms based on the similar underlying assumptions: positivist, interpretive and critical. Their work is more relevant to this study as they look into the methodological and philosophical issues in IS research. Orlikowski and Baroudi (1991) and Goles and Hirschheim (2000) indicates that positivism dominates IS research while studies adopting other paradigms are relatively small in number. However, Walsham (1995) and Chen and Hirschheim (2004) argue that interpretive approach has gained increasing attention in IS research. Hence, positivism and interpretivism might better reflect IS research. Both paradigmatic approaches are compared and discussed here.
Ontologically, positivists believe that there is an objective reality out there in the world and can be described by measurable properties which are independent of human experiences while interpretivists emphasise the subjective meaning of the reality that is constructed and reconstructed through social interactions such as language, consciousness and shared meanings. Epistemologically, positivists are concerned with the hypothetic-deductive test of theories, with the attempt to seek verification and attain generalisation. Interpretivists, however, believe that the understanding of phenomena should be obtained through the human and social interaction. Methodologically, positivists employ formal propositions, quantifiable measures of variables, hypothesis testing and the drawing of inferences from samples to populations. The survey in quantitative method is a typical positivist instrument. Interpretivists, by contrast, do not predefine dependent and independent variables, but engage in the complexity of human and social interaction. Field studies are appropriate instrument for researchers to engage in the real social setting (Myers 1997; Orlikowski & Baroudi 1991; Chen & Hirschheim 2004). The distinctions between positivism and interpretivism are depicted in Table 4.1.

Table 4.1 Distinctions between positivism and interpretivism (adapted from Chen & Hirschheim 2004)

<table>
<thead>
<tr>
<th>Positivism</th>
<th>Interpretivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>The formulation of hypotheses, propositions, quantifiable measures of</td>
<td>No deterministic perspectives imposed by the researchers.</td>
</tr>
<tr>
<td>variables, models or casual relationships among variables.</td>
<td></td>
</tr>
<tr>
<td>The use of quantitative methods to test theories or hypotheses (although</td>
<td>The phenomena are examined with respect to cultural or contextual setting.</td>
</tr>
<tr>
<td>not always necessary).</td>
<td></td>
</tr>
<tr>
<td>Objective and value-free interpretation by researchers.</td>
<td>An analysis based on participants’ viewpoints.</td>
</tr>
</tbody>
</table>

It is important to take note that interpretive is not synonymous with qualitative. Qualitative research may or may not be interpretive, depending upon the underlying philosophical assumptions of the researcher (Myers 1997). In another word, qualitative research can be positivist, interpretive or critical. For example, case study research can
be positivist (Yin 1984; Benbasat et al. 1987), interpretive (Walsham 1995; Klein & Myers 1999) or critical. However, in some cases, the interpretive paradigm is ostensibly referred as qualitative research, and the positivist paradigm as quantitative research (Gable 1994).

4.3 Research Methods in Information Systems

The study of Information Systems (IS) or Management Information Systems (MIS) has evolved for more than three decades (Farhoomand & Dury 1999; Claver et al. 2000; Chen & Hirschheim 2004; Oates 2006). It seems that there has been a change of methodological and paradigmatic assumptions in the IS research community. Traditionally, quantitative research methods and positivist paradigm tend to dominate the field of IS (Kraemer 1991; Orlikowski & Baroudi 1991). However, qualitative research methods and interpretive paradigm have also become more popular in the IS field (Walsham 1995; Silverman 1998; Claver et al. 2000; Oates 2006).

From previous empirical examinations of IS research, Kraemer (1991) pointed out that survey research has been widely employed in the MIS field since 1979. Orlikowski and Baroudi (1991) conducted an empirical examinations of IS research’s paradigmatic and methodological assumptions. They examined 155 articles published between 1985 and 1989 in some of the prestigious IS journals, such as MIS Quarterly, Communications of the ACM, Management Science and Proceedings of the International Conferences on Information Systems (ICIS). Their findings indicated that the positivist paradigm significantly dominated the IS research community (96.8%) whereas the interpretivist paradigm constituted only 3.2%. There was no empirical research work that uses critical paradigm (0%). From the 96.8% of positivist paradigm, quantitative research methods such as survey research (49.1%) and laboratory experiments (27.1%) that aim for hypothetic-deductive testing and reasoning were the dominance. Qualitative research methods such as case studies only constituted 13.5%, with 0.6% action research. It is surprising to note that only 3.2% used mixed methods in IS research.

Farhoomand and Dury (1999) examined 2098 IS articles published in eight leading journals and the ICIS proceedings in the 12-year period between 1985 – 1996. Their
findings indicated that quantitative research methods are still the preference of the IS research community. Non-empirical studies that emphasises ideas and concepts constituted 39%, followed by survey research (32%), case study (17%), laboratory experiment (10%) and field experiment (2%). Claver et. al. (2000) investigated 1121 IS articles published in two leading journals in the 17-year period between 1981 – 1997. Their findings depicted that more empirical studies (68.7%) are conducted than the non-empirical studies (31.3%). However, they excluded survey research in their examination. Their findings depicted an increasing interest in qualitative research methods, with 21.2% case study, in comparison to quantitative research methods, such as field study (39%), laboratory experiment (7.5%) and field experiment (1%).

Chen and Hirschheim (2004) provide the latest analysis of paradigmatic and methodological assumptions in IS research. They extended the analysis of Orlikowski and Baroudi (1991) by examining 1893 articles published in eight leading IS journals outlets between 1991 and 2001. Their findings indicated that positivist research still dominates in IS research, with total 81%. In particular, US journals tend to be more positivist, quantitative, cross-sectional and survey oriented than European journals. Survey research is still the most widely used method (41%), but there is a significant growth in case studies (36%). This implies that IS researchers are becoming more interested in obtaining scientific knowledge in real world settings.

4.3.1 Research Methods in Executive Information Systems (EIS)

Empirical studies of EIS have been widely reported in the mid and late 1990s (see Table 4.2. Notably, positivist research dominates the study of EIS. Quantitative research methods, especially survey research are most widely used in the EIS community. The criteria for categorising research paradigmatic approaches, as depicted in Table 4.2 is based on Orlikowski and Baroudi’s (1991) and Walsham’s (1995) definitions. Positivist research consists of the indication of hypotheses, propositions, model formation, quantifiable measures of variables and the inferences drawn from samples to populations. Interpretive research comprise, first, articles that do not involve any positivist indicators as described, that is, no deterministic perspectives imposed by the researchers. Second, participants’ perspectives are taken as the primary sources of understanding and examining the phenomena. Third, the phenomena are investigated with respect to cultural or contextual circumstances.
<table>
<thead>
<tr>
<th>Researcher</th>
<th>Year</th>
<th>Research Method</th>
<th>Research Paradigm</th>
<th>Samples &amp; subjects</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watson, Rainer and Koh</td>
<td>1991</td>
<td>Survey</td>
<td>Positivist</td>
<td>112 usable responses</td>
<td>Current EIS practices, concerning the development, operation, support and capabilities.</td>
</tr>
<tr>
<td>Watson, Rainer and Frolick</td>
<td>1992</td>
<td>Survey</td>
<td>Positivist</td>
<td>68 usable responses from 300 firms listed in The University of Georgia's EIS database</td>
<td></td>
</tr>
<tr>
<td>Watson and Frolick</td>
<td>1993</td>
<td>Telephone survey &amp; questionnaire survey</td>
<td>Positivist</td>
<td>54 telephone interviews and 98 usable responses from survey</td>
<td>Ongoing study of current EIS practices</td>
</tr>
<tr>
<td>Leidner and Elam</td>
<td>1993</td>
<td>Survey</td>
<td>Positivist</td>
<td>46 usable responses received from senior managers in 23 firms</td>
<td>The effects of EIS use on executive decision making</td>
</tr>
<tr>
<td>Edwards and Peppard</td>
<td>1993</td>
<td>Case study</td>
<td>Interpretive</td>
<td>7 organisations that use EIS at the senior management level</td>
<td>Characteristics of EIS</td>
</tr>
<tr>
<td>Nord and Nord</td>
<td>1995</td>
<td>Survey</td>
<td>Positivist</td>
<td>152 usable responses</td>
<td>Usage of EIS, benefits of EIS, desired EIS characteristics</td>
</tr>
<tr>
<td>Watson et al.</td>
<td>1995</td>
<td>Survey</td>
<td>Positivist</td>
<td>43 firms with EIS in application</td>
<td>Critical success factors of EIS development, desired EIS functions or features, problems and failures of EIS development.</td>
</tr>
<tr>
<td>Stein</td>
<td>1995</td>
<td>Case study</td>
<td>Interpretive</td>
<td>2 Australian firms</td>
<td>EIS use in re-engineering executive work practices</td>
</tr>
<tr>
<td>Rainer and Watson</td>
<td>1995</td>
<td>Structured interviews, Survey</td>
<td>Positivist</td>
<td>48 persons comprised three constituencies (executive users, EIS professionals &amp; vendors and consultants); and 149</td>
<td>Keys to successful EIS development and ongoing operation.</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Year</td>
<td>Study Type</td>
<td>Methodology</td>
<td>Sample Size</td>
<td>Research Focus</td>
</tr>
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<td>---------------------------</td>
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</tr>
<tr>
<td>Young and Watson</td>
<td>1995</td>
<td>Survey</td>
<td>Positivist</td>
<td>128 usable responses</td>
<td>The relationship between EIS characteristics and executive acceptance, and the relationship between EIS support staff characteristics and executive acceptance.</td>
</tr>
<tr>
<td>Walstrom and Wilson</td>
<td>1997</td>
<td>Survey</td>
<td>Positivist</td>
<td>43 EIS users</td>
<td>Usage of EIS with regard to different EIS user types.</td>
</tr>
<tr>
<td>Rai and Bajwa</td>
<td>1997</td>
<td>Survey</td>
<td>Positivist</td>
<td>70 EIS-adopted companies, 210 usable responses</td>
<td>Current EIS Adoption in US organisations.</td>
</tr>
<tr>
<td>Vandenbosch and Huff</td>
<td>1997</td>
<td>Field study</td>
<td>Positivist</td>
<td>36 senior managers from 7 organisations that use EIS</td>
<td>The relationship between information retrieval behaviour and perceptions of organisational performance; and the relationships between information retrieval behaviour and individual differences, system characteristics, and organisational context.</td>
</tr>
<tr>
<td>Bajwa, Rai and Brennan</td>
<td>1998</td>
<td>Survey</td>
<td>Positivist</td>
<td>69 firms, 238 usable responses</td>
<td>The relationship between top management support, IS support, vendor/consultant support and EIS success.</td>
</tr>
<tr>
<td>Koh and Watson</td>
<td>1998</td>
<td>Case studies</td>
<td>Interpretive &amp; positivist</td>
<td>8 EIS managers</td>
<td>Issues in EIS data management</td>
</tr>
<tr>
<td>Singh et al.</td>
<td>2002</td>
<td>Survey</td>
<td>Positivist</td>
<td>51 EIS users</td>
<td>Support of EIS for the strategic management process</td>
</tr>
<tr>
<td>Salmeron</td>
<td>2002</td>
<td>Survey</td>
<td>Positivist</td>
<td>77 usable responses from 3 leading Spanish companies</td>
<td>Current situation of EIS in large Spanish businesses</td>
</tr>
<tr>
<td>Walters et al.</td>
<td>2003</td>
<td>Survey</td>
<td>Positivist</td>
<td>116 usable responses</td>
<td>EIS interface in SMEs</td>
</tr>
</tbody>
</table>
Positivist research in EIS study is widely used because it is generally considered more scientific, generalisable and reliable (Chen & Hirschheim 2004). It is also less time consuming than interpretive research (Walsham 1995). Survey research is considered the most popular research method in previous empirical studies of EIS. EIS researchers find it easier to gain feedback from senior managers through quantitative research methods, such as questionnaires than qualitative research methods, such as interviews or observation. The reason is that senior managers are less likely to commit their time for qualitative research due to their time constraints in different managerial roles. Even with survey research, EIS studies had used selective sampling methodologies primarily because EIS were in their infancy and only a small number of firms were believed to have an EIS in place (Leidner & Elam 1993; Watson et al. 1991; Watson & Frolick 1993; Watson et al. 1995; Walstrom & Wilson 1997). As a result, the sample size was relatively small in number. Most of the past EIS studies were hypothetical-deductive, where they used hypotheses or formal claims to test or prove, to elucidate causal relationships and even to provide descriptive statistics. The deductibility of survey research gives strengths in generalisability, but poor in discoverability (Gable 1994).

The interpretive research that addresses qualitative issues is rarely found in the past EIS studies. Only a few EIS studies that used case study and field study, as primary research methods in interpretive research. Although Walsham (1995) argued that there has been an increase of in-depth case studies which focus on human actions and interpretations surrounding the development and use of computer-based information systems, this is not the case in EIS study. The interpretive approach provides a better understanding of the social contexts and the social processes and the linkages between them. Thus, it provides the opportunity to ask penetrating questions and to capture the richness of organisational or individual behaviour, but the conclusion drawn may not be generalisable (Gable 1994). If executive works are characterised by brevity, variety and discontinuity (Mintzberg 1973) and executive information is soft-oriented and mess-processing related (Young 1987), the interpretive paradigm that employs qualitative research methods will be more appropriate to understand the perceptions of the executives who are to be involved with the system.
4.4 Methodological Setting for This Study

The aim of the research is to identify executive criteria of intelligent EIS design and development and to propose an agent-based design model for building intelligent EIS with agent-based solution. This study entails, first, the exploration of the current state of executive information and information processing behaviour in the light of Internet era. Second, this study involves the examination of executives’ perceptions on the adoption of software agents in EIS design and development.

Quantitative research, such as survey research is considered as not appropriate for an in-depth exploration and examination of executives’ behaviour and perceptions. Survey research is only suitable to produce quantitative descriptions of some aspects of a fraction of the study population through structured and predefined questions in order to generalise the findings to the entire population (Pinsonneault & Kraemer, 1993). This study is, however, focusing on specific target users who have specific and changeable needs and requirements of using EIS. Laboratory experiment and field experiment that involves examination of a phenomenon in a designed and controlled setting (laboratory-based) or in a real world setting (field-based) is likewise not appropriate as managerial works are characterised by brevity, variety and discontinuity and highly personal-oriented. Therefore, the positivist paradigm is not adopted in this study.

The main methodological setting of this study is based on the interpretivist paradigm that addresses qualitative issues. The empirical research is structured on a four-stage process, as illustrated in Figure 4.1. The research methods for this study comprise the focus group study and semi-structured interviews, in which the findings provide the primary data for this study (see Chapter 5 & 6).
Stage I: Literature Review
The first stage of research adopts the inductive approach that aims to induce appropriate questions for empirical studies. This stage reviews theoretical literature pertinent to executive intelligence activities and empirical literature on EIS studies and software agent applications. The aim is to generate research questions for empirical studies (refer Chapter 3, Section 3.10). The theoretical literature review outlines the notion of executive intelligence activities, and the need for supporting executive intelligence activities (refer Chapter 2, Section 2.9). The empirical literature review revisits the preceding empirical studies of EIS (refer Chapter 2, Section 3.5), and explores the potential of intelligent software agents for intelligent EIS design and development (refer
Chapter 3, Section 3.7, 3.8, 3.9). The review of theoretical literature and empirical literature lays the foundation and direction for empirical studies.

Stage II: Interface Prototype
In this stage, an interface prototype is designed to demonstrate some of the basic attributes of software agents for intelligent information processing. The concept of software agents is new and executives may find it difficult to grasp the concept of software agent application without a prototype. Hence, the interface prototype serves as a representation of some of the software agent attributes. The prototype is used to support the focus group study and semi-structured interviews in order to aid understanding, thus, generate more insights on executives’ perception on the design of agent-based EIS. It is not used for methodological setting, but methodological support. Therefore, this interface prototype is not built for technological implementation, evaluation or experimentation. The goal of this interface prototype is to help executives understand the concept of software agents and to stimulate executives’ thinking and imagination for further exploration. Section 4.5 describes the design of the prototype for this study.

Stage III: Focus Group Study
The first research method for the empirical study is focus group. Section 4.6 outlines the focus group design and analysis. The focus group study is chosen as an initial exploratory study into current state of executive information and information processing behaviour, followed by executives’ perception and concerns on agent-based solutions for supporting executive intelligence activities. The focus group study will be an inductive approach that aims to induce issues (themes) raised from the focus group discussion. The focus group is essentially a qualitative data gathering method that allows managers to freely express their thoughts and perceptions on the above exploratory issues in a permissive, non-threatening environment (Krueger 1994). The group synergy allows more issues or perceptions to be uncovered (Krueger 1994; Hines 2000). The focus group study aims: (1) to identify current executive’s information environment and information processing activities in order to examine the validity of the conventional views of EIS purpose, functions and design guidelines; (2) to gain useful insights for improving EIS design and
development; (3) to identify executive criteria of agent-based system for supporting executive intelligence activities; and (4) to understand executives’ concerns about the adoption of software agents. An initial agent-based EIS design model will be proposed for in-depth exploration in the semi-structured interviews.

Stage IV: Semi-structured Interviews

The second research method for empirical study is semi-structured interviews. Section 4.7 outlines the semi-structured interview design and analysis. The semi-structured interviews are used to gain deeper insight on how to better support executive intelligence activities with software agents. A semi-structured interview combines a structured agenda with the flexibility to ask subsequent questions. In a one-to-one semi-structured interview, open-ended questions provide the executive with the sense of control, as well as the possibility for the executive to elucidate his or her answer or introduce further relevant information, ideas and concepts that may not have been uncovered in the focus group. This interview aims: (1) to identify factors that influence executive’s information processing activities in order to provide implications of the additional and/ or complementary support on executive intelligence activities; and (2) to elucidate value-added attributes and processes needed for an agent-based EIS design model.

4.3.2 Design of Interface Prototype

An interface prototype was developed with Dreamweaver, Action Script Panel (ASP), and MySQL database. Dreamweaver is software used to build web pages, websites and Internet applications, developed by Macromedia. ASP is the advanced technology that supports the creation of dynamic web pages. ASP allows efficient processing and database connectivity. ASP was chosen because it is relatively easy for non-technical users even to programmers who have not had any prior knowledge of web development and Object-
4.5 Interface Prototype

4.5.1 Reasons of using Interface Prototype
Creating a prototype is a good way of communicating the ideas, improving feedback collection and exploring new concepts. Interface prototypes are representations of a design created to inform both design features and design process. They range from sketches to different kind of models at various levels — "looks like," "behaves like," "works like" — to explore and communicate propositions about the design and its context (Buchenau & Suri 2000).

Sullivan (1991) has used laboratory observation and focus groups in combination of an interface prototype for a usability study. Sullivan’s (1991) study aims to investigate users’ understanding of the system’s interface, accessibility and intuitiveness. The interface prototype also allows users to give feedback on the potential features for future development. Sullivan (1991) concludes that the need for complementarity is great in research methods. It increases the quality of feedback from users.

The applications of software agents are still in its infantry. A simple interface prototype that consists of representation of agent attributes can demonstrate how the software agents can support executive intelligence activities. The prototype will serve as a complementary tool to generate understanding and to stimulate executives’ thinking and imagination on agent-based solutions for supporting executive intelligence activities in the focus group study and semi-structured interviews.

4.5.2 Design of Interface Prototype
An interface prototype was designed with Dreamweaver, Active Server Pages (ASP) and MySQL database. Dreamweaver is software used to build and manage websites and Internet applications, developed by Macromedia. ASP is the Microsoft technology which supports the creation of dynamic web pages. ASP allows server-side processing and database connectivity. ASP was chosen because it is relatively easy language to learn, even to programmers who have not had any prior knowledge of web development and Object-
Oriented Programming. The key advantages of using ASP instead of CGI and Perl, are those of simplicity and speed. In this case, the interface prototype could be developed quickly and with low cost. A simple database is needed for the prototype in order to demonstrate how the software agents retrieve and process information intelligently. MySQL, an open source software was used for this purpose. MySQL is a fast, easy-to-use RDBMS (Relational Database Management System) used for databases on web-based environment.

Due to the nature of executive work, the interface prototype must be friendly and easy to use so that senior executive can quickly understand the features and access the benefits of the system without wasting a lot of time learning how to use it. It is beyond the scope of this study to use the prototype in an online setting with live data streams, hence, a rather limited data repository is built into MySQL database for demonstration. Since this prototype is not built for technological testing, evaluation and experimentation, it is less dynamic in its demonstration. Figure 4.2 – 4.5 show examples of screen shots of the prototype system that demonstrate agent-based support for executive intelligence activities.
Figure 4.2 Screen shot 1 of executive’s browsing and searching window

By default, the left-hand window is an environment for executive’s browsing and searching activities, as illustrated in Figure 4.2 – Screen Shot 1. The executive may browse in this window to scan and search for both internal and external information (Intranet and Internet). The information agents in the space of search engines and other tools for navigation of the web are rapidly expanding, the future trend toward browsing and search activities is potentially to be dynamic and personalised toward individual user’s interests and behaviour. For example, Alexa (http://www.alexa.com), the service behind Netscape’s “What’s Related”, tracks user-browsing history, and uses collaborative clustering and usage paths to recommend new pages. It performs to a certain level of intelligence as it provides information, news, and statistics about web sites and sites that are similar to the one users are currently viewing (see Figure 4.3 – Screen Shot 2).
This window also serves like an Enterprise Information Portal (EIP), where it provides a personalised workspace that integrates, aggregates, and presents data from multiple sources internal and external to the business, including the Web, newsfeeds, internal reports, data warehouses, images and file servers. However, current EIP components are still lacking the proactiveness of information provision, i.e. automatically tracks internal data and triggers user’s attention of critical data.

The right-hand window is the agent window. This agent environment performs its own browsing activity and sending signals and relevant news to the executive in a dynamic manner based on the past information search activities and pre-defined information needs in “user profiles”. This idea embodies a vision of a future in which busy executives do not
need to form a query to request information. However, executive also have the flexibility to express new information needs from time to time as his strategic concern changes over time. The executive would probably have the option to change the information description and store the relevant sites into his user profiles for future reference. The user profiles will be useful for agent to perform proactive tasks, i.e. sending out signal on new stimuli from particular site, or refining search findings by matching with previously stored information.

Here, executive can set up his personal agent through 'Agent setup', by predefining his information needs and requirements in simple natural language, as illustrated in Figure 4.4—Screen Shot 3. Scanning agent will continuously and autonomously scan and search data from multiple internal and external sources. Filtering agent will screen out irrelevant information and retrieve information that is potentially relevant to the executives. The concept here is very similar to what Lieberman and his team called, *reconnaissance agents*—program that look ahead in the user's browsing activities and act as an advance scout to save the user needless searching and recommend the best paths to follow (Lieberman et al. 2001). They are also acting like learning agents that infer user preferences and interests by tracking interactions between the user and the machine over the long term. In other words, the agent window acts like a personal assistant that triggers executive's attention to look at information that might be critical to executive's decision-making process.
In addition to the regular information provided by reconnaissance agents based on past executive information search behaviour, the interpretation agent intelligently analyses the information using case-based learning to understand the meaning or implication of information. Ideally, software agents are able to provide executive with relevant breaking news, give recommendations for further exploration, and alert executive of any incoming threats in a continuous and autonomous basis (see Figure 4.5 – Screen Shot 4). The executive is also able to give explicit feedback to the information agents through a rating system. Whenever the executive finds that the agents fail to provide concrete and sufficient
information, he can always give his comment to the agents in order to improve his user profiles (see Figure 4.6 – Screen Shot 5).
But Mr. Galliard added that carriers had been preparing for a possible conflict in the Gulf and a war, especially a short one, would be unlikely to cause much disruption to international air traffic.

British Airways said on Tuesday it was suspending all flights to and from Kuwait and Israel.

And Germany's biggest airline, Lufthansa, said it was considering measures to allow passengers who were nervous about travelling because of war to rebook or cancel their flights.

Survival measures

On Monday, United Airlines asked a US bankruptcy court to let it scrap existing labour contracts in order to get itself back on track.

United, the country's second largest carrier, also said it may have to ask all workers to accept a further 5% wage cut to offset the impact of a war against Iraq.

The credit ratings agency Moody's said it was considering downgrading two more US airlines - Delta and Northwest.

And American Airlines began formal negotiations with its major unions over pay and benefit cuts in order to try to save it from bankruptcy.

The battered aviation industry has shed about 400,000 jobs since September 2001.

**Note:** If my interpretation is incorrect, please provide your interpretation (in natural language).

The sales will be ...

---

Figure 4.6 Screen shot 5 of user’s explicit feedback
4.6 Focus Group Study

Although focus groups were originally used in marketing research, they have now widely been used in sociological research (Fontana & Frey 1994). Gloet (2002) used focus group interviews in the study of managerial implications of knowledge management and Hines (2000) used a focus group study to examine entrepreneurial decisions taken by owner-managers. Historically, the development of the focus group methodology is often attributed to Merton and his colleagues (Merton et al. 1956) in their investigation of people’s reactions to wartime propaganda. Merton coined the term ‘focused interview’ to apply to a situation in which the interviewer asks group members very specific questions about a topic after considerable research has been conducted. Today, group interviews are generically referred to “focus group” interviews, even though there are considerable differences in the nature and characteristics of group interviews. The distinguishing feature of the focus group and other group interviews is a discussion that is focused on a specific topic area where group dynamics help generate the data.

Krueger (1994, p.6) defines focus group as “a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non威胁ing environment”. Typically, a focus group is comprised of a moderator and a small group of participants. The moderator (facilitator) facilitates the participants through an hour or two hours discussion focused on a topic of interest to the researcher. Blumer (1969, p.41) indicates that “seeking participants ...who are acute observers and who are well informed .... A small number of such individuals brought together as a discussion and resource group, is more valuable many times over than any representative sample”. And Krueger (1994, pp.10-11) argues that “the focus group interview works because it taps into human tendencies. Attitudes and perceptions relating to concepts, products, services, or programmes are developed in part by interaction with other people. We are a product of our environment and are influenced by people around us .... Often the questions asked in a focused interview are deceptively simple. They are the kinds of questions an individual could answer in a couple of minutes. When questions are asked in a group environment and nourished by skillful probing, the results are candid portraits of customer (participant)
The focus group method seems to offer more advantages than other methods for obtaining perceptions and understandings on a specific area of interest. Nevertheless, the advantages and disadvantages of focus group are listed in Table 4.3.

Table 4.3 Advantages and disadvantages of focus group study

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Inexpensive as cost per respondent is less than with individual interviews</td>
<td>- The emerging group culture may interfere with individual expression</td>
</tr>
<tr>
<td>- Data enriching due to additional perspectives from other participants</td>
<td>- Dominance of particular group member</td>
</tr>
<tr>
<td>- Open-ended questioning format offers flexibility for wider and deeper issues</td>
<td>- Groupthink phenomenon</td>
</tr>
<tr>
<td>- Participants develop new topics in the course of interaction</td>
<td>- Flexibility in open-ended questioning can lead to an unfocused group discussion</td>
</tr>
<tr>
<td>- Stimulating to participants, synergism and snowballing in discussion</td>
<td>- Difficult to research sensitive issues</td>
</tr>
<tr>
<td>- Aids recall, i.e. audio, video</td>
<td>- Dependent on the skills of the moderator</td>
</tr>
<tr>
<td>- Cumulative and elaborative for greater understanding</td>
<td></td>
</tr>
<tr>
<td>- Peer interaction provides a social context for participant input that is lacking in individual interviews – group norms identification</td>
<td></td>
</tr>
<tr>
<td>- Highlights the participants’ attitudes, priorities, language and framework of understanding</td>
<td></td>
</tr>
</tbody>
</table>


The focus group study is chosen as an initial exploratory study to examine current state of executive information and information processing behaviour, followed by executives’ perception and concerns of agent-based solutions for supporting executive intelligence activities. This is due to: 1) Executives’ perceptions cannot be easily understood by external researchers through conventional survey research. 2) Managerial work (e.g. information processing) may be observed through action research or observational techniques, however, findings are inevitably limited to the individual executive. Focus
groups provide a forum for peer executives to speak out and to exchange views within the defined area, from which minimum consensus or differences can be attained.

4.6.1 Focus Group Design
A poorly designed and planned focus group can lead to an uncontrollable and unfocused group discussion. Focus group design should therefore take into consideration the following aspects: the development of the protocol for conducting the discussion, question design, group size, group composition and recording.

- **Focus Group Protocol**
The session starts with a brief introduction on the definition of focus group, the confidentiality of study, and ground rules for the discussion, e.g. role of moderator, one participant talks at a time, disagreement is welcomed. The research rationale and objectives are briefly introduced, followed by the concept of software agents and their applications. The interface prototype will then be demonstrated to participants to show the representation of agent attributes for supporting executive intelligence activities.

The objectives of the focus group are: (1) to identify current executive’s information environment and information processing activities in order to examine the validity of the conventional views of EIS purpose, functions and design guidelines; (2) to gain useful insights for improving EIS design and development; (3) to identify executive criteria of agent-based system for supporting executive intelligence activities; and (4) to understand executives’ concerns about the adoption of software agents.

- **Question Design**
Krueger (1994) suggests that focus group questions must move from the general to the specific, from less sensitive to more sensitive topics. Preferably, there is a series of introductory questions that acquaint participants with the topic and initiate conversation. Typically, two to five key questions that are central to the analysis are sufficient in a focus group study (Krueger & Casey 2000).
Based on the above objectives of the focus group, the following interview questions are posted to the participants:

1. In your opinion, what are the challenges of today's executive information processing activities?

2. If software agents can play a part, to what extent do you desire and expect software agents to contribute in your current information processing activities?

3. What would be your concerns if software agents act as your 'personal assistant' in your information processing activities?

- **Group Size**

Focus groups are generally comprised of six to ten participants (Morgan 1997). Krueger's (1994) experience suggests that five to eight participants provide an optimal balance of "air time" and logistical considerations for focus groups of adults. The moderator may find difficulty in facilitating larger group of participants due to too much competition for "air time" and the increasing number of potentially dominant participants.

Four focus groups discussion were conducted with a total of 41 middle towards top-level managers, who attended the Executive MBA (part time) at Luton Business School. The size of the focus group was between 7 to 16 persons per group. Table 4.4 shows the sample size and characteristics of focus group participants.

Table 4.4 Focus group sample size

<table>
<thead>
<tr>
<th>Focus Group</th>
<th>Sample Size</th>
<th>Management Level</th>
<th>Organisational's Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Strategie</td>
<td>Tactical</td>
</tr>
<tr>
<td>No 1</td>
<td>n=7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>No 2</td>
<td>n=8</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>No 3</td>
<td>n=16</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>No 4</td>
<td>n=10</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>n=41</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>39%</td>
<td>39%</td>
</tr>
</tbody>
</table>
**Group Composition**

Group homogeneity can affect the way participants express agreement and disagreement. Status differences may affect participants' responses or their willingness to respond constructively. Research shows that the focus group methodology requires that participants are relatively homogeneous, however, too much homogeneity can limit the range of perspectives or generate inaccurate results (Dreachslin 1999).

The participants for this focus group study are relatively homogeneous as all participants were attending the part time Executive MBA. Although participants came from different industry backgrounds, most of them are at managerial level and involved in some forms of executive intelligence activities (management level - 39% strategic & 39% tactical). Executive MBA part time students in Luton Business School were selected for three reasons: (1) participants are in the middle towards top-level managers, thus, involved in critical information processing activities; (2) it is unlikely to gather a group of managers for a focus group interview from the marketplace; (3) it saves time and cost for recruiting the participants.

**Recording**

Audiotaping and videotaping are generally used to record discussions in most focus groups. Some studies rely on the moderator or an observer to take notes. Although non-verbal cues can sometimes be key to communication intent, which will not be evident from an audiotape or notes taken during the discussions, videotaping is however obtrusive and usually not worth the effort according to Krueger (1994).

Audiotaping was used in this focus group study. In addition, field notes were taken by a colleague who serves as an observer and note-taker. The note-taker observed group interactions and summarised points and observations that were not captured by the audio tape. Participants were reminded at the beginning of the session to allow one participant talks at a time. Participants were also advised to speak audibly to ensure clarity of recording.
The Length

One to two hours is the common length for conducting focus group study (Krueger 1994; Morgan 1997). Two hours is found to be the maximum for focus group study as it is a physical and psychological limit for most people (Krueger & Casey 2000). The participants of the discussion session will dictate the length of the sessions based on the amount of information they have and their willingness to share. Hence, it depends on the nature of participants as successful focus groups have been conducted as short as one hour (Myers 1998).

In this study, the focus group was designed for 60 minutes to 75 minutes. However, all focus group sessions took between 45 minutes to 60 minutes to complete all questions. It was noticed that participants began to lose their thoughts and group synergy began to lessen after 45 minutes. The 45 minutes to 60 minutes length of the focus group sessions was sufficient in answering all the questions.

4.6.2 Roles of Moderator

The role of moderator or facilitator is also key to a successful focus group. Merton et al. (1956) specify three skills needed by the group interviewer. First, the interviewer must keep one person or a small coalition of persons from dominating the group; second, the interviewer must encourage recalcitrant respondents to participate; and third, the interviewer must obtain responses from the entire group to ensure the fullest possible coverage of the topic. Frey and Fontana (1994) add the importance of balance the directive interviewer role with the role of moderator in managing group dynamics, where the interviewer must simultaneously worry about the script of questions and be sensitive to the evolving patterns of group interaction. One distinctive and essential role of moderator in focus group is to guide discussion without controlling it, yet provide minimal response with occasional probing and no evaluation in order to amplify participants' comments (Krueger & Casey 2000). In this study, the moderator role is essential in guiding and providing occasional explanation of the new concept of software.
agents. The author who has adequate knowledge on software agents served as a moderator in this focus group study.

4.6.3 Focus Group Analysis

Catterall and Maclaran (1997) reveal a basic difference in the focus group data analysis between market researchers and social scientists. Generally, "market researchers adopt an holistic and interpretive approach to the data and this is accompanied by a dismissive and rather negative attitude to the employment of coding, numbers, counting, and computers to assist with analysis. Whereby, social scientists have a much more positive attitude to coding, cutting and pasting data, counting words or text segments, and using computers to assist with analysis" (Catterall & Maclaran 1997, p.3). Krueger (1994) offers four strategies for analysing focus group results, ranging from the least to the most time-intensive and cost-intensive: memory-based, note-based, tape-based, and transcript-based. Transcript-based is the most cost-intensive, in terms of both time and effort, but it is more comprehensive in capturing all data. Krueger (1994) estimates that transcript-based analysis for a hypothetical series of three focus groups requires 30-48 hours for transcript preparation and 30-48 hours for analysis, while note-based analysis is estimated to take 8-12 hours. Henderson (1995) identifies three competencies need by the focus group analyst: first, the ability to organise disparate information into categories; second, the ability to analyse key points that will support decision making; third, the ability to detach self from the findings and report negative findings as good data for decision making.

Gordon and Langmaid (1988) identify two approaches to the analysis of focus group data in market research. The large-sheet-of-paper approach, or the long-table approach (by Krueger & Casey 2000) is the equivalent of manual cut and paste of transcripts and involves breaking the transcripts down into text segments and allocating them under themes identified deductively and/or inductively. The key benefit of this approach is that each transcript is considered as a whole rather than as a set of discrete responses. The second approach is the annotating-the-scripts approach, that involves reading the transcripts (and/or listening to the audio tapes) and writing interpretive thoughts about the
data in the margins. This approach is a rapid approach and less rigorous for analysis. Computers have been used more recently in qualitative data analysis. Social scientists who employ focus groups have a much more positive attitude to coding, cutting and pasting data or text segments with the assistance of computers (Morgan 1993; Catterall & Maclaran 1997). Krueger and Casey (2000) suggest that focus group researchers can use as simple as the word processor to perform the long-table analysis, for example, using the cut and paste functions of word-processing programs to code quotes. Other more advanced qualitative analysis software packages are The Ethnograph (Seidel & Clark 1984), NUD*IST (Richards & Richards 1991), and NVivo (Richards 1999). These programs allow researchers to “nest” codes (themes) for analysis. More discussion on Nvivo qualitative software in Section 4.7.6.

All the discussion of this focus group study was transcribed verbatim for late analysis. The transcript-based strategy is adopted as it offers a comprehensive approach for analysis. A sample of the focus group transcript is enclosed in Appendix A.1

The organisation of raw data into structured, meaningful themes can be approached from two perspectives. A deductive analysis involves arranging quotes into a set of predetermined categories, whereas an inductive analysis allows the themes and categories to emerge from the data, rather being imposed before analysis (Patton 1990; Krane et al. 1997). The inductive analysis is adopted as this study aims to elicit themes and structure managers' descriptions of their perceptions of current executive information processing and expectations of agent-based solution for supporting executive information processing activities. The inductive analysis procedure began with familiarisation of raw data, listening to the discussions, reading each transcript several times, highlighting meaningful quotations, and making notes on the emergent themes.

The method of thematic qualitative analysis (TQA), similar to the long-table approach was used here for inductive analysis (Mason 2002). This method comprises of a two-stage procedure of the identification of themes, followed by a more detailed interpretive conceptual analysis. First of all, the generalised themes that emerged from the raw data
are categorised as first order themes. Themes emerged from the first order themes are then grouped and categorised as second order themes. In this study, raw data were organised and emerging themes were identified and categorised from the transcripts as first order themes or second order themes. The themes described and exemplified the managers’ experiences of current information processing activities and the perceptions of an agent-based solution for supporting executive intelligence activities. The themes inevitably bear some relation to the original impetus behind the main research questions that are drawn from theoretical literature and empirical reviews in Section 3.9.

Spreadsheet was used to group and regroup related themes. Spreadsheet allows cutting and pasting quotes, and organising and structuring easily into different range of cells and columns in accordance to themes. Qualitative software tools, e.g. NUD*IST, NVivo are not employed at this stage because the amount of raw data is manageable within the Spreadsheet. Emerging themes and related themes are organised into tree-structures (see example in Table 4.5, and a sample of the coding of themes is enclosed in Appendix A.2). Each structure illustrates how the analysis progressed from the initial quotes in the left-hand column, through each level of categorisation to the general dimension on the right-hand side. All tree-structures are manipulated until completeness checks of data groupings are fulfilled and a satisfactory result achieved. This process is called categorisation, "a process of funneling the data into relevant categories for analysis" (Dey 1993, p.42), whereby relationships and connections between data themes are identified.

Secondly, the conceptual analysis was conducted, in which meanings were sought from "between the lines" of the text of the transcripts and through reading and re-reading identifies consensus, dilemmas, and contradictions (Nicholas & Anderson, 2003). The aim of the conceptual analysis here is to explore the data in depth to identify the processes that underlie the discussions in the groups and to detect the meaning attributed to the content of the discussion by the respondents. Selected quotes are provided as to explore the meaning within the right contexts.
<table>
<thead>
<tr>
<th>Raw Data (example quotes)</th>
<th>First order themes (example)</th>
<th>Second order themes (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;... conventional searching gives you too much information, but not the right information.&quot;</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
</tr>
<tr>
<td>&quot;I am agreed with the information overload, the quantity of information pouring into my consciousness.&quot;</td>
<td>duplication of information sources</td>
<td></td>
</tr>
<tr>
<td>&quot;...there's plenty of super fluid material that is coming to me that there is no filter in between.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...you tend to see information on multiple locations.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;... information is put on the Intranet and send it to me again as email,&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the amount of different systems that provide information.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;The challenge is not so much to get information to the desk, but is actually to go and get it from the shop floor.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...you have to rely on people where the information comes from.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...difficult to identify sources of data.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the big issue is the different types of information.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...difficult to quantify information in an appropriate format.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;There's a real sort of balance of the context of information within the context of the organisation.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;It depends on whether they will actually tell you the context, justification where about the information are coming from.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;If I am looking for something, there might be in my head ten or eleven different words which mean the same thing.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the frustration of natural language through the experience of search engines.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Sometimes we rather spend all the time looking the information ourselves, information that is understandable to us.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the raw data needs to be processed in a meaningful way.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the value of information in terms of the truthfulness of information.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the information may be distorted when the requested information is not effectively communicated and collected.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Obviously, it's the availability of information.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...to meaningfully look at everything that is available.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...processing information through so that executives can have every single thing covered.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...most search engines on the Internet miss most of the sites.&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.6.4 Reliability and Validity of Focus Group Study

One of the main issues with regard to reliability is the effectiveness of transcription. To maintain acceptable levels of reliability, the focus group discussion should be recorded with the interviewees' permission. The discussion should then be transcribed as soon as possible by the researcher (Mishler 1986). In this study, the permission to audiotape participants' discussion was sought right at the beginning of the study. The confidentiality of the interview was stated to ensure reliability so that participants do not hesitate to discuss things freely (Dean & Whyte 1978). Participants were also reminded not to mention their name or company name in the course of giving their examples or personal experiences. The discussion was immediately transcribed and compared with the field notes taken by a colleague who served as an observer to ensure the reliability of transcription. A relatively small group is better for reliable results because it gives each participant more time to raise opinions and facts (Krueger 1994; Chioncel et al. 2003). Morgan (1997) suggests six to ten people are appropriate group size. Here, 3 out of 4 focus groups conducted in this study have less than 10 people.

Coding and interpreting data are inevitably time-consuming and complex. Coding data itself is not so difficult, but interpreting data is more challenging (Chioncel et al. 2003). Reliability in qualitative data analysis can be achieved through the use of multiple interpreters in order to reach the inter-subjective agreement between two coders for the same interviews (Kvale 1996). This reliability test is called inter-rater reliability analysis (Morse 1997). This is achieved in this study by extracting parts of the transcripts and sent for double blind interpretation. Two research colleagues who were in the same discipline of research were asked to code the first order themes in order to check the percentage of similar interpretation of quotes for the first order themes. 50 direct quotes from the first question of focus group were selected as a sample for this reliability test. This represented
nearly 50% of the 106 quotes from the first question. Two researchers independently read and re-read the selected quotes from the transcripts and allocated each individual quote into the index provided. The percentage of quotes that matches the second order themes is taken into consideration as it represents the final interpretation of raw data. 80 percent of quotes interpreted by the first colleague and 74 percent of quotes interpreted by the second colleague were similar to the author’s interpretation. A relatively high percentage of reliability has achieved even without the final level of agreement between two researchers. Carey et al. (1996) has used two coders for reliability test and the results showed that only 45% were coded with the same coding. Carey et al. (1996) asked the two coders to discuss and resolve their disagreements in order to recode for the second time. The results showed a substantial improvement with the level of agreement of 88.1%. The reliability test of qualitative data analysis is enclosed in Appendix A.3.

Validity in qualitative research is harder to ensure, given that transcriptions are a tool for interpreting the discussion rather than an analysis in themselves (Kvale 1996). Validity in focus group can be determined by the procedures of conducting the focus group (Krueger & Casey 2000). The focus group protocol (see Section 4.6.1) was developed to ensure the focus group procedures were clearly planned. Validity also requires that participants are competent to answer the research questions (Chioncel et al. 2003). Focus group questions were tested by fellow researchers and MBA part time students to ensure that they were understood. The participants of this study comprised Executive MBA part time students who have at least a number of years of working experiences and who are in the senior position. This ensures that they are competent to answer the questions. A number of logical factors are also important for the validity and reliability of the focus group research (Chioncel et al. 2003), for example, a clear time schedule to ensure all research questions are answered.

The methods of obtaining the transcripts needs to be set up properly so that the validity of the transcripts can be analysed. The best way is to use audio-taping rather than just notetaking, which is subsequently transcribed word for word (Chioncel et al. 2003). In some cases, video-taping can increase the validity because non-verbal communication is not
missed in the recording (Morgan 1997). For this focus group study, audio-taping is employed. The use of video-taping may cause participants to feel uncomfortable.

Johnson and Johnson (2000) argue that the ‘groupthink’ phenomena due to group polarisation or dominance and passivity of some participants can endanger the validity and reliability of the findings. It is important to recognize that the focus group dynamics can lead the discussion in completely new direction. In this case, the role of moderator is to ensure that, firstly, all participants engage in the discussion without having someone monopolise or control the discussion; and secondly, participants understand each question by giving occasional probing and clarification in order to steer the discussion in the right direction.
4.7 Semi-structured Interviews

4.7.1 Different Types of Interview

Interviewing is viewed as an art of sociological sociability, as it involves the study of interaction between people in view to try to understand our fellow human beings (Fontana & Frey 1994). Interviewing method ranges from individual interview to group interview, and from telephone interview to face-to-face interview. Interviewing can be structured, semi-structured and unstructured. An interview can be a one-time, brief conversation, or it can take place over multiple, lengthy sessions, sometimes even days (Fontana & Frey 1994). According to Gorden (1987), most researchers recognise interviews as social interactions, but the literature on interview strategy and techniques remains primarily concerned with maximising the flow of valid and reliable information while minimising distortions of what the respondent knows.

**Structured interview** refers to a situation in which an interviewer asks each respondent a preset of questions with a limited set of response categories (Fontana & Frey 1994). The interviewer controls the pace and dynamic of the interview by playing a neutral and passive role, never interjecting his or her opinions to the respondent’s answers. The respondent is also passive in giving his or her opinions outside the predetermined questions. There is very little flexibility, in which the interview must be conducted in a standardised and straightforward approach. Structured interview is often associated with survey research, which is often called survey interview. It is often used for deductive purpose, aiming to investigate a larger population for generalisability.

**Unstructured interview**, on the other hand, provides great flexibility for both interviewer and respondent. Unstructured interviews attempt to understand complex phenomena without preestablished categories or predetermined questions, but having clear idea on issues to explore. It is often used in parallel with participant observation. The goal of unstructured interview is understanding, rather than explaining (Fontana & Frey 1994). The notion of unstructured interview, or ethnographic interview is informal, non-directive and time-consuming. It also demands a higher commitment from
respondents because it often requires multiple sessions and days to complete an in-depth study. Douglas (1985) proposes a creative perspective for conducting unstructured interview. Creative interviewing is basically against the “how-to” ways to conduct interview, instead interviewers must adapt themselves to the ever-changing phenomena. This allows respondents to express themselves freely. It is largely based on “an understanding of friendly feelings and intimacy, to optimize cooperative, mutual disclosure and a creative search for mutual understanding” (Douglas 1985, p.25). Holstein and Gubrium (1995) argue that creative interviewing is rather emotional oriented. What Douglas does not recognise is that the active subject could constitute the source of experience in rational terms.

Semi-structured interview is defined as “an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena” (Kvale 1996, p.5-6). Semi-structured interviews use a series of predetermined themes of questions with allowance to certain level of flexibility of changing the questioning approach to suit specific context. A semi-structured or in-depth interview will be most appropriate for use where the questions are either complex or open-ended, and where the order and logic of questioning may need to be varied (Eastery-Smith et al. 2002; Jankowicz 2000). The semi-structured interview allows the respondent to contribute his or her own opinions, rather than responding to preset of questions with a limited set of response categories. In a semi-structured interview, open-ended questions provide the interviewer with greater flexibility and less restriction (Kadushin 1990). An open-ended question also allows the respondent to feel the sense of control, which is essential for key informants like senior managers.

4.7.2 The Use of the Semi-structure Interview

One of the key requirements of executive information system (EIS) is a personalised information processing and delivery solution. The design of an agent-based executive information support system require a thorough understanding of what managers want from the system and how the system should serve the individual manager. Managers are more likely to agree to be interviewed, rather than complete a questionnaire, especially
where the interview topic is seen to be interesting and relevant to their work (Saunders et al. 2003).

Executives who usually have time constraints, and are frequently interrupted and so are unlikely to commit to an unstructured interview. Since the audience are specifically targeted, a semi-structured interview is more appropriate to be used to obtain relevant feedback and offers the interviewer the opportunity to explore specific issues. As a semi-structured interview combines a highly structured agenda with the flexibility to ask subsequent questions, it gives freedom to explore issues in greater details through open-ended questions (Kadushin 1990). Semi-structured interviews also provide the possibility for the interviewee to introduce new ideas and concepts to areas that the interviewer may not have thought of during the question selection. More importantly, semi-structured interview provides the participant a sense of individuality as interviewee is given a sense of control and greater measure of freedom in expressing his ideas and viewpoints.

Besides the usability for exploratory purposes, the semi-structured interviews also useful for explanatory research. It can be used to confirm what is already known, and often the information obtained from the semi-structured interview will provide not just answers, but the reasons for the answers. Ambiguous topics and sensitive topics can be raised for clarification. Semi-structured interviews can sometime provide information about the interviewee’s feelings and more likely to provide information about the interviewee’s explanation of his attitudes and behaviours (Kadushin 1990).

In summary, semi-structured interviews are employed to gain deeper insights (explanatory) and to explore new or uncovered issues (exploratory) with regard to agent-based systems for supporting executive intelligence activities. Nevertheless, there are several guidelines to follow according to York (1998): (1) The interviewer must be aware of his own predispositions about the subject under study so that the interviewer does not focus only on personal views and interests. (2) It is necessary for the interviewer to clarify their notes so that there is little room for misinterpretation. (3) The interviewer should recognise themes that are prevalent
throughout the interview process. (4) The interview should engage in note taking skills so that analysis can be carried out in an accurate manner.

4.7.3 Sampling Decision and Selection

The study is for the purpose of discoverability and explanatory, rather than for the purpose of statistical generalisability. Hence, it is not a sampling research, whereby the sample should necessarily match the profile of the overall population under investigation. The sampling decision is decided to facilitate the research objectives.

In terms of qualitative interview research, Kvale (1996) notes that the emphasis should move towards more thorough analysis of data, rather than increased sample size. With no predetermined sample size, the use of what Seidman (1991) and Glaser and Strauss (1967) refer to as “saturation” will determine the overall sample size. Saturation happens when similar themes begin to re-emerge from interview respondents where little new is being identified by the researcher, and interview respondents are adding little or no value to the research. For this reason, the number of interview respondents does not need to be predetermined beforehand.

A good informant is one who has the knowledge and experience in the subject under study. Hence, the criteria for sample selection are senior managers in medium (50 to 249 employees) and large (over 250 employees) organizations in the finance, insurance, travel and estate industries. Senior managers are selected because they are key informants who participate in strategic intelligence activities. These industries are selected due to the higher reliance of information for strategic decision-making (Franke 1987). The primary objective for the interview is to gain deeper insights on individual executives’ perceptions towards adopting agent-based EIS for supporting executive intelligence activities. It is not to examine the research questions for the purpose of generalisability. For this reason, this study adopts maximum variety sampling, which is “the process of deliberately selecting a heterogeneous sample and observing commonalities in their experiences” (Morse 1994, p.229). With the differences of industries in the sample choice, this can
provide significant shared patterns of commonalities that exist among the senior executives.

The sample is taken from the FAME (Financial Analysis Made Easy) online database with the SIC(92) code of 65 – Financial Intermediation, except Insurance and Pension Funding; code 66 – Insurance and Pension Funding, except Compulsory Social Security; code 67 – Financial Auxiliary; code 63 – Travel; code 70 – Real Estate. Besides the general information such as location, numbers of employees and additional information such as financial performance, the FAME database provides information about directors, such as names, general positions and whether the directors are on the board of any other companies. An invitation letter was sent out to the sample choice, addressed by name to individual directors. A personalised invitation can increase the response rate. Individual letters on university letterhead were signed, instead of photocopied. Letters were sent out in batches according to sample groups from SIC code. Since this is not quantitative research, the response rate does not affect the validity of research as long as sufficient samples are acquired to reach the saturation in findings. A copy of invitation letter is enclosed in Appendix A.4.

4.7.4 Participants
Twenty five participants took part in the semi-structured interview. An overview of their details is presented in Table 4.6. All participants were in the managerial levels who were involved in strategic intelligence activities (80% of Senior Executive, 20% of Middle Executive). Title positions of senior executives consisted of Chief Executive Officer, Chief Operating Officer, Chief Information Officer, Chief Finance Officer, Managing Director, Vice President etc. Title positions of middle managers included Associate Director, Customer Centre Manager and Strategic Planning Manager. Most of the participants worked in the City of London, the financial hub of the UK. The average age was 45. The majority of participants (14, 64%) were proficient in their IT skills.

It is acknowledged that the study participants are not a representative sample of the general population of executives, and are thus not statistically significant. However, it is
argued that the set of participants matches the purposes of the study well, which is to gain deeper insights and to explore new or uncovered issues with regard to agent-based system for supporting executive intelligence activities. Hence, the findings are interpreted to provide implications and suggestions rather than as providing conclusive findings.

Table 4.6 Participants in the Semi-structured Interview

<table>
<thead>
<tr>
<th>No</th>
<th>Participant (nickname)</th>
<th>Position</th>
<th>IT Skills</th>
<th>Company Size</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adam</td>
<td>Deputy Managing Director</td>
<td>Proficient</td>
<td>250</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>Becky</td>
<td>Head of Corporate Governance</td>
<td>Proficient</td>
<td>12000</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>Chris</td>
<td>Director</td>
<td>-</td>
<td>100</td>
<td>53</td>
</tr>
<tr>
<td>4</td>
<td>David</td>
<td>Managing Director</td>
<td>-</td>
<td>400</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Eve</td>
<td>Chief Operating Officer</td>
<td>Proficient</td>
<td>130 (UK)</td>
<td>39</td>
</tr>
<tr>
<td>6</td>
<td>Ford</td>
<td>Service Director</td>
<td>Proficient</td>
<td>-</td>
<td>38</td>
</tr>
<tr>
<td>7</td>
<td>Gary</td>
<td>Chief Information Officer</td>
<td>Proficient</td>
<td>-</td>
<td>46</td>
</tr>
<tr>
<td>8</td>
<td>Henry</td>
<td>Associate Director</td>
<td>Proficient</td>
<td>-</td>
<td>42</td>
</tr>
<tr>
<td>9</td>
<td>Ian</td>
<td>Strategic Planning Manager</td>
<td>Novice</td>
<td>150</td>
<td>33</td>
</tr>
<tr>
<td>10</td>
<td>John</td>
<td>Managing Director</td>
<td>Proficient</td>
<td>420</td>
<td>44</td>
</tr>
<tr>
<td>11</td>
<td>Ken</td>
<td>Deputy Director</td>
<td>Advanced</td>
<td>100</td>
<td>55</td>
</tr>
<tr>
<td>12</td>
<td>Larry</td>
<td>Head of CEO</td>
<td>Proficient</td>
<td>1200</td>
<td>45</td>
</tr>
<tr>
<td>13</td>
<td>Mark</td>
<td>Trading Director</td>
<td>Proficient</td>
<td>400</td>
<td>40</td>
</tr>
<tr>
<td>14</td>
<td>Nelson</td>
<td>Customer Centre Manager</td>
<td>Advanced</td>
<td>150</td>
<td>37</td>
</tr>
<tr>
<td>15</td>
<td>Oscar</td>
<td>Chief Executive Officer</td>
<td>Proficient</td>
<td>2600</td>
<td>53</td>
</tr>
<tr>
<td>16</td>
<td>Peter</td>
<td>Chief Operating Officer</td>
<td>Advanced</td>
<td>1000</td>
<td>36</td>
</tr>
<tr>
<td>17</td>
<td>Quin</td>
<td>Business Development Director</td>
<td>Proficient</td>
<td>76</td>
<td>45</td>
</tr>
<tr>
<td>18</td>
<td>Robert</td>
<td>Vice President</td>
<td>Advanced</td>
<td>1900</td>
<td>57</td>
</tr>
<tr>
<td>19</td>
<td>Smith</td>
<td>Chief Finance Officer</td>
<td>Proficient</td>
<td>-</td>
<td>41</td>
</tr>
<tr>
<td>20</td>
<td>Tim</td>
<td>Middle Manager</td>
<td>Advanced</td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>21</td>
<td>Victor</td>
<td>General Manager of Group</td>
<td>Advanced</td>
<td>300</td>
<td>55</td>
</tr>
<tr>
<td>22</td>
<td>William</td>
<td>Operations &amp; Systems Director</td>
<td>Expert</td>
<td>1500</td>
<td>43</td>
</tr>
<tr>
<td>23</td>
<td>Xandra</td>
<td>Head of IT Strategy</td>
<td>Proficient</td>
<td>30000</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>Yann</td>
<td>Director</td>
<td>Proficient</td>
<td>200</td>
<td>48</td>
</tr>
<tr>
<td>25</td>
<td>Zach</td>
<td>External Relations Director</td>
<td>-</td>
<td>4000</td>
<td>52</td>
</tr>
</tbody>
</table>
4.7.5 Interview Process

The interview process for this study comprises five stages, as illustrated in Figure 4.7 (adopted from Kvale 1996).

- Thematising

Thematising refers to a conceptual clarification and a theoretical analysis of the theme investigated, and the formulation of interview questions (Kvale 1996). At this stage, the key concerns for planning an interview investigation are: (1) obtaining a preknowledge of the subject matter to be investigated (the what question); (2) clarifying the purpose of the study (the why question); and (3) deciding techniques of interviewing and analyzing in order to obtain the intended knowledge (the how question). The inductive approach of focus group study has provided the preknowledge for the semi-structured interview investigation. The focus group has elicited themes that describe current state of executive information and information processing behaviour and executives' expectations and concerns of agent-based solution for supporting executive information processing activities (see Chapter 5 for the elicited themes). In this case, the semi-structured interview aims to gain deeper insights on those preknowledge in order to identify value-added criteria for designing agent-based EIS system for supporting executive intelligence activities. The decision
on using semi-structured interview technique has been discussed in Section 4.7.2. The decision on interview analysis techniques will be discussed in Section 4.7.6 and Section 4.7.7.

- Designing

Designing stage consists of overall planning and preparation for obtaining the intended knowledge and meeting the intended purpose of study (Kvale 1996). This includes designing interview questions and procedures. With the intended knowledge and purpose of study in mind, the semi-structured aims to discuss the following broad topics with executives:

- How do current executives collect and process their strategic information?
- What would be the executive criteria of agent-based systems for supporting their information processing activities?

The above two discussion topics serve as thematic research questions to meet the following purposes of this study:

1. To identify factors that influence executive's information processing activities in order to provide implications of the additional and/or complementary support on executive intelligence activities.
2. To elucidate value-added attributes and processes needed for an agent-based EIS design model.

Table 4.7 depicts the translation of thematic research questions in strategic intelligence activities and support into interview questions to provide thematic knowledge and contribute dynamically to a natural conversational flow. Open-ended interview questions were carefully worded to ensure the executives interpret the questions correctly. Follow up questions and prompts were prepared and used to probe for more insights, as well as to provide occasional probing and explanation to executive. This is not to mean that the follow up questions and prompts merely coax the interviewees into preferred responses to the interview questions. Rather, they may help executives to articulate their thoughts much better without any misunderstanding.
or the lack of understanding. A copy of interview questions with follow ups and prompts is enclosed in Appendix A.5.

Table 4.7 Thematic Research Questions and Interview Questions

<table>
<thead>
<tr>
<th>Thematic Research Questions</th>
<th>Interview Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do current executives process their strategic information?</td>
<td>Thinking of strategic information that you use, can you tell me how it is collected and processed?</td>
</tr>
<tr>
<td></td>
<td>How do you scan and search for your strategic information?</td>
</tr>
<tr>
<td></td>
<td>How do you choose which information to be examined further?</td>
</tr>
<tr>
<td></td>
<td>How do you go about combining information from different sources?</td>
</tr>
<tr>
<td></td>
<td>How do you make sense of the significance of information?</td>
</tr>
<tr>
<td>What would be the executive criteria of agent-based systems for supporting their information processing activities?</td>
<td>In terms of scanning and searching capabilities, what would be the minimum criteria or requirements that you would set for the system for you to consider it to be useful?</td>
</tr>
<tr>
<td></td>
<td>Imagine you have an ideal software agent that assists you in information scanning and searching, how would your criteria or requirements differ?</td>
</tr>
<tr>
<td></td>
<td>In terms of filtering and refining capabilities, what would be the minimum criteria or requirements that you would set for the system for you to consider it to be useful?</td>
</tr>
<tr>
<td></td>
<td>Imagine you have an ideal software agent that assists you in information filtering and refining, how would your criteria or requirements differ?</td>
</tr>
<tr>
<td></td>
<td>In terms of interpretation capabilities, what would be the minimum criteria or requirements that you would set for the system for you to consider it to be useful?</td>
</tr>
<tr>
<td></td>
<td>Imagine you have an ideal software agent that assists you in information interpretation, how would your criteria or requirements differ?</td>
</tr>
</tbody>
</table>
Interview procedures are planned in such a way to make sure participants understand the purpose of the research, feel comfortable with the issue of confidentiality, answer all questions, and are appreciated by their participation and contribution. The demonstration of interface prototype is incorporated into the semi-structured interview, in order to shows the representations of agent attributes for supporting executive intelligence activities. The interview procedures can be summarised as below:

a) Thank participant for considering the request and agreeing the meeting
b) State the purpose of research
c) Reemphasise the right to confidentiality and anonymity – i.e. “nothing said by the participant would be attributed to her or him or their employing organisation without first seeking and obtaining permission.”
d) State the research contribution, i.e. what the research is intended to lead and what would happen to the data collected.
e) Ask permission for the use of digital audio recorder
f) Brief the participant the topics to be covered in the discussion
g) Start with simple open-ended questions
h) Demonstrate the interface prototype to the participant
i) Ask more interview questions
j) Asking for any other comments
k) Collect executive profiles through a simple interview form
l) Thank participant for his or her time

Basic demographic information was collected at the end of the interview (summarised in Table 4.6).

**Interviewing**

Each interview lasted about 45 minutes to 1 hour 15 minutes. All interviews (except one at home) were conducted in the workplace of the interviewee. All interviews were digitally recorded. Digital recorder has better quality reproduction than analogue tape recorder. Digital recorders generally have a much higher signal to noise ration (noise reduction), thus, reduces the risk of lost data and results in faster, less
expensive and more accurate transcription. The digital audio recording is an effective alternative to cataloguing, storing and managing (Maloney & Paolisso 2001). It is also easy and inexpensive to backup and archive digital audio files, and does not deteriorate with repeated use in comparison to audiotape recording. When listening to the transcripts, audio editing programme (supplied by the software vendor) allows better control over the adjustment of volume and noise level, as well as easy access to transcripts. However, the audio quality still depends on using a suitable external or built-in microphone.

Three pilot interviews were conducted internally with the senior managers in Luton Business School. The objectives of pilot interviews were three-fold: First, to improve the effectiveness of the questions with respect to wording and understanding. Second, to ensure the smooth flow of interview questions in conjunction with the demonstration of interface prototype. Third, to increase author's self confidence and establish effective communication with respondents. In many ways, the pilot interview serves as a validation tool.

- Transcribing

Atkinson and Heritage (1984) argued that the production and use of transcripts are "research activities" and should not be considered as merely a “technical detail” that precedes analysis. There is no universal transcription format for qualitative data gathering, however, some practical considerations can help researchers systematically organise and then analyse textual data, regardless of the analytical techniques used (Kvale 1996; McLellan et al. 2003). McLellan and colleagues (2003) suggest five practical considerations in terms of “how to settle on what is transcribed”, “how to manage the transcribed data most efficiently”, “how to handle confidential and sensitive information”, “how the transcript is systematically formatted” and “how to review transcripts for accuracy’.

The level of transcription should complement the level of the analysis (Drisko 1997). The analysis of this study focuses on exploring new knowledge and providing an in-
depth description of the preknowledge identified from the focus group. Thus, the
verbatim transcription was adopted for all interviews, where each interview was fully
transcribed in a verbatim account. For the interviews in this study, it took the author
about 5 to 6 hours to type verbatim an interview of 45 minutes. All transcripts were
typed and saved in Rich Text Format (.rtf) in MS Word. They were then exported to
computer-assisted software (NVivo) for analysis. One copy of an interview transcript
is enclosed in Appendix A.6.

- **Analysing**

Kvale (1996) outlines five main approaches to interview analysis: categorisation of
meaning, condensation of meaning, structuring of meaning through narratives,
interpretation of meaning, and generating meaning through ad hoc methods. In
summary, *Categorisation of meaning* implies that the transcripts are coded into
simple categories. The categories can be predetermined categories or newly emerging
categories from the analysis. It is a process of funneling the data into relevant
categories for analysis (Dey 1993). This approach is similar to the method of thematic
qualitative analysis (TQA), described and used in the focus group study (refer to
Section 4.6.3). The TQA method comprises of a two-stage procedure of the
identification of themes, followed by a more detailed interpretive conceptual analysis.
*Condensation of meaning* summarises the meanings expressed by the interviewees
into briefer statements in which the main sense and content is rephrased in a few
words. *Structuring of meaning through narratives* involves the temporal and social
organisation of a text to bring out its meaning. It focuses on the generation of a new
story or a coherent story. *Interpretation of meaning* goes beyond the structures and
relationships of a transcript, it goes deeper and more or less speculates interpretations
of the text. *Generating meaning through ad hoc methods* is the combination of
various approaches, including quantitative methods in order to bring out the meanings
of different parts of the material.

The choice of analytical approaches depends with the thematic questions set at the
start of the investigation and followed up through designing, interviewing and
transcribing (Kvale 1996). The thematic purpose of the semi-structured interview is to elucidate value-added attributes and processes needed for an agent-based EIS design model. The categorisation of meaning approach, which is similar to the thematic qualitative analysis (TQA) is adopted for the semi-structured interview analysis. The idea is to seek occurrence and non-occurrence of a phenomenon, for example, to explore the significance of the value-added attributes and functions for an agent-based EIS. Both deductive and inductive analysis are used for meaning categorisation. The deductive analysis allocates quotes into the predetermined categories identified through the focus group study. The inductive analysis adds new categories for newly identified issues that are relevant to the research questions. Both analyses began with familiarisation of raw data, reading each transcript several times, highlighting relevant and meaningful quotations, and making notes on the emergent themes. Qualitative analysis software was used to assist in analysis due to the high volume of raw data. More discussion on interview analysis is discussed in the following Section 4.7.6 and Section 4.7.7.

4.7.6 Using CAQDAS for Qualitative Data Analysis

Traditionally, qualitative researchers used index cards or shuffling cards, scissors, photocopies, coloured pencils or pens to analyse their qualitative data. Today, computer-aided qualitative data analysis software (CAQDAS) or as qualitative data analysis (QDA) software are employed for efficient handling, managing, searching and displaying data and related items like codes (Weitzman 2000; Seale 2000). Although it is sometimes argued that CAQDAS do not save time because of the learning time needed, the real gain of time is particularly worth it for more complex tasks and large amount of data (Weitzman & Miles 1995).

CAQDAS also increases the quality in qualitative research due to the consistency and extra rigour in analytic procedures (Weitzman 2000; Seale 2000). It can provide a more complex way of looking at the relationships in the data (Barry 1998). Although there is fear that the use of CAQDAS can lead to a mechanistic and quantitative approach to analysis (Dey 1993), the key advantage is that data management becomes easier with
CAQDAS. For examples, CAQDAS allows the definition of indexed quotes, the construction of electronic cross-references via ‘hyperlinks’, the storage of researchers’ comments (‘memos’), the use of variables and filers, the retrieval of quotes, as well as the retrieval of quantitative attributes (Kelle 2000). For the amount of raw data collected from the semi-structured interviews, CAQDAS packages were considered and used for better handling and management of data, as well as analysis.

The number of CAQDAS packages available continues to grow, ranging from general-purpose approaches, i.e. word processors, text retrieval programs, textbase managers, to special-purpose approaches, i.e. code-and-retrieve programs, code-based theory-builders and conceptual networking-builders (Weitzman & Miles 1995; Weitzman 2000; Seale 2000). Weitzman and Miles (1995) provide excellent software reviews and details of specific text preparation and formatting requirements of CAQDAS such as Atlas/ti, The Ethnograph, QSR N4 (classic NUD*IST), Kwalitan, MAX and MECA. QSR software (N6 and NVivo) and Atlas/ti are considered the main qualitative analysis software packages (Barry 1998).

Barry (1998) compares Atlas/ti and QSR (NUD*IST or N4) with regard to the structural design and the project complexity, and concludes that Atlas/ti is more appropriate for simple projects and researchers who prefer to work in a more complex software environment, while QSR software (NUD*IST) is more appropriate for researchers to work in a sequential structured style, particularly for complex projects. The QSR software packages offer a more structured organisation of quotes, coupled with sophisticated searching tool and project management function, i.e. annotation. Hence, QSR is considered for the qualitative data analysis of this study.

QSR software is generally regarded as being one of the more sophisticated qualitative analysis packages (Weitzman & Miles 1995) and is well used world-wide. It was developed by Richards and Richards (1991, 1994). There are now two distinct QSR software packages (NUD*IST and NVivo) but they are developed from one root and use the same underlying concepts – code-based theory building concept. Basically, QSR
software packages have evolved from NUD*IST 2 (N2) and N3 through N6 to NVivo. Both NUD*IST and NVivo create an environment in which researchers can create, manage and explore ideas and categories through coding. The codes are kept in the nodes. Nodes are the places where researcher stores ideas and categories. Hence, nodes can represent any categories, i.e. concepts, people, abstract ideas, places etc. Nodes can be kept without organisation as free nodes, or organised hierarchically in tree-like structure of coding. The software packages provide facilities for data management, for coding and retrieving text, and for theory testing.

NUD*IST 4 (N4) and NVivo were both attempted. NVivo was found more user-friendly than N4. NVivo provides a range of tools for handling rich text via the emergence of screen interfaces. It can directly import transcripts in rich text format, whereby texts are presented in different fonts and styles and sizes and colours (Richards 2002). NVivo allows character-based coding, where one can code exactly the text one wants to, and not just text-unit chunks, as in N4. NVivo also allows “edit-while-you-code”, that is the ability to edit already-coded documents in a project without invalidating the coding references. Multi-media data, e.g. pictures, audio files can also be presented in proxy documents. As a result, NVivo was employed for the interview data analysis.

4.7.7 Steps of Using NVivo in this Study
The interview data was analysed inductively and deductively with the following steps:

Step 1: Preparing textual data as documents
Transcripts in rich text format (.rtf) file from MS Word are imported to the Documents component in NVivo. Each document comprises the transcript of each interviewee. Documents can be browsed, managed and accessed by outline in the Document Explorer (see Figure 4.8).
Step 2: Creating nodes with predefined code scheme

The findings from focus group study provide the predefined code scheme for creating nodes in the Nodes component. Nodes are organised hierarchically in a tree-like structure of coding according to the thematic purpose (see Figure 4.9). In this study, for example, value-added attributes are nodes for usability design in an EIS design model, which entails ease of use, personalisation and controllability. Nodes are managed via the Node Explorer and can be flexibly altered, viewed, organised, combined or shifted, created and deleted.

Step 3: Coding data with the predefined code scheme or new coding

Each document (transcript) is browsed and analysed, relevant quotes are coded to the predefined code scheme (nodes). Newly emerging issues will be categorised as new nodes. Uncertain quotes will be kept as free nodes. For examples, any quotes that are related to personalisation attribute will be categorised under the ‘personalisation node’. A number of quotes stress on manageability issue, this attribute is related to usability criteria, hence, new node called ‘manageability’ is created under the usability criteria (see Figure 4.9). New issues, such as Intranet
application, that cannot be categorised into existing nodes will be placed under free nodes for later consideration.

Figure 4.9 Nodes in NVivo

**Step 4: Specifying attribute values for documents or nodes**

Information about documents, or text coded by nodes comprises attributes that describe about them. This information can be stored as descriptive coding, which can be used in seeking patterns and asking questions about the study. In this study, demographic information about interviewees provides attribute values for each document, such as age, IT skills, position and qualification (see Figure 4.10).

**Step 5: Writing and linking memos**

Thoughts and interpretation of quotes can be recorded as annotations or memos in NVivo. They can be placed as *DataLinks* like the hyperlinks in web browsers and advanced word processors. In this study, for instance, a memo is attached (*DocLinks*) to describe the ability to personalise according to the role of
executives is important in personalisation attribute. An annotation is attached (DataBites) to the memo itself to describe the meaning of role-related personalization (see Figure 4.11).

Figure 4.10 Attributes for documents in NVivo
The ability to personalise according to the role of executives is important. It would be very much about targeting the informal organisation. It will save a lot of time, effort system to target information at certain level. The middle manager.

Very much depend on individuals. Some managers say 'send me everything', some managers would be to me, I just want the flavour of what is going on should have personal way to enable how the system.

Figure 4.11 Linking memos in NVivo

Step 6: Examining quotes under the same nodes

Quotes that are extracted into nodes are examined thoroughly to consider the significant of themes, thus provide deeper insights and descriptions of categories or theories. In this study, for example, all the quotes that talk about current information processing activities are examined carefully and subcategories are identified and recoded as new nodes such as information sources, acquisition behaviour and processing behaviour (see Figure 4.12).
Step 7: Generating modeling

Models in NVivo provide visual representation of patterns and discoveries which researcher to see things more clearly. Models can have different icons for documents, nodes and attributes and their values. Textual commentary, including a model description can be included in the model. In this study, models are generated to provide preliminary insights of findings. For examples, a usability model that entails different attributes is able to indicate users’ overall perceptions of attributes, significance of attributes and relationship between attributes (see Figure 4.13). More discussion can be found in Chapter 6.
4.7.8 Reliability and Validity of Semi-structured Interview

Verification of knowledge is commonly discussed in the social sciences with regard to the concepts of reliability, validity and generalisability. The interview objective is to gain deeper insights on executives' perceptions towards adopting agent-based EIS in strategic intelligence activities. The research method is for the purpose of discoverability and explanatory, rather than for the purpose of statistical generalisability. Hence, the reliability and validity issues will be discussed based on the objectives of the semi-structured interviews.

Reliability refers to the degree of consistency of the research findings, in which instances are assigned to the same category by different observers or by the same observer on different occasions (Hammersley 1992). The key issues concerning reliability in interview research are the effectiveness of transcription and analysis. In terms of transcription reliability, it is similar to focus group transcription, as discussed earlier in Section 4.6.4. For instance, the interview should be transcribed as soon as possible by the
researcher (Mishler 1986). In this case, most of the interviews were transcribed immediately after each interview. They were digitally recorded and transcribed onto word processors using the same template, followed by exporting to NVivo for analysis. Kvale (1996) suggests that the same interview can be transcribed by two persons, and quantitatively check the number of words that differ between the two transcriptions to reduce transcription errors. However, listening to the interview records and reading the transcriptions for a number of times to familiarise with each interview would confirm the reliability of each interview in terms of identifying transcription errors. The verbatim transcription of each interview would also ensure the reliability (Silverman 2001).

In terms of analysis reliability, this is achieved through the inter-subjective agreement between two coders for the same interviews (Kvale 1996). The predefined code scheme derived from the focus group study has been tested in terms of its reliability by extracting parts of the transcripts and sent for double blind interpretation (see Section 4.6.4). As stated earlier, the interview research is built on the focus group findings for further investigation, thus, the categorisation of meaning approach in the interview analysis is likewise reliable in terms of the interpretation and coding of data.

Validity refers to the truth and correctness of a statement, or an account that represents the social phenomena (Kvale 1996). The idea of validity originated in quantitative research, hence validity in qualitative research is harder to ensure, given that transcriptions are a tool for interpreting the discussion rather than an analysis in themselves (Kvale 1996). According to Kvale (1996), validity in interview can be determined with regard to the adequacy of the interview design for the intended purpose of the study. The interview design that entails interview procedures was clearly planned in this study (refer to Section 4.7.5). Each interview was conducted by using the same procedures. These procedures make sure participants understood the purpose of the research, felt comfortable with the issue of confidentiality, answered all questions, and felt appreciated of their contribution. Three pilot interviews were conducted to ensure that the procedures are carried out smoothly with sufficient time to cover all the areas of investigation.
Validity also requires that participants are competent to answer the interview questions (Chioncel et al. 2003). The sampling choice is valid because all participants were in the managerial levels who were involved in strategic intelligence activities (80% of Senior Executive, 20% of Middle Executive). The majority of participants (14, 64%) were also proficient in their IT skills. This suggests that most of them were able to understand the concept of software agents support through the interface prototype demonstration. The pilot interviews were also used to check that participants understand the meaning of the questions and the interface prototype. Follow up questions and prompts are prepared to ensure right interpretation of interview questions.

In terms of validity analysis, this has to do with whether the interpretation of an interview text is valid and whether the logic of the interpretation is sound (Kvale 1996). Silverman (2001) suggests two forms of validation, especially appropriate to the logic of the interpretation. First, the combination or comparison of different kinds of data (e.g. quantitative and qualitative) and different methods (e.g. observation and interviews) to see whether they support one another. The use of multiple methods is called ‘triangulation’ (Denzin & Lincoln 1994). It attempts to secure an in-depth understanding of a phenomena, as well as serves as an alternative to validation. Second, the respondent validation, in which the findings are taken back to the subjects being studied. This can be achieved through revisiting respondents in order to seek responses and feedback. However, this method is not attempted due to the difficulty to gain access to senior executives again

The use of the focus group study and semi-structured interviews in this research provides the form of triangulation for validation purpose. The findings from semi-structured interview validate the focus group findings and vice versa. This provides validity to the research. For example, if the results from the interview and focus group were conflicting with one another, the research is considered not valid. The semi-structured interviews are used to gain deeper insights on focus group’s findings, and to explore new issues that have not been covered in the focus group study. In this case, most of the findings in the semi-structured interview confirm the findings in the focus group study. The focus group’s findings suggest an agent-based EIS design model for in-depth exploration in the semi-
structured interviews. Semi-structured interviews then elucidate value-added attributes and processes needed for an agent-based EIS design model.

4.8 Reflections on the Research Methodology

The generalisability issue is reflected in this study. Very often, quantitative and qualitative researchers have restricted themselves to just one particular notion of generalisability, which is the statistical, sampling-based notion of generalisability. The statistical, sampling-based conception of generalisability remains widely and inappropriately used in nonstatistical, nonsampling research associated with top IS journals and conferences (Lee & Baskerville 2003). Yin (1984, 1994) distinguishes the statistical notion of generalisability as Level-1 inference, a process of generalising from a sample to population characteristics or from experimental subjects to experimental findings. Yin (1984, 1994) describes another form of generalisation that generalises from the population characteristics to theory or from the experimental findings to theory. Yin (1984, 1994) refers this as Level-2 inference, for example, generalising from case study findings to theory. Likewise, Walsham (1995) argues that researchers can generalise from the facts through observation or the rich description of a case to concepts, theory, specific implications or rich insight. Lee and Baskerville (2003) outline a framework that shows that generalisation can occur in four ways: From empirical statements to other empirical statements, from empirical statements to theoretical statements, from theoretical statements to empirical statements, and from theoretical statements to other theoretical statements. Therefore, criticisms that case studies and qualitative studies are not generalisable would be inappropriate.

This study shows that generalisation can achieve from empirical statements to theoretical statements. This involves generalising measurement, observation or other description to a theory (Lee & Baskerville 2003). In this case, the empirical descriptions serving as inputs to the process of generalising consists of sample that represents the population characteristics of senior executives in the UK, who are rich information participants and
key informants who participate in executive intelligence activities. The resulting theoretical statement would be a theoretical agent-based design model for supporting executive intelligence activities. In other words, this study generalises from the qualitative methods of focus group study and semi-structured interviews to some useful implications and insights of executive intelligence activities support.

In conclusion, the chosen methodology was appropriate to the study of executive intelligence activities. As the review of literature indicated, executive intelligence activities are influenced by the heterogeneity of managerial roles, information needs and information processing behaviour. Quantitative research will be difficult to explore in-depth issues which focus on human actions and perceptions surrounding the development of advanced computer-based support systems. However, both the focus group study and semi-structured interviews adopted in this study are able to provide an interpretive paradigm to address qualitative issues on executives’ information processing behaviour and perceptions on agent-based EIS for supporting executive intelligence activities.

The transcription work in a verbatim account was inevitably time-consuming for both focus groups and interviews. However, the trade-off was that the analysis and interpretation of data became easier. Relevant quotes can easily be extracted for analysis and the conceptual analysis of data can be conducted, where meanings can be found between the lines of the whole transcripts. Similarly, the use of NVivo required a significant time to learn and understand. However, once the author became familiar with the software, the coding and interpretation process became much easier.

The next two chapters will outline the findings of focus group study and semi-structured interviews in details, followed by discussion and implications for this research.
Chapter 5

Focus Group Study

5.1 Introduction

This chapter reports and discusses the findings of the focus groups study. An overview of the focus group study method is presented in Section 5.2. Section 5.3 to Section 5.5 provides detailed findings of each respective question of focus group. Section 5.6 discusses the findings and suggests implications of the study. Section 5.7 proposes an initial agent-based EIS design model for further examination. Lastly, conclusion is drawn in Section 5.8.

5.2 Overview of Focus Group Method

The focus group study is chosen as an initial exploratory study into current state of executive information and information processing behaviour, followed by executives' perception and concerns on agent-based solutions for supporting executive intelligence activities. The focus group study aims: (1) to identify current executive's information environment and information processing activities in order to examine the validity of the conventional views of EIS purpose, functions and design guidelines; (2) to gain useful insights for improving EIS design and development; (3) to identify executive criteria of
agent-based system for supporting executive intelligence activities; and (4) to understand executives’ concerns about the adoption of software agents.

Based on the above objectives of the focus group, the following interview questions were posted to the participants: (1) In your opinion, what are the challenges of today’s executive information processing activities? (2) If software agents can play a part, to what extent do you desire and expect software agents to contribute in your current information processing activities? (3) What would be your concerns if software agents act as your ‘personal assistant’ in your information processing activities?

Four focus groups discussion were conducted with a total of 41 middle towards top-level managers, who attended the Executive MBA (part time) at Luton Business School. The size of the focus group was between 7 to 16 persons per group. Each session begins with a brief statement on the purpose of the focus group, the confidentiality and ground rules for the discussion, the demonstration of interface prototype and the discussion questions. An interface prototype is designed to demonstrate some of the attributes of software agents. The purpose is to aid understanding, thus, generate more insights on executives’ perception on the design of agent-bases EIS.

All focus group sessions took between 45 minutes to 60 minutes to complete all questions. All the discussions were tape recorded and transcribed verbatim for later analysis. Analysing raw data follows two steps: firstly, organising raw data into structured, meaningful themes according predefined or newly emerging themes and categories (Dey 1993). Secondly, using thematic qualitative analysis (TQA) (Nicholas & Anderson 2003) to conduct a detailed interpretive conceptual analysis and mapping. Meanings were sought from the transcripts to identify consensus, dilemmas, and contradictions.

The method of thematic qualitative analysis (TQA) was used here for analysis (Mason 2002). This method comprises of a two-stage procedure of the identification and categorisation of themes, followed by a more detailed interpretive conceptual analysis.
Spreadsheet was used to group and regroup emerging and related themes into tree-structures. Meanings were sought from "between the lines" of the text of the transcripts and through reading and re-reading identifies consensus, dilemmas, and contradictions (Nicholas & Anderson 2003). Selected quotes are provided as to explore the meaning within the right contexts. The following Section 5.3, 5.4, and 5.5 outlines the themes that emerge from the raw data, as well as selected quotes for discussion.

5.3 Findings: Current Executive’s Information Environment and Information Processing Activities

This section reports findings on the "what" issues pertinent to current executive’s information environment and information processing activities. In total, eight themes emerged from four focus group study that pose challenges to conventional EIS underpinnings. Four themes revealed the characteristics of current executive information that lead to the challenges of EIS design and development. Another four themes revealed the characteristics of executive’s information processing behaviour that also pose challenges to EIS design and development. Emerging themes and related themes are organised into tree-structures, as illustrated in Table 5.1 and Table 5.2.

5.3.1 Characteristics of Executive Information

The following findings provide selected quotes that confirm the themes emerged from the focus group study. Four final themes emerged as characteristics of current executive information: over-abundance of information, heterogeneity of information attributes, ambiguous value of information, and diverse use of information. Table 5.1 depicts sample of direct quotes from the focus group study.
Table 5.1 Sample supporting evidence (direct quotes) on characteristics of executive information

<table>
<thead>
<tr>
<th>Raw Data (example quotes)</th>
<th>First order themes</th>
<th>Second order themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;... conventional searching gives you too much information, but not the right information.&quot;</td>
<td>sheer volume of information</td>
<td>Over-abundance of information</td>
</tr>
<tr>
<td>&quot;I am agreed with the information overload, the quantity of information pouring into my consciousness.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...there's plenty of super fluid material that is coming to me that there is no filter in between.&quot;</td>
<td>duplication of information sources</td>
<td></td>
</tr>
<tr>
<td>you tend to see information on multiple locations.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;... information is put on the Intranet and send it to me again as email.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the amount of different systems that provide information.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;The challenge is not so much to get information to the desk, but is actually to go and get it from the shop floor.&quot;</td>
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<tr>
<td>&quot;...you have to rely on people where the information comes from.&quot;</td>
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<td></td>
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<tr>
<td>&quot;... difficult to identify sources of data.&quot;</td>
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<tr>
<td>&quot;... the big issue is the different types of information.&quot;</td>
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<tr>
<td>&quot;...you have to be careful of those information that are fall on fact and those that are fall on opinion.&quot;</td>
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<tr>
<td>&quot;There's a real sort of balance of the context of information within the context of the organisation.&quot;</td>
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<tr>
<td>&quot;It depends on whether they will actually tell you the context, justification of where about the information are coming from.&quot;</td>
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<td></td>
</tr>
<tr>
<td>&quot;If I am looking for something, there might be in my head ten or eleven different words which mean the same thing.&quot;</td>
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<td></td>
</tr>
<tr>
<td>&quot;...the frustration of natural language through the experience of search engines.&quot;</td>
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<td></td>
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<tr>
<td>&quot;Sometimes we rather spend all the time looking the information ourselves, information that is understandable to us.&quot;</td>
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<td></td>
</tr>
<tr>
<td>&quot;...the raw data needs to be processed in a meaningful way.&quot;</td>
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<td></td>
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<tr>
<td>&quot;...the value of information in terms of the truthfulness of information.&quot;</td>
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<td></td>
</tr>
<tr>
<td>&quot;...the information may be distorted when the requested information is not effectively communicated and collected.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Obviously, it's the availability of information.&quot;</td>
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</tr>
<tr>
<td>&quot;...to meaningfully look at everything that is available.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;... processing information through so that executives can have every single thing covered.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...most search engines on the Internet miss most of the sites.&quot;</td>
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<tr>
<td></td>
<td>sources of information</td>
<td>Heterogeneity of information attributes</td>
</tr>
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<td></td>
<td>types of information</td>
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<td>context of information</td>
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<td></td>
<td>semantic of information</td>
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<td></td>
<td>credibility of information</td>
<td>Ambiguous value of information</td>
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<td>reliability of information</td>
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<td></td>
<td>availability of information</td>
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<td></td>
<td>scalability of information</td>
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</tbody>
</table>
Over-abundance of information
Focus group participants complained that they have suffered the over-abundance of information due to the vast amount of information and the duplication of information sources. They are getting the same information from different sources. A few managers quoted that,

"From my perspective, it is the sheer volume now, the number of sources you have to refer to, filtering that down to get something meaningful out of it ... you tend to see things now on multiple locations." [FG1 – First Focus Group]

"One of the other challenging activities is the amount of different systems that provide information." [FG2 – Second Focus Group]

"... there's plenty of super fluid material that is going to me that there is no filter in between ..." [FG3 – Third Focus Group]

Heterogeneity of information attributes
In addition to the vast amount of information and the duplication of information sources, managers emphasise that the amount of information sources and types they received is a problem, rather than a benefit. Participants expressed the different sources and types of information they could possibly cope. A manager expressed that,

"... now you see it on the newspaper, on the Web, and on the report you get, so you are wasting time reading things three four times from different sources." [FG1]
The soft information that entails opinion is a concern to one manager. A participant stressed,

"I think also you have to be careful of those that are based on fact and those that are based on opinion." [FG3]

Managers' information sources are difficult to identify, as suggested by a manager. This may be because managers deal with a variety of events and conduct a number of activities simultaneously. However, executives perceived personal sources or human sources as useful information sources. A manager commented that,

"I think that the challenges of executives today is not so much to get information to the desk, but is actually to go and get it from the shop floor level ... I would say go and talk to people." [FG2]

Participants also recognised the importance of having the right context of information. To them, contextual information is associated with the semantic aspect of language. Participants expressed their frustration over the limitation of using natural language in current search engines. A few participants raised the risk of missing out information caused by the different contextual meanings of different words used in search engines. For example, a manager said,

"If I am looking for something in my business, they might be in my head ten or eleven different words, which mean the same thing. But in various filter to get them, I have to put all those in. And then I might be missing something, because somebody else might call it something else." [FG1]

**Ambiguous value of information**

According to participants, the value of information seems to be ambiguous. Different participants raised the different issues with regard to the value of information. To them, the value of information is associated with the credibility, reliability, availability and
scalability of information. Information is considered credible when it is relevant, meaningful and understandable to the users. Example of comments were:

"The raw data needs to be processed in a meaningful way. ...I think the challenge is to make sure that it conveys your meaning ..." [FG4]

"Sometimes we rather spend the time looking the information ourselves, information that is understandable to us." [FG2]

Information is perceived as reliable when no corruption and distortion is found in the data. According to one participant,

"...the value of information in terms of whether it's the truthful information that come across, or it's someone's perception of information or any deception as well; because you know that it could be somebody maliciously bring something into the system just to cause corruption and separation within organisation." [FG1]

The availability of information refers to the ability to gain access to both internal and external sources. Participant was frustrated when the information needed is not available for processing. For example, one manager expressed that,

"Information is not made available. For example, I know this information is there, is sitting there somewhere. When my associate searches for it, it doesn't show up." [FG3]

Participants would also like to have a full coverage of all information needed. An incomplete information is perceived as a problem in the information gathering. Some comments were:

"...passing information through, processing information through so that they can have every single thing covered." [FG3]
Diverse use of information

The diverse use of information is another challenge in current executive information. Participants were concerned on the way the information is stored and structured for future reference. Often, participants faced the difficulty to retrieve information. It is evident from the following statement:

"In regards to information processing, is also where you place that information once you have it. I think sometimes when you're talking to executives, they know they got some information somewhere, but they haven't managed the way to put that information, and they can't find it again very quickly." [FG1]

The same issue with the way the information is reported. The information should be reported in the appropriate format according to the individual executive. One manager stressed that,

"...needs to deposit the information in a way that is produced for the executive ... the information for the executive is going to be concise." [FG1]

5.3.2 Characteristics of Executive's Information Processing Behaviour

The following findings provide selected quotes that confirm the themes emerged from the focus group study. Four final themes emerged as characteristics of executive’s information processing behaviour: heterogeneity of executive attributes and roles, heterogeneity of information processing behaviour, dilemma of information reduction and constraints of time. Table 5.2 depicts sample of direct quotes from the focus group study.
Table 5.2 Sample supporting evidence (direct quotes) on characteristics of executive’s information processing behaviour

<table>
<thead>
<tr>
<th>Raw Data (example quotes)</th>
<th>First order themes</th>
<th>Second order themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Good executives would have a good team around them, well-organised, and seek feedback themselves in the shop floor.&quot;</td>
<td>executive attributes</td>
<td>Heterogeneity of executive attributes &amp; roles</td>
</tr>
<tr>
<td>&quot;...poor executives being somebody not organised, not very good in time management, needs facilities to help them out.&quot;</td>
<td>executive roles</td>
<td></td>
</tr>
<tr>
<td>&quot;...information that you need according to your role.&quot;</td>
<td>issue-related processing</td>
<td></td>
</tr>
<tr>
<td>&quot;...if it’s key information that you need firstly according to your role.&quot;</td>
<td>information-related processing</td>
<td>Heterogeneity of information processing behaviour</td>
</tr>
<tr>
<td>&quot;...there is specific occasion that I will probe for information.&quot;</td>
<td>preference-related processing</td>
<td></td>
</tr>
<tr>
<td>&quot;...certain types of issues that are particular receptive to information, I would likely to search for it.&quot;</td>
<td>restrict information sources</td>
<td></td>
</tr>
<tr>
<td>&quot;...information associated with the Intranet, it should be utilised by executives in different ways.&quot;</td>
<td>risk in information filtering</td>
<td>Dilemma of information reduction</td>
</tr>
<tr>
<td>&quot;...the way you interpret different types of information is different.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the information to be searched is up to me.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;My executive just scans through information which he regards is relevant or not.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...you need to restrict the sources where it comes back.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...filtering data from lots of different sources.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...that all the information is checked that only the relevant information gets to me.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;There's a great possibility that you are actually filtering out fringe of information that could be probably more beneficial to you.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...by being too restricted, you can miss things as well.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the more you refine it down, the more you may miss out on information.&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
...you are wasting time reading information three four time from different sources."
"...time and research time needed to decide what information useful."

"The information to be searched is up to me in ways that I don't really want to act on if it demands putting on my time."
"We are talking about using executive time effectively and efficiently."
"Due to lack of time, it should be manageable, with a small amount of information."

"...you have to read through almost all information."
"...to meaningfully look at everything that is available is a job itself."

"...the time you spend on information processing in comparison to the time you could spend on other things."
"...you only spend that time if it is a key information that you need."

Heterogeneity of executive attributes and roles
Most participants reckoned that the success of information process depends on the attributes of an executive and how well the individual executive knows and handles their managerial role. Some comments were:

"Good executives would have a good team around them, well-organised, and seek feedback themselves in the shop floor. ...poor executives being somebody not organised, not very good in time management, needs facilities to help them out."  [FG2]

"The key driver for the executive is you got to say what the executive's role itself is before you could decide how you could use a system like this."  [FG1]

Heterogeneity of information processing behaviour
Participants recognised the heterogeneity of their information processing behaviour. It appears that each individual executive will scan or probe for information on different
occasions, with different issues in mind, and based on different criteria. One manager gave this comment:

"There is specific occasion that I will probe for information ...or there is particular issue I am researching, you know certain types that are particular receptive to information, I would likely to search for it. In other situation, like other objectives that I want to do, the information to be searched is up to me in ways that I don't really want to act on it if it demands putting on my time, because of its certain urgency." [FG3]

The way participants would process information is governed by the issues that they are concerned, or the information they need, or simply their personal preference. Example of comments were:

"I have the problem that I am trying to solve or there is particular issue I am researching, you know certain types that are particular receptive to information, I would likely to search for it." [FG3]

"...information associated with the Intranet, it should be utilised by executives in different ways." [FG1]

**Dilemma of information reduction**

Participants perceived the immediate need for information reduction by restricting information sources and screening out irrelevant data due to the information overload. However, some participants opposed because they perceived the risk of filtering out potentially useful and important information. This holds a different view, for examples:

"There is an immediate need for this filtering mechanism because of the volume of the workload." [FG1]
"There's a great possibility, very high risk, you are actually filtering out fringe of information that could be probably more beneficial to you than the initial information that you are looking for in the first place." [FG2]

**Constraints of time**

One thing that has been raised across all focus groups was the issue of time constraints. Participants were very concerned with the time needed in processing their information. They found that the multiplication of information sources demands plenty of time to process them. One argued that,

"The key driver is time, because the time you need to spend on the system. You only spend that time if it's key information that you need firstly according to your role."

[FG1]

Participants were also aware of their time constraints for being a manager. They would like to see a trade-off in spending time for information processing activities. Some comments were:

"It's about time constraints. We are talking about using executive time effectively and efficiently." [FG2]

"...the time you spend on information processing in comparison to the time you could spend on other things. ...you only spend that time if it is a key information that you need." [FG1]

Due to time constraints, it was suggested that the amount of information provided must be manageable and the time spent on processing the information must be minimum. Managers express that the key issue is to have the right balance of the amount of information. A manager suggested,
"Due to the lack of time, it should be manageable, with a small amount of information." [FG4]

5.4 Findings: Perception on Agent-based Support in EIS

This section reports findings on perception or expectation of an agent-based executive information system. Five themes emerged from the study: fundamental issues of design, usability, adaptability, intelligence and information manipulation. These themes suggest implications for an agent-based EIS design model. Emerging themes and related themes are organised into tree-structures, as illustrated in Table 5.3.

The following findings provide selected quotes that confirm the themes emerged from the focus group study. Table 5.3 depicts sample of direct quotes from the focus group study.
<table>
<thead>
<tr>
<th>Raw Data (example quotes)</th>
<th>First order themes</th>
<th>Second order themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;I think the system should be a complimentary rather than replacing.&quot;</td>
<td>complementary tool</td>
<td>General issues of EIS design</td>
</tr>
<tr>
<td>&quot;It is a decision support tool, isn't it? It's not a decision make up.&quot;</td>
<td></td>
<td></td>
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<tr>
<td>&quot;I would never see it replacing discussion with competitors in the market place.&quot;</td>
<td></td>
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<tr>
<td>&quot;Senior executives would use it more as gaining background knowledge and keeping up-to-date.&quot;</td>
<td>additional information support</td>
<td></td>
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<tr>
<td>&quot;Once the information comes in, the executive can get a rule of thumb, ... give a flash, for example, about new information.&quot;</td>
<td></td>
<td></td>
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<tr>
<td>&quot;... to provide recommendation based on information provided.&quot;</td>
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<tr>
<td>&quot;I think that should be simple for recipient to utilise the information.&quot;</td>
<td></td>
<td></td>
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<tr>
<td>&quot;... what I can see is minimum management.&quot;</td>
<td></td>
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<tr>
<td>&quot;... has the ability to take that information ... in a simple form but not in a complex form.&quot;</td>
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<tr>
<td>&quot;...must be tailored made to individual industries, according to the information needs.&quot;</td>
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<tr>
<td>&quot;...provide personal feature of information rather than a generic one.&quot;</td>
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<tr>
<td>&quot;...how you want to search, how you use it and it almost needs to be tailored into the context of the organisation.&quot;</td>
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<tr>
<td>&quot;...you need control over how you, what you want to see, what you don't want to see.&quot;</td>
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<tr>
<td>&quot;...is to define what he wants and how much control of information he will get.&quot;</td>
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<tr>
<td>&quot;...you still got to teach the agent what you need.&quot;</td>
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<tr>
<td>&quot;I think the fact we need to re-teach, reteach and reteach.&quot;</td>
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<tr>
<td>&quot;...ask you to give you an option to act to this, or you want to get rid of others.&quot;</td>
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<tr>
<td>&quot;...in terms of the profile of the agent, presumably it can retain some of your interests and thoughts of yesterday as well as today.&quot;</td>
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<tr>
<td>&quot;...I think the fact is that the system would have learning curve.&quot;</td>
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<tr>
<td>&quot;...need to be knowledge-based in order to process and understand the level of important.&quot;</td>
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<tr>
<td>&quot;It depends on whether they will actually tell you the context, justification of where about the information are coming from...&quot;</td>
<td></td>
<td></td>
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<tr>
<td>&quot;...the way to improve is to understand the natural language.&quot;</td>
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</tbody>
</table>
| "There's also the complexity of language ... there might be in my head ten or eleven different words which mean the same thing."

Table 5.3 Sample supporting evidence (direct quotes) on perception of an agent-based executive information support system
"...keep you updated with information from external business environment that is spontaneous."
"...you set up to run overnight, or whatever, and when I come in the morning, there will be something to look at ..."
"...you set them right and run them in the background..."

"...set themselves up with a piece of information that leads you somewhere else."
"I mean as information is changing, it would pick it up and bring it to you."
"If the agent hasn't searched for a while, it could actually suggest to the user."

"...you want to actually have the agent to be aware of that daily change."
"If I define within the agent, this is what I need now, but tomorrow could be something completely different."

**General Issues of EIS Design**

Participants raised some general issues of designing and developing an agent-based information support system for executives. Executives would treat EIS as a complimentary tool that supports executive information processing activities rather than in any way to replace it. They would see the system as a tool to support their decision-making process, rather than making decision for them. The main reason explained by the participants is intuitive nature of management decisions which requires human intelligent instinct. For example,

"I would just see it as a completely complementary. I would never see it replacing discussion with competitors in the market place, with competitors' customers, with their employees.” “One concern is decision making must be based on rules. You have a set of rules, and so and so, all depend on the credibility of the rules you set up. Secondly, I think instinct. A lot of decision making is intuitive”; “...you got the fact and then you make a decision from some instincts...that software doesn't have this intelligence instinct.” [FG2]
It suggests that an agent-based EIS may play limited role in directly support managerial decision making. However, the system has been perceived useful in the way that provides executive with additional information support, for example, to gain background knowledge, to provide recommendation and to provide the rule of thumb for decision making. Some comments were:

"I think senior executives would use it more as gaining background knowledge and keeping up-to-date." [FG1]

"Once the information comes in, the executive can get a rule of thumb, ... give a flash, for example, about new information." [FG4]

Usability
Usability is perceived as an important criterion in the design and development of an agent-based EIS. In this case, the system must be user-centred in its assistance. This means that the system understands the relevant characteristics of end-users. Due to the nature of managerial attributes and works, the system must be of ease of use. It would make certain features more accessible, manageable and simple for users to use and manipulate. One participant compared the usability with how a human personal assistant would be able to assist,

"A personal assistant in a human form would know your personality, would have learned what to put for and what not to put for, I am not sure the IT software can take, has the ability to take that information ... a simple form but not in a complex form.." [FG2]
Usability requires personalisation, in which information is processed according to the user’s information processing behaviour and interests. The information provision is in relation to the context of the organization and the specific requirements of the user. It is argued that,

“The bigger mistake made is one usually driven by the software developer to drive what the rules are (not senior executives) ... (the agent-based system) having rules around the context of the organisation of what we want to search, how you want to search, how you use it, and it almost needs to be tailored into the context of the organisation.” [FG1]

According to the participants, it is important that the users can control the system for performance improvements. For example, user is able to decide and control the amount, types and sources of information he wants. A manager suggested,

“One thing can improve for executive is to define what he wants and how much control of information he will get.” [FG4]

**Adaptability**

Participants raised the importance of adaptability of the system, i.e. the system should be flexible to adapt to changing situation and individual executive’s managerial behaviour through learning and coaching. This implies that the system understands the relevant characteristics of end-users. Hence, the setting of user profile and preferences must be specific to individual user needs and industry sectors. It is important for the system to learn within itself or through user feedback (coaching). One manager suggests that the system must have a sort of adaptability within itself to retain some of the user’s interests and thoughts as well as to develop.

“In terms of the profile of the agent, presumably it can retain some of your interests and thoughts of yesterday as well as what you’re thoughts are today, may well then ask you to give you an option to act to this, or you want to get rid of others. So I
reckon it must have a sort of flexibility within itself to retain as well as to develop.”  
[FG1]

The key to ensure EIS adaptability is the agent knows very clearly what the executive is looking for and what structure or format he or she would like it. Most managers suggest that the great efforts are needed in order to coach the agent and to enhance its learning capability. A manager stated,

“I think the object will be in the setting up of the agent. I think that's where the work would be, making sure the agent knows very clearly what it's that the executive is looking for and what structure or format he or she would like it.”  
[FG1]

Participants also perceived the need for contextual support and semantic support as many were frustrated of the incapability of system to retrieve information in the right context and right meaning. User profiling that contains knowledge of user’s requirements and interests would provide contextual support and semantic support in the process of information. It is evident from the following statements:

“It depends on whether they will actually tell you the context, justification of where about the information are coming from...”  
[FG3]

“Software agents need to be knowledge-based in order to process and understand the level of importance ...I think for me the way to improve is to understand the natural language.”  
[FG4]

Intelligence

Participants’ ideas of intelligence criteria in an agent-based system can be divided into three broad categories of attributes: autonomy, proactivity, and reactivity. In this case, the term ‘intelligence’ is in line with the definition of executive intelligence activities, which comprises the continuous, self-reactive and self-adaptive activities in information
processing. According to the participants, these are the useful attributes of agents support. The autonomy attribute is perceived as the ability to perform the tasks spontaneously and autonomously. Some comments were:

"...keep you updated with information from external business environment that is spontaneous." [FG4]

"... you set up to run overnight, or whatever, and when I come in the morning, there will be something to look at ..." [FG2]

In terms of proactivity attribute, participants refer to the ability to take initiative in taking action or bringing information into user’s attention. For example, one participant suggested the following,

"If you are sure and you know who your competitor is, I’m supposed what you can do is to tag into their information bases, and just keep checking and when some information changes, it pops up to you. And I’m supposed if you could set it with many fields, may be the natural news, the global news, something like that, you set them right and run them in the background. ... I mean as information is changing, it would pick it up and bring it to you.” [FG2]

Participants refer reactivity as the ability to react to changes of information itself as well as user’s information needs. One participant suggested the ability of the agent to react to changes and then take appropriate changes without depending on the user’s instructions. For example,

"You want to actually have the agent to be aware of that daily change. Today, priority for me is one thing. Tomorrow, it’s something completely different. Now if I define within the agent, this is what I need now, tomorrow could be something completely different.” [FG1]
5.5 Findings: Executive's Concern on The Assistance of Software Agents

This section reports findings on executive’s concern on the assistance of software agents in their information processing activities. Four themes emerged from the study: fear of changed in managerial roles, fear of limited executive development, uncertainty of system capability and uncertainty of system intelligence. These suggest key factors that determine executive’s willingness in adopting an agent-based information support system. These themes suggest the potential impact of using an agent-based EIS. Emerging themes and related themes are organised into tree-structures, as illustrated in Table 5.4.

The following findings provide selected quotes that confirm the themes emerged from the focus group study. Table 5.4 depicts sample of direct quotes from the focus group study.
Table 5.4 Sample supporting evidence (direct quotes) on executive’s concern on the assistance of software agents

<table>
<thead>
<tr>
<th>Raw Data (example quotes)</th>
<th>First order themes</th>
<th>Second order themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;... system can actually force me to look at things that I don't want to look at.&quot;</td>
<td>change in information processing behaviour</td>
<td>Fear of change in managerial roles</td>
</tr>
<tr>
<td>&quot;I think it might be more of a cultural challenge to get the system to work for you.&quot;</td>
<td>replacement of executive role</td>
<td></td>
</tr>
<tr>
<td>&quot;...would it replace executive when it learns too much?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...the redundancy of managers ...&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...this system would actually limit the development of senior executives.&quot;</td>
<td>limiting development</td>
<td>Fear of limiting executive development</td>
</tr>
<tr>
<td>&quot;...the concern is this limiting development kept coming back to me.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...they become relying on this, they don't broaden their knowledge.&quot;</td>
<td>over reliance on the system</td>
<td></td>
</tr>
<tr>
<td>&quot;... will be becoming more and more dependent on the software and not thinking for ourselves...&quot;</td>
<td>limiting creativity</td>
<td></td>
</tr>
<tr>
<td>&quot;...reducing creativity ...&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...sitting in front of computer, limit the creativity, losing the skills ...&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;My other concern is does the software do the decision making ... a lot of decision making is intuitive.&quot;</td>
<td>unsure about decision-making capability</td>
<td>Uncertainty of system intelligence</td>
</tr>
<tr>
<td>&quot;... you got the fact and then you make a decision from some instincts...that software doesn't have this intelligence instinct.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;I have extreme concern about that interpretation function.&quot;</td>
<td>unsure about interpretation capability</td>
<td></td>
</tr>
<tr>
<td>&quot;...certainly for me, I interpret the data myself.&quot;</td>
<td>human intelligence is better</td>
<td></td>
</tr>
<tr>
<td>&quot;The PA can make a judgment whether or not that piece of information is important to you.&quot;</td>
<td>system security</td>
<td></td>
</tr>
<tr>
<td>&quot;A PA in a human form would know your personality.&quot;</td>
<td>system integrity</td>
<td>Uncertainty of system capability</td>
</tr>
<tr>
<td>&quot;...security is essential ...&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...it is about confidentiality if we ask software agents to interpret.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;The software agent needs to have the real confidence in analysing the information.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...would people stop putting information, which is freely accessible and can be used.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;...you may engage some discussion via another colleague.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;If you just receive it from an agent, it may not be a two way communication.&quot;</td>
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</tbody>
</table>
Fear of change in managerial roles
Firstly, participants expressed their concerns of possible changes in their managerial roles, in particular, their informational roles. They also feared that their managerial roles could be replaced by the system. As the system is becoming capable of learning and performing the information processing tasks on behalf of executives, the roles of executives will be threatened. Some comments were:

“(The agent) system could actually force me to look at thing I don’t want to look at ...” [FG1]

“...would it replace executive when it learns too much?” [FG2]

Fear of limiting executive development
Another major impact perceived by executives is over-dependent on the system, which will limit executives’ personal development, as well as creativity as a senior manager. This is particularly a concern if software agents begin to support executive’s information processing activities effectively. They expressed that:

“...this system would actually limit the development of senior executives...the concern is this limiting development kept coming back to me... I think we will be becoming more and more dependent on the software and not thinking for ourselves, reducing creativity.” [FG1]

“My another concern is probably people would completely start depending on the system rather than using their own brain.” [FG2]

Uncertainty of system intelligence
Participants were unsure about the intelligence function, like the decision-making and interpretation capability. Participants believed that the decision-making activity and interpretation activity should be performed by the users themselves. They found it difficult to place their trust on a system, which has no human intelligence. Participants
reckoned that the immediate need is to have a more intelligent filtering mechanism to cope with the information overload, rather than the interpretation mechanism. The comments were:

"One concern is decision making must be based on rules. You have a set of rules, and so and so, all depend on the credibility of the rules you set up. Secondly, I think instinct. A lot of decision making is intuitive ... software doesn’t have this intelligence instinct." [FG1]

"... there is an immediate need for this filtering mechanism because of the volume of the workload." [FG1]

**Uncertainty of system capability**

Participants also raised a few issues that concern the system capability with regard to system security, system integrity, and system interactivity. For examples,

"... it is about confidentiality if we ask software agents to interpret." [FG4]

"The software agent needs to have the real confidence in analysing the information." [FG3]

"... if you just receive it from an agent, it may not be a two way communication." [FG1]

The next **Section 5.6** discusses the findings of the focus group study and suggests useful insights for improving EIS design and development through the identification of current executive’s information environment and information processing activities, executive criteria of agent-based system for supporting executive intelligence activities, and executives’ concerns about the adoption of software agents.
5.6 Discussion and Implications

The discussion is structured into four key areas: (1) characteristics of executive information; (2) characteristics of executive’s information processing behaviour; (3) perception on an agent-based support in EIS; and (4) executive’s concern on the assistance of software agents.

5.6.1. Characteristics of Executive Information

The concept of organisation environment issues has been actively studied since 1960s (Emery & Trist 1965; Lawrence & Lorsch 1967; Thompson 1967; Duncan 1972; Leblebici & Salancik 1981; Stoffels 1994). The organisation environment is viewed as a source of information that continually creates signals and messages that organisation should attend to (Auster & Choo 1994). Characteristics contribute to the uncertainty of organisational environment, in general, have been identified as complex and dynamic (Emery & Trist 1965; Thompson 1967; Duncan 1972). The complexity refers to the number and diversity of external factors facing the organisation and that the management must consider when making decisions. The dynamism refers to the degree of change exhibited in those factors. However, very few studies have been conducted to explore characteristics that contribute to the uncertainty of executive information.

Insofar, the nature of executive information environment has not been taken into deep consideration in the study of EIS field. If value-added information is defined in terms of its ability to reduce uncertainty (Daft & Macintosh 1981), insights on characteristics contribute to that uncertainty will be useful for developing value-added information systems. One of the main purposes of the focus group study is to explore current executive’s information environment. The findings of this study suggest implications that current executive information is uncertainty due to the following characteristics, which pose challenges to conventional EIS underpinnings and the design and development of EIS, as depicted in Figure 5.1.
The findings suggest that the nature of executive information is perceived as uncertain due to the following four characteristics. These characteristics challenge conventional views of EIS purpose, functions and design guidelines.

a) Over-abundance of information

The findings confirm that executives are suffering from the over-abundance of information. Executives receive both internal and external information, from both informal and formal sources. Most EIS are designed with the assumption that the critical deficiency is the lack of relevant information, as a result, executives are supplied with more information than they can possibly absorb. Ackoff (1967) has foreseen this dilemma since the introduction of management information systems (MIS). He strongly believes that the emphasis of a manager 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 MIS cannot be expected to be used effectively” (Ackoff 1967, p. 148).

The duplication of information sources also causes the excess of information. With the increasing amount of distributed information and heterogeneous information...
sources, executives are pressurised to spend more time and effort to cope with these challenges. Hence, effective data management is often cited as a key to success of EIS development (Koh & Watson 1998). One of the major concerns is the ability to combine data from multiple sources.

b) **Heterogeneity of information attributes**

Conventional studies on executive information focus mostly on executive information attributes (sources, types and contents) and executive information needs. Researchers believe that the identification of executive information attributes, and the determining of executive information needs or requirements would contribute to the successful design and development of EIS (McLeod et al. 1984; Wetherbe 1991; Watson & Frolick 1993; Watson et al. 1997; Keane 1998; Salmeron 2002). Information system developers are expected to understand and identify executives' information needs, information sources and types. The findings, however, suggest that the nature of executive information is diverse, dynamic and heterogeneous. This means that executive’s information attributes and information are changing rapidly over time. Often, by the time useful information is acquired and reported, the strategic issues facing the executive have changed. Though a generic pattern is possible to identify, it is unlikely information system developers can identify an exclusive list of executive information types and sources, as well as exclusive pattern of executive needs or requirements for individual executive.

Mintzberg's (1973, p.145) description of executive information is that, "First, the management scientist has, along with the rest of us, lacked formal knowledge of the manager's working processes. These are complex; they cannot be subject to analysis until they are clearly described. Second, the management scientist has been implicitly denied access to much of the manager’s information. The manager is the nerve centre of his organisation, with unique access to a wide variety of internal and external contacts that provide privileged information. But most of this information is not documented, and much of it is unsubstantiated and nonquantitative. As a result, the manager lacks a systematic method for passing it on to the management scientist, and
most of it never reaches him". Notably, without the understanding of the individual executive information, how can the EIS developers design an effective EIS for executives? Jones and McLeod (1986) find that executives can manage information to some extent by controlling their information sources and types. This allows them to achieve control over the manageable volume of information and potential value of information.

c) Ambiguous value of information

The findings suggest that the credibility and reliability of information are key values for executives. The credibility of information refers to the provision of relevant, meaningful and understandable information. The reliability of information refers to the consistent provision of trustworthy information. The availability and scalability of information are also perceived as important.

Conventional studies of executive information mainly look into the preference sources and types of information rather on the value of information (Daft et al. 1987; McLeod et al. 1984). However, the underlying problem is that the value of information cannot be assessed until the information arrives. Unexpected and unpopular sources and types can generate high value information. In addition, the perceived value of a specific set of information may vary for different executives according to individual differences. Nevertheless, the findings suggest that the value of information is associated with the provision of semantic and contextual support on information acquired. Executives believe that the semantic support on natural languages and contextual support on information content would reduce the ambiguity of information value.

d) Diverse use of information

Executives use information for different purposes. Information use involves the selection of information from a larger content of information in order to attend to or to act on, for examples, to make sense of a situation (enlightenment), understand a problem (problem solving), make a decision (instrumental), determine facts (factual),
verify another piece of information (conformational), predict possible outcomes or trends (projective), initiate or sustain personal involvement on a particular course of action (motivational), or develop relationships (personal/political) (Taylor 1986; Choo 1998).

The findings suggest little insights on the above uses, instead executives are more concerned on the way the information is selected and stored for future references, and the way the information is disseminated and reported. Executives could use information for any purposes, the support they need is to improve information retrieval and dissemination. Ackoff (1967) postulates that it is necessary to determine how well managers can use needed information. He states that if managers are unable to use it well, they should be provided with data manipulation tools and decision support tools. The manipulation tools and decision support tools will help (especially ‘weak managers’) to gather and structure information for efficient retrieval and dissemination.

Besides posing challenges to conventional views of EIS purpose, functions and design guidelines, the findings also suggest useful insights for improving EIS design and development. With the over-abundance of information, there is a need to reduce redundant and irrelevant information to a reasonable amount for executives to process and digest. Any additional information made available by the system will not be considered useful by executives unless the volume of information is manageable. Since information system developers are unlikely to identify an exclusive list of executive information types and sources, as well as exclusive pattern of executive needs or requirements for individual executive due to the dynamic and heterogeneous nature, there is a need for individual executives to define, modify and control their respective information attributes and needs. With the increasing amount of distributed electronic information made available for executives, there is also a need to provide semantic and contextual support to the information acquired in order to increase its credibility and reliability. Lastly, executives could use information for different purposes, but the need is
to provide data manipulation tools and decision support tools to improve executive's information retrieval and dissemination.

5.6.2. Characteristics of executive's information processing behaviour


This study, however, focuses on information processing behaviour. It refers to those activities an executive may engage in searching, scanning, filtering, refining, interpreting and understanding information for decision making. It is found that most of the studies conducted on executive information processing behaviour focus on information acquisition and scanning behaviour (Daft et al. 1988; Jones et al. 1993; Auster & Choo 1994; Wang & Chan, 1995; El Sawy 1995; Vandenbosch & Huff 1997; Liu 1998a,b; Sawyerr et al. 2000; Hough & White 2004), mostly adopted from Aguilar’s (1967) concept of environmental scanning. Virtually no study is done on executive’s information filtering behaviour although a few studies are attempted on executive’s information interpretation behaviour (Thomas et al. 1993; Liu 1998a,b). The second purpose of the focus group study is to explore challenges faced by executives in their current information processing activities. The findings of this study suggest implications on characteristics of executive’s information processing behaviour that pose challenges to conventional EIS underpinnings and EIS design and development, as depicted in Figure 5.2.
The findings suggest that the nature of executive information processing behaviour is perceived as uncertain due to the following four characteristics. These characteristics challenge conventional views of EIS purpose, functions and design guidelines.

a) **Heterogeneity of executive attributes and roles**

The findings confirm that executives are individuals who perform different roles with different agendas, cognitive styles and mental models (Mintzberg 1973; Kotter 1982, 1999; McKenney & Keen 1974; Isenberg 1984). Conventional studies of EIS mainly look into Mintzberg's managerial roles, few actually look into the implicit factors, such as executive's agendas, cognitive styles and mental models. Mintzberg (1973) identified ten managerial roles, which he grouped into three groups: interpersonal, informational and decisional. Clearly, some executives may engage more in certain roles than the others. According to Kotter (1982, 1999), the informational and interpersonal roles allow them to build networks of people and set agenda for their decisional roles. In the process of gathering information and evaluating information, executives can actually either exhibit preceptive or receptive approach, systematic or...
intuitive approach (McKenney & Keen 1974). In addition, executives often work with combined thinking with acting, linking agendas and mental models in their work (Isenberg 1984).

The findings also confirm that executives comprise novice users and expert users of executive support system (Hung 2003), and some are considered leaders or laggards in executive information gathering and processing (Xu & Kaye 1995). Hence, it is unlikely to design a common EIS for executives with heterogeneous attributes and roles. System developers must be conscious of, not only the executive roles, but also the implicit agendas, cognitive and mental models in developing EIS.

b) Heterogeneity of information processing behaviour
Due to the above heterogeneity of executive attributes and works, executive information processing behaviour is, therefore, complex, dynamic and heterogeneous. Executive information processing behaviours can be characterised as: apparently fractionated and opportunistic but strategically linked; highly inferential and intuitive; highly interpersonal; using action as experimental probes to aid understanding; and 'off-line' idea generation (Young 1987).

The findings reveal that executives exhibit different information gathering and processing behaviours over different occasions and time. Hence, it is unlikely to determine the specific behaviour of gathering and processing strategic information, especially when they are continuously and rapidly confronted with changing and diverse information. This challenges conventional EIS studies that believe a common EIS can be developed to provide executive information based on the understanding of executive’s information needs and their behaviour in acquiring information. This includes ascertaining executives’ information sources, information type, information storage, process of interpretation and sense making, and information dissemination (Jones et al. 1993; Xu et al. 2003).
The findings also imply that EIS should be personalised to fit individual user's profile and preferences, and should be coached to mimic individual user's information processing behaviours. Centre to this approach is EIS usability and adaptability. Mintzberg (1973) used to suggest that certain important information processing and strategy making tend to be centralised in the hands of the one man in each organisation who heads it. As a result, managers will operate the systems in man-machine or manager-analyst systems. A logical argument following this speculation is that the focus of EIS design needs to shift from developing a common EIS to developing an EIS environment or platform on which executives can develop, control and coach the EIS for their particular needs at particular events. Hopefully, an adaptive EIS will progressively understand and mimic some of the executive's information processing behaviours.

c) Constraints of time

The executives usually have time constraint issues with frequent interruption yet concern on a wide range of internal and external business environment issues (Kotter 1982, 1999). The over-abundance of information and the multiplication of information sources demand substantial time and effort to process them. There is a need for time reduction. Time reduction refers to reduce the time and effort an executive needs to gather and process information.

The findings show that executives are very concerned with the amount of time spent on information gathering and processing. Executives will resist using EIS if it demands more time and effort to learn and use the system than using other means to gather and process information. Hence, executives often rely on external information providers or their knowledge workers who search, gather and process information on behalf of them.

d) Dilemma of information reduction

Due to the time constraints and the over-abundance of information, the reduction of information is critical in the design of EIS. The findings suggest that executives can
only digest a manageable amount of information. However, there is a dilemma in the process of reducing information, in which, potentially valuable information may be accidentally screened out. Taylor’s (1986) ‘noise reduction’ criteria in the value-added processes of information suggests three processes of information reduction: the process of exclusion, or withholding information, the process of inclusion, or supplying information within some boundaries, and the process of precision, which has to do with focus and specific information. The idea of exclusion is to restrict or to contain the amount of information presented, excluding information that is not relevant and useful. The intent of inclusion is to assure that nothing of conceivable value is omitted. The intent of precision is to assure that only the feasibly defined information is presented (Taylor 1986).

Hence, EIS with its emphasis on supplying information will not help this process without a basic change in the filtration (or evaluation) and condensation (or filtering) of information, as Ackoff (1967) suggested. Simon (1971) states it clearly that, “It is conventional to begin designing an Information Processing System by considering the information it will supply. In an information-rich world, however, this is doing things backwards. The crucial question is how much information it will allow to be withheld from the attention of other parts of the system” (Simon 1971, p.43).

Besides posing challenges to conventional views of EIS purpose, functions and design guidelines, the findings also suggest useful insights for improving EIS design and development. The heterogeneity of executive attributes and roles suggests that there is a need of using an end-user centred approach to develop specific EIS for specific individual executives. This leads to the need to design a personalised and adaptable EIS that fits user profiles and capable of learning user behaviours, and eventually capable of adapting to the heterogeneous information gathering and processing activities of executives. For many executives, time is money. Hence, there is a need for an easy to use system that requires little effort and time to learn and to use, in particular, the ability to know how to control the system in accordance to the executive’s time availability. With the over-abundance of information, the reduction of information is becoming critical for
efficient processing. However, there is a need to filter irrelevant information without omitting potentially relevant information.

5.6.3. Perception on an agent-based support in EIS

The current emergence of the intelligent software agent, as a concept and a technology with applications, allows improved support of executive information processing activities. However, executive criteria of agent-based support must be elucidated by executives themselves in order to develop a system that is considered useful for them. Executive criteria refer to critical requirements for an agent-based support system based on executive’s desires and perceptions in judging the usefulness of the agent’s functions or attributes. Through the initial exploration of the focus group study, the identification of executives’ perceptions on agent-based solutions for supporting executive intelligence activities help determine executive criteria of agent-based support in EIS. The findings suggest implications on the following executive criteria of agent-based support in EIS, as depicted in Figure 5.3.

![Figure 5.3 Executive criteria of agent-based support](image)

a) Usability

Conventional EIS design focuses on performance monitoring and control via friendly and colourful interface such as graphical, tabular, and/or textual information presentation based on pre-determined requirements (Vandenbosch & Huff 1997; Edwards & Peppard 1993; Watson et al. 1991; Nord & Nord 1995; Young & Watson 1995). From the focus group’s findings, this appears to be less important in EIS design. The findings however suggest that executives need a system that is more
accessible, personalised and simple for them to use and manipulate. Executives find that personalised information processing and manipulation in relation to the context of the organisation and the specific requirements and interests of individual executives will be useful. The findings also suggest that it is important that the users can control the system for performance monitoring and improvements. For example, an executive is able to decide and control the amount, types and sources of information he wants.

b) Adaptability

More recent EIS literature implies that an ideal EIS should include a scanning, filtering and reporting function in order to collect and synthesise information from multiple sources and proactively report brief and aggregated information to executives (Vandenbosch & Huff 1997; Xu & Kaye 1995, 1997; Liu 1998b). This study finds that executives in general welcome the scanning function, yet express concerns on depending on such a function. Mainly, executives are concerned with the duplication of similar information resulted from multiple information sources scanning without executive’s control and guidance. On the other hand, scanning without semantic and contextual support could lead to over-abundance of irrelevant information.

Conflicting views on using filtering function have been raised in the study. Participants in favour of filtering function see a filter as a means to deal with the problem of information overload. Scanning without filtering will inevitably exacerbate information over-abundance. Ackoff (1967) perceives the over-abundance of irrelevant of information as more critical than the need of supplying relevant information. He argues that two most important functions of an information systems for managers are filtration (or evaluation) and condensation. Another reason of using a filtering function is that executives can only digest a small amount of the information provided that requires less of their time to process. Nevertheless, participants raised their major concern of using the filtering function, which is the possibility of screening out potentially relevant information. This could happen in two
situations: firstly, the pre-determined criteria set for filtering may no longer reflect executives’ changing needs and preferences; secondly, the filter is not able to semantically and contextually recognise incoming messages without continuous coaching. Hence, the filtering functions in EIS require an automated learning mechanism or some sorts of user feedback or coaching in order to cope with the changing information needs.

c) Intelligence

In the conventional view of intelligent EIS design, an informed-speculation or interpretation of data would be considered a unique and ideal feature of EIS (Young 1987; El Sawy & Pauchant 1988). With the presumption that executives hunger for more meaningful information, EIS developers and researchers suggest the need to incorporate interpretation function in the EIS (Liu 1998a, 1998b). The findings do not support the need for interpretation as most participants prefer and tend to interpret data, and to make sense of the data themselves. This partially confirms El Sawy and Pauchant’s (1988) argument that executives do not and will not delegate their scanning and interpretation activities to software agents. However, the findings suggest that executives take a positive attitude towards developing an intelligent support of EIS. They perceive an intelligent EIS can possibly provide capabilities, such as autonomous information searching, continuous information update and backup, reactive towards information and requirements changes, proactive in taking appropriate action or bringing information into user’s attention, and continuous learning and improvement. However, the findings also show that there are concerns related to the possible impact of the system on their managerial roles and development.

Evidently, the findings suggest that there is a need for an EIS design model that meet the above criteria raised by executives. The findings from executives’ perception on an agent-based EIS shed light on the design and development of an agent-based intelligent EIS.
5.6.4. Executive’s concern on the assistance of software agents

Markus (1984) identifies three major causes of resistance to information systems – people problems, weakness in the technology and issues raised from the interaction of people and technology. While resistance is seen as a people problem from the system developer’s perspective, users often view the information technology as the source of the problem. However, Markus (1984) believes that resistance is best attributed neither to people nor technology but rather to the interaction between human and technology. Despite the possibility and potential of building an intelligent agent-based EIS, executives raise concerns over the agents’ capability, reliability and intuition, as well as their informational roles and personal development. These concerns may cause resistance in the adoption of agent-based EIS. The following Figure 5.4 suggests the factors which contribute to executives’ concerns on agent-based intelligence systems.

![Figure 5.4 Executive’s concern on the assistance of software agents](image)

Figure 5.4 Executive’s concern on the assistance of software agents

a) **Fear of change in managerial roles**

Although not all managerial roles, as identified by Mintzberg (1973), can be fully supported by information systems, some roles can be potentially supported by information systems. For example, the monitoring and disturbance handling roles rely heavily on information acquired from both the internal and external business
environment, the disseminator role allows electronic information to be instantly transmitted and the entrepreneur role helps executives to identify business threats and opportunities. Executives fear that their managerial roles will be weakened or replaced by the agent-based EIS, hence, they may resist in using the system. The findings suggest that the resistance will become more apparent if executives feel that they do not have control over the system.

b) Fear of limiting executive development
If an agent-based system becomes more useful and reliable, executives fear that the over-dependence on an agent-based EIS will cause them to lose their creativity and limit their personal development. Executive’s entrepreneur role lead him spend much of his time scanning his information environment, looking for opportunities and for problems to solve. Over-relying on the system will stop executive use different means or approaches to strengthen his entrepreneur role, and perhaps other informational roles as well.

c) Uncertainty of system capability
The findings raise a few concerns on system capability, such as security, integrity and interactivity issues. Security can be extremely important because of the sensitivity and confidentiality of strategic information. Integrity can also be important because it influences the trust level of executives. Interactivity issue involves the capability to involve other users or software agents in information processing activities. Nevertheless, technical concerns are of relatively small factor in EIS adoption and implementation in comparison to other major factors, like executive involvement issues, information quality, information delivery issues and impact on executive work (Watson et al. 1997).

d) Uncertainty of system intelligence
The findings suggest that executives are unsure about the intuitive functions in the system, such as, the capability to interpret or make sense of data. Executives will not or adopt rather a passive attitude with regards to software agents’ intelligence. Any
intuitive functions that require user’s cognitive and mental models are unlikely dependent on technology, but on users themselves. It is believed that agent-based systems are more likely to serve in the context of personal aids, such as assistant and guide (Janca 1995). Although information systems with limited intelligence are not suited for supporting cognitive senses needed for managerial intuition, Kuo (1998) proposes an ecological EIS model of managerial intuition that aims to improve executives’ effectiveness in coping intelligence in the future.

It is noted that findings on this third focus group question have not generated strong insights on executives’ concerns on the assistance of software agents. Participants did not elaborate their concerns, rather they gave only brief comments. This could imply that participants were not able to foresee the challenges or limitations of software agents without actually using them. This research question will be more appropriate when executives start adopting the application of software agents in their information processing activities. As a result, no further study is conducted on this topic, which means that the semi-structured interview will not explore on this topic. Nevertheless, the findings can be used to shape the design model of agent-based EIS.
5.7 Implication for an initial agent-based EIS design model

Based on the above findings and discussions of focus group study, an initial agent-based EIS design model for supporting executive intelligence activities is proposed. This model outlines executive criteria on agent-based system for supporting executive intelligence activities in a usability-adaptability-intelligence trichotomy model, as illustrated in Figure 5.5.

![Figure 5.5 An initial agent-based EIS design model](image-url)
The notion of executive intelligence activities comprise of three key processes: information acquisition, information synthesis and information interpretation (refer to Section 2.8). Information acquisition (scanning and searching) and information synthesis (filtering and refining) are perceived as key elements for EIS. Information interpretation process will be excluded in this model as findings suggest that executives decline the assistance of information interpretation. The dotted lines indicate that with the advancement of information agent technology, the interpretation function may be perceived as important in the future.

The information acquisition process is responsible for scanning and searching information from the heterogeneous and geographically distributed information environment, as well as managing information contents, sources and types or formats. The information synthesis process is responsible for screening out irrelevant information and refining information acquired for further manipulation and utilisation. Both processes can happen concurrently as searching and filtering are carried out at the same time. For example, the user defines his search criteria as well as his filter criteria. The system would search and scan the information needed, while refine the information and filter the irrelevant information. Both processes are supported by a three-levels agent-based design model that comprises the following executive criteria: *usability-adaptability-intelligence trichotomy*. These criteria are critical requirements for designing an agent-based support EIS based on executive’s desires and perceptions in judging the usefulness of the agent function. It is considered as a usability-adaptability-intelligence trichotomy model because it comprises these three elements that serve as guidelines for designing and building an agent-based EIS.

**Usability** refers to the extent to which a system can be used by specified users to achieve specified goals of information processing in a specified domain of work and information. Usability is highly critical in managing the uncertainty of executive information processing behaviour. Every senior executive is unique individual working in specific business context with specific information needs. A usability criterion aims to provide a user-centred EIS, rather a developer-centred EIS. From the focus group findings and
discussions, value-added attributes contributing to usability criterion are ease of use, personalisation and controllability. Ease of use aims to reduce the difficulty of using the system via relevant interface in order to increase the accessibility of information. Executives are impatient users due to daily time constraints, thus, unlikely to devote much time in computer-based information support systems. Personalisation is the capability to manage and customise information for specific executives for specific purposes based on individual executives’ profiles and interests. Personalisation of information acquisition and synthesis helps to search and scan information with potential value for executive needs, as well as screens out the irrelevant information based on user preferences (Foltz & Dumais 1992). Controllability is the capability to exhibit control over executive work profiles and information profiles. Ackoff (1967) stresses that, “No system should ever be installed unless the managers for whom it is intended are trained to evaluate and hence control it rather than be controlled by it” (Ackoff 1967, p.153). It is important that executives are given the right to alter their information needs and preferences, as well as their information domain without depending on system developers. The usability criterion is the first step to assure the executives that the system is tailored designed and developed for individual executives.

**Adaptability** refers to the extent to which the system fits the specified and right context of work and information, with the ability to strengthen the responsiveness of system in coping with the uncertainty of executive information. This is akin to Taylor’s (1986) definition of adaptability in his value-added model. The adaptability criterion aims to increase the level of relevance and contextualisation of information, with the appropriate semantic and contextual support. From the focus group’s findings and discussions, value added attributes contributing to adaptability criterion are learning, coaching, contextual support and semantic support. Learning is the capability of the system to improve its information processing activities by observing executive’s information processing behaviours and information preferences. This is similar to the implicit relevance feedback approach (Morita & Shinoda 1994; Fasli & Kruschwitz 2001). Coaching, however, allows executives to train the system in order to increase its robustness, thus, to support the user in successfully achieving their objectives in the work domain and information
domain. This is achieved through executives' explicit evaluation and feedback on the information acquired. This is akin to the explicit relevance feedback approach in the study of information retrieval (Roccio 1971; Salton & Buckley 1990). Contextual support refers to the capability to provide information in the right context for the right user. The goal of contextual support is to reduce the ambiguity of information and increase the richness of information according to the user's context. Semantic support refers to the capability to assign meaning to the information with the availability of an ontology—an explicit, declarative and representation of a domain. The goal is to transform distributed documents into semantically enriched and relevant documents. Notably, the adaptability criterion requires user participation implicitly and explicitly to increase its relevance and contextualisation. As the system becomes more adaptable, executives are more likely to adopt the next level of intelligence criterion.

**Intelligence** refers to the extent to which the system exhibits continuous, self-reactive and self-adaptive activities of acquiring, synthesising and interpreting information for executives, with no or very little executive interaction. With the emergence of agent technology (Sycara et al.1996; Jennings & Wooldridge 1998; Klusch 2001), software agents or information agents are potential for building an agent-based EIS. The representation and processing of ontological knowledge and semantic metadata, user profiles and natural language input, translation of data formats as well as the application of machine learning techniques enable software agents to acquire and maintain knowledge on itself and its environment, thus, achieve appropriate intelligence functions (Klusche 2001). The intelligence criterion aims to autonomously, reactively and proactively manage information on behalf of executives or other agents, preferably on the online basis.

From the focus group's findings and discussions, preliminary value added attributes contributing to intelligence criterion are identified as autonomy, proactivity and reactivity. Autonomy is the capability to operate without the direct intervention of users. The agents have control over their own actions and their own internal state. For example, executive allows the system to process information continuously in the background,
identifying information that might interest the executive and bringing up to executive's attention that is seemed appropriate. Reactivity refers to the capability to perceive user's information environment and act timely in response to the changes in the environment without user's intervention. The notification of change presented by the system involves no user interaction. For instance, once the system perceives changes in executive information environment, either information needs or information attributes, the system would adjust and adapt to meet those changes. Proactivity is the capability to exhibit goal-directed behaviour by taking the initiative where appropriate without user's intervention. For example, the system is able to take appropriate decision and action in information process, manipulation and presentation, like rank the relevance and significance of information, recommend executives of new and relevant information and alert executives of information threats.

In summary, the findings make the purpose of using EIS more explicit, that is to enable executives gaining background knowledge, keeping up-to-date, and backup tacit knowledge. More emphasis is put on using EIS to enhance information processing and learning than to support direct decision-making. A fundamental conception of an agent-based EIS is that the system should be treated as a complimentary tool that supports executive information processing activities, mainly on information acquisition and synthesis.

5.8 Conclusion

Conventional studies of EIS have neglected the characteristics that contribute to the uncertainty of executive information and executive's information processing activities. Characteristics of current executive information and information processing behaviour are found to be uncertain due to the diversity and dynamism of factors identified in the focus group study. This poses a number of challenges on conventional views of EIS purpose, functions and design guidelines. For examples, a generic EIS for all executives is impractical and a static EIS with predetermined information process for static
performance monitoring and control is inflexible. EIS must be personalised and adaptable according to specific individuals. Evidently, there is a need to revitalise current EIS with agent-based solutions in order to support continuous, self-reactive and self-adaptive activities in executive’s information processing. This study proposes an agent-based EIS model for supporting executive intelligence activities. This model is further investigated for deeper insights through the semi-structured interviews in Chapter 6.

6.1 Introduction

This chapter reports and discusses the findings of the semi-structured interviews. An overview of the semi-structured interview method is presented in Section 6.2. Section 6.3 in Section 6.4 outlines the findings of the interviews in detail, followed by discussion and implications for an agent-based EIS design in Section 6.5. Lastly, Section 6.6 concludes the interview study.

6.2 Overview of Semi-structured Interview Method

The empirical outcome of focus group study has provided the preknowledge for the semi-structured interview investigation. The focus group has enriched demands and cognitive needs of executive information and information processing behaviour and executive criteria of agent-based solution for supporting executive intelligence activities (such as Chapter 5). Here, the semi-structured interview was used to gain deeper insight on the preknowledge identified, which is used to better support executive intelligence activities with software agents. A semi-structured semi-structured interview open-ended questions provide the executive with the agent of control, as well as the possibility for the
Chapter 6

Interview Study

6.1 Introduction

This chapter reports and discusses the findings of the semi-structured interviews. An overview of the semi-structured interview method is presented in Section 6.2. Section 6.3 to Section 6.4 outlines the findings of the interview in details, followed by discussion and implications for an agent-based EIS design in Section 6.5. Lastly, Section 6.6 concludes the interview study.

6.2 Overview of Semi-structured Interview Method

The inductive approach of focus group study has provided the preknowledge for the semi-structured interview investigation. The focus group has elicited themes that describe current state of executive information and information processing behaviour and executive criteria of agent-based solution for supporting executive intelligence activities (refer to Chapter 5). Here, the semi-structured interviews are used to gain deeper insight on the preknowledge identified, which is how to better support executive intelligence activities with software agents. In a one-to-one semi-structured interview, open-ended questions provide the executive with the sense of control, as well as the possibility for the
Twenty five participants took part in the semi-structured interview. An overview of their details is presented in Table 4.6 in Section 4.7. All participants were in the managerial levels and involved in executive intelligence activities (80% of Senior Executive, 20% of Middle Executive). With the thematic research questions in mind, the following research questions were raised: (1) How do current executives collect and process their strategic information? (2) What would be the executive criteria of agent-based systems for supporting their information processing activities? Open-ended interview questions are carefully worded to ensure the executive interpret the questions correctly. Follow up questions and prompts were used to probe for more insights, as well as provide occasional probing and explanation to executive. A copy of interview questions with follow ups and prompts is enclosed in Appendix A.5.

Each interview lasted about 45 minutes to 1 hour 15 minutes. All interviews (except one at home) were conducted in the workplace of the interviewee. All interviews were digitally recorded and transcribed verbatim for analysis. The categorisation of meaning approach, which is similar to the thematic qualitative analysis (TQA) was adopted for the semi-structured interview analysis. All transcripts were coded into predetermined categories from the preknowledge of focus group study, as well as into newly emerging categories for analysis. With the high volume of raw data obtained from all the transcripts, qualitative analysis software, NVivo was selected and employed for efficient handling, managing, searching, displaying and analysing of findings. Each transcript was analysed and coded into either the predefined code scheme (nodes) or newly emerging nodes. For a more detailed interpretive conceptual analysis, meanings were sought from
the quotes to identify consensus, dilemmas, and contradictions through reading and re-reading of transcripts (Nicholas & Anderson 2003). Selected quotes are provided as to explore the meaning within the right contexts. The following Section 6.3, 6.4, and 6.5 outlines the selected quotes for discussion.

6.3 Findings and Discussion: Factors that Influence Executive’s Information Processing Behaviour

The focus group study has explored on the “what” issues pertinent to current executive’s information environment and information processing activities. This section reports findings on the “how” issues pertinent to information collection and processing by individual senior managers or organisational members. It is virtually not feasible to identify explicit patterns of executive’s information processing behaviour due to the brevity, variety and discontinuity nature of managerial works, as well as the visceral need and conscious need in them (Taylor 1968). However, factors that influence executive’s information processing behaviour are more likely to be identified. For example, knowing how executives search and process information will suggest common factors that influence their behaviour. Understanding factors that influence executive’s information processing behaviour could provide implications of the additional and/ or complementary support on executive intelligence activities.

The following four follow up questions were raised as to explore executive’s information processing behaviour with more in depths.

- How do you scan and search for your strategic information?
- How do you choose which information to be examined further?
- How do you go about combining information from different sources?
- How do you make sense of the significance of information?
Overall, the interview findings confirm that executive’s information processing behaviour is dynamic, complex and heterogeneous. Information processing behaviour involves information seeking, information collection or acquisition and information use. The findings suggest that executive’s information processing behaviour is influenced and driven by eight key factors: process-oriented, cognitive-oriented, affective-oriented, situational-oriented, strategy-driven, people-driven, information-driven, and technology-driven. Table 6.1 depicts the percentage of total interviews coded at different factors that influence and shape executive’s information processing behaviour. The percentages are not the main mode of qualitative analysis, but to provide the overview insights of factors that influence executive’s information processing behaviour. The results show that executive’s information processing behaviour is mainly shaped by the people who work with the executives (people-driven, ≈ 21%), the executive’s work and organisational contexts (situational-oriented, ≈ 18%) and the feelings of executives (affective-oriented, ≈ 14%). The executive’s information processing behaviour is less influenced by the systematic stages of information search and process (process-oriented, ≈ 7%), the organisational strategy (strategy-driven, ≈ 7%) and the thinking efforts of resolving problems (cognitive-oriented, ≈ 8%).

<table>
<thead>
<tr>
<th>Factors</th>
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<tr>
<td>People-driven</td>
<td>≈ 21%</td>
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<tr>
<td>Situational-oriented</td>
<td>≈ 18%</td>
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<tr>
<td>Affective-oriented</td>
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<tr>
<td>Technology-driven</td>
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<tr>
<td>Information-driven</td>
<td>≈ 11%</td>
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<td>Cognitive-oriented</td>
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<td>Process-oriented</td>
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<td>Strategy-driven</td>
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<td>Others</td>
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Figure 6.1 Factors that influence executive's information processing behaviour

Figure 6.1 illustrates the different factors that influence executive's information processing behaviour in Nvivo's model representation. The significance of factors that influence executive's information processing behaviour can be viewed from the concentration of lines (documents) that emerges from each factor. For example, people-driven factor consists of higher concentration of lines in comparison to other factors. This implies that executive's information processing behaviour is strongly influenced by the people who work with the executives (people-driven factor).
Factors that influence executive’s information processing behaviour

People-driven

The flow of information and the access to information sources within an organisation influence the information processing behaviour of its members (Choo 1998). McCall & Kaplan (1990) suggest that there are four important sets of sources for managers: 

- (a) systems and structures set up to keep them appraised of ongoing events, 
- (b) the people around them who volunteer information and can be approached in search of trouble signs, clues, and missing pieces of puzzles, 
- (c) the values of the organisation, which point people in certain directions and define the critical variables in a complex array of possibilities, and 
- (d) the manager’s own direct experience” (p.16). The findings reveal that executives rely heavily on the people around them to provide information for their further information process and decision making. The findings also suggest that executives tend to rely on a specialised organisational unit to support their information gathering, scanning, refining and reporting process.

“I don’t prepare that information, there is a separate unit within BT ... as senior manager, you don’t get into information searching and scanning about customer and competitors ... that’s already got a whole unit established in BT and I used that unit for providing information.” (Becky, Head of Corporate Governance)

“We don’t have specific external agency to get information from, but we have an R&D department, a searching development department, and it’s their job to collect information.” (William, Operations & Systems Director)

According to the participants, the organisational unit comprises of “knowledge workers” or “information workers” whom roles are to process the information on behalf of the executives. They are delegated with responsibilities to collect, analyse, prepare and report information to the executives for further information process or decision making.
"We have a business development unit and there we have 5 research people, accumulating all kinds of business and market and competitor information, analysing that and putting it into a format, and therefore it is much more structured." (Smith, Chief Finance Officer)

"External information would be drawn from people analyzing the marketplace, analyze trend of the business, and opportunities, also to look on what our competitors are doing in terms of direction." (Xandra, Head of IT Strategy)

"The information is prepared by the team. I scan through the information and ask the question." (Ford, Service Director)

In some cases, executives would personally request information from the "information workers" for further information process. In other cases, the "information workers" would raise any potentially significant information for executives' attention.

"Personally I would access that information via the business planning team. So we have a team who are responsible for business planning and what we call capital allocation, who produce information about how the market is evolving." (Eve, Chief Operating Officer)

"...our market intelligence people who are providing information ... rather giving me the detail, they flag it up and I am able then to dip in and dip out, and pick almost in random basis information that may be personal to making decision." (John, Managing Director)

The findings also imply that executives tend to rely on people for information search and process via an informal and personal channel, i.e. business meeting, phone calls.

"We have all sorts of people in a global scale, that we're consistently and continuously given information through them. ...a lot of verbal communication on
strategic issues due to the global management we are in. When you ring around, the optimal dialog explains the issues we are in." (Oscar, Chief Executive Officer)

"I also talk to people in order to get people's opinion. There are definitely trends to be identified, ...I am sure the pattern would emerge much quicker through talking to certain people." (Nelson, Customer Centre Manager)

"... a particular area you are interested but you are not familiar, you ask your personal assistant to find out." (Yann, Director)

Nevertheless, more and more companies are building knowledge-based or intelligence systems that collect, analyse and prepare information for the use of executives. Executives can reactively or proactively rely on the system to supply them information for further information process or decision making.

"We implant what we called knowledge based information system that we have collectively on how certain product information flow so that key respective people will be informed, or trigger will be set to inform right senior management people of what is the developing out there, what is changing, what have changed internally that would affect our business plan or what would affect our execution of our business plan." (Robert, Vice President)

"We have a system, the marketing people will collect information from our key competitors, and then they will put it in the Intranet." (Zach, External Relations Director)

The above findings imply that the people around the senior executives who provide information and who can be approached in search of useful and relevant information have a greater influence on executive's information processing behaviour. People within the organisation are among the more important and often used information sources. In most
cases, organisations consist of a specialised organisational unit that is responsible for supporting the information gathering, scanning, refining and reporting process. Within this organisational unit, there are “information workers” or “knowledge workers”, whose roles centre on seeking, gathering, analysing and interpreting information in order to provide value-added information for senior executives. Senior executives will then either perform higher level of information process or make decision based on the provision of the value-added information.

**Situational-oriented**

The findings suggest that executive's information processing behaviour is largely influenced by the executive's work situations and organisational contexts. The usefulness or value of information is based not only on the subject area or how well the information content matches a particular keyword, query, or topic, but also on the requirements, norms, and conditions that are dependent on the user's work and organisational contexts (Choo 1998). Taylor (1991) calls these organisational contexts as information use environments (IUEs), which may be grouped into four categories: sets of people (the nature of their work), problem dimensions (typical concerned problems), work settings (organisational culture, style and structure) and problems resolution assumptions (perceived and anticipated ways to problem resolution).

In terms of sets of people, the findings confirm that executives’ educational and professional training backgrounds shape their assumptions and attitudes about the nature of their work that act on their information processing behaviour. For executive who know his nature of work and strategy well, he would find it easy or quicker in his information search and process.

"I use my experience and my education and training to make sense of information." (Larry, Head of CEO)
"It's not difficult to assess whether a piece of information is important or not. Because as a senior manager, you know your strategy, your know your neighbourhood, you know your organisation." (Yann, Director)

"You know I tend to discard information very quickly. And also I tend not to look at things unless they are interesting, then I would spend my time." (Oscar, Chief Executive Officer)

Problem dimensions are the characteristics of the typical problems that a set of people are concerned with (Taylor 1991). In terms of problem dimensions, the findings suggest that executives process information based on typical issues (problems) that executives are concerned with. Strategic issues (problems) are dynamic and change over time as new information is received, thus change their perceptions. The new perceptions will cause executives to change their information search and process behaviour.

"It really depends on what we focus on that time, the focus of our business changes from time to time. Sometimes there are things that on one minute become of interest for specific topics." (Xandra, Head of IT Strategy)

"The way of choosing information to be examined further, I think it depends on issues, on particular strategic issues where you come across particular piece of information." (Oscar, Chief Executive Officer)

"...it just depends on what particularly. If it is a relatively short term issue, then it is just a question of what the issue is will determine what information needs to be investigated." (David, Managing Director)

Work settings are the social and physical attributes of the organisation or unit that a set of people work in, in which these attributes influence attitudes toward information needs and information process (Taylor 1991; Choo 1998). Taylor (1991) identified four key attributes in work settings: organisation culture, structure and style, domain of interest,
perceived accessibility of information and confident in history and experience. The interview confirms some of these attributes that influence executives’ information processing behaviour, for examples, the organisation culture and perceived accessibility of information. One senior executive recognises the challenge of how organisation’s working culture would shape people’s perceptions about the value of information, hence, influence the information process behaviour.

"I know that are certain websites which hold very good information you know which have specifically of interest to us...” (Ian, Strategic Planning Manager)

"We do gather certain things that are very interesting to our industry like regulating information...” (Becky, Head of Corporate Governance)

"... because what you tend to find people don’t like to tell people bad news. Therefore, they would filter the bad news or they would condition somewhere...because of what people provide and because of the culture as well, we hope the culture isn’t wrong here, you could end up with the wrong output based on the right input.” (John, Managing Director)

Problems resolution assumptions are the perceptions shared by a set of people about what constitutes the resolution of their typical issues (problems) (Taylor 1991; Choo 1998). These assumptions guide information search and process, for instance, provide a frame of reference to view and structure the issues, and create expectations about the information traits required to manage or resolve the issues (problems). The findings confirm that executives’ information processing behaviour is shaped or by their perceptions of what information constitutes the resolution of an issue or a problem. The problem resolution assumptions indirectly control the breadth and depth of their information search and process, for examples, how much and what kinds of information require more response, the time and effort to spend on searching and processing, and how information received is to be filtered.
“I will tend to respond on emails where come to me, something that requires my action, or if the information within there is potentially important that I might need to respond or forward it on.” (John, Managing Director)

“...the standard packs that comes through the automatic course I will tend to look through fairly quickly, if we are going into probably reserving cycles, then I will tend to review that information in a lot more detail.” (Eve, Chief Operating Officer)

“If it is 10 minutes or half an hour maximum, then I will do it. If it tends to be longer than that, perhaps a number of days of research, then it could be assigned to individual.” (Chris, Director)

In summary, the findings above confirm that executives’ information processing behaviour is situational-driven, wherein is influenced by the nature of their work, the typical concerned problems, their work settings and their perceptions about problem resolution. The heterogeneity and dynamic of executive’s work situations and organisational contexts result different approaches and intensity of their information search and process.

**Affective-oriented**

The emotional (affective) responses often regulate information processing by channelling attention to potentially important and relevant information, pointing out doubt and uncertainty, indicating likes and dislikes, and motivating effort (Choo 1998). For example, a person in an invitational mood would explore more sources while a person in an indicative mood would seek information that leads to closure and action (Kelly 1963). The findings confirm that executives’ information processing behaviour is often governed by the affective feelings and emotions, rather than the logical and systematic process. The uncertainty of executive information environment drives them to use the affective approach in information seeking and processing. As Kuhlthau (1993b) describes how the
affective responses could ease the uncertainty and increase confidence in the course of information search.

“There is no logical process. Probably emotionally say, ‘That piece of information if I don’t do something with it could have potentially big impact on the business.’” (Ford, Service Director)

“I have to map out what the future trends are, that is always a mystery but it’s just what you feel.” (Victor, General Manager of Group)

“I can personally felt that first thing in the morning. I will look at the sales report from the previous day to show top lined sales. I will go through sales first thing in the morning and if it don’t feel quite right, I will go into the system to have a look into the individual sales.” (Mark, Trading Director)

Besides the gut feelings, executives also rely on their affective judgment to make sense of information.

“It’s a jigsaw always, you take different parts of information and then you make a judgment based on that.” (Quin, Business Development Director)

“Judgement, which is based on our experiences. Our managers here in this business, a lot of producer managers tend to have 10 to 15 years of experience at least. There’s no systematic decision making process of using structured information.” (Peter, Chief Operating Officer)

The findings reveal that the affective feelings and judgment are associated with the past experiences that the executives have gained over a period of time. A more experienced executive seems to have better feel and judgment on his information process. These experiences can be industry-related or non-industry-related. Similarly, Bhattacharjee &
Moreno (2002)’s study suggests that professional experience is one factor that influences individuals' assessments of the informational value of affective reactions.

“If I am honest, I think you do it through intuition and experience.” (Ford, Service Director)

“But up to a point, you really have to base on experience which is fundamentally guts feeling that would come from industry experience, or from experience of other type of industry ...” (Robert, Vice President)

“But then through the years it's more like you read something, you say 'Hey wow, this is interesting maybe I want to know a bit more about this, and then can somebody look into that?' and that's how it proceeds.” (Smith, Chief Finance Officer)

Nevertheless, executives’ information process is not entirely affective-oriented. In most cases, the information search and process involves both systematic and affective approach. As the information search and process progress, the systematic approach helps users to verify their information, while the affective approach helps users to move from uncertainty to increased certainty, thus the feelings shift toward increased confidence and satisfaction.

“It’s a mixture but at the end of the day, when logic can only bring you up to a certain point, because human feelings sometimes don’t go based on logic, based on a lot of influences and changes that happen at that time...” (Robert, Vice President)

“I guess as you read, it comes down to feel. Although I tend to follow the same method of gathering information, a kind of systematic approach, it’s still more about feel, more about comparing.” (Nelson, Customer Centre Manager)
To sum up, executive's information processing behaviour is influenced by affective feelings and judgment through intuition and experience. The uncertainty of executive information motivates the use of affective responses in information search and process. These affective responses help to reduce uncertainty and increase confidence, thus increase the executive's ability to construct meaning or make sense of the information.

**Technology-driven**

The findings suggest that executives' information processing behaviour is moderately driven and influenced by the use and reliance of information technology or information system. Traditional information systems (technology) are unable to help executives seek trigger, speculative and current information, instead they provide largely internal, historical and precise information of an aggregated and reference nature (Mintzberg 1973). Although executives still use information systems for internal, historical and aggregated information, the findings suggest that current information systems begin to provide executives with external, current, speculative information of a trigger nature.

"We here got an Internet where we have a number of resource scanning units, so current information concerning competitors within this application is available for this sort of knowledge based data." (Becky, Head of Corporate Governance)

"And a lot of is computer-based as well, through portals to provide us information on regular basis by scanning trusted news sources." (Oscar, Chief Executive Officer)

"...we implant what we called knowledge based information system that we have collectively on how certain product information flow so that key respective people will be informed, or triggered will be set to inform right people senior management of what is the developing out there." (Robert, Vice President)

The findings suggest that executives rely on information systems more and more in their information search and process, in particular the corporate database or portal. Many
companies either build their own corporate database or they subscribe to information providers for specific information they want, such as customer and competitor information.

"The corporate database, which is what we use for the competitor information, everyone in the business has access to that and everyone can input to that, ...and it is live" (Adam, Deputy Managing Director)

"A great deal of my information comes from student record systems that we have in the university. because I spend a lot of my time collecting data from the systems and presenting it. " (Ken, Deputy Director)

"It is a electronic...in addition to simply what we get through our subscription based information sources." (Ian, Strategic Planning Manager)

With the advancement of information technology, executive’s information processing behaviour is undoubtedly shaped by the use and adoption of information systems. Nevertheless, there is need for developing a more rational executive information system that is more capable to handle current, speculative, trigger information, so that senior managers can focus on other more undefined and uncertain strategic issues. This is similar to Isenberg’s (1984) belief that, “rational systems free senior executives to tackle the ambiguous, ill-defined tasks that the human mind is uniquely capable of addressing” (p.89). The key benefits of rational systems are to provide more value-added information for decision making, as well as time saved. Huber (1984) argues that “a good deal of the information relevant to top management will not be available through computer. ...What computers and communications technology will do, however, is reduce the amount of time needed to scan less sensitive environments and thus produce more time for chats and gossip sessions that provide the soft and sensitive information that the manager needs to complete his or her mental model” (p.947).
Information-driven

From the focus group's findings, it is found that manager's information is considered as uncertain due to the over-abundance of information, the heterogeneity of information attributes, the ambiguous value of information and the diverse use of information. Mintzberg (1973) perceives that managers tend to seek for the following nature of information: current information, trigger information and verbal information. The findings suggest that executives' information processing behaviour is moderately influenced by the above characteristics contributing to the nature of executive information. For example, information that is considered as interesting and relevant will be processed more thoroughly. With the wide range of information sources, executives tend to scan the information quickly.

"Some information that comes to me I find more relevant than others, so some I will tend to just scan through and pass over, others I will tend to look at in a great deal more detail." (Eve, Chief Operating Officer)

"I mean I have a range of news sources coming to me daily. I will open them, scan what is in the headlines. ... If it has the headline terms that are relevant to the topic of my consideration, then I will look deeper." (Oscar, Chief Executive Officer)

"Some of them are very interesting, some are not interesting or that one is particularly relevant to me. I'll print that and take that into the meeting about these particular prospect." (Garry, Chief Information Officer)

With the heterogeneity of information sources and attributes, executives find it a challenge to process them, especially when they find it difficult to see the value in it. One executive summarised that the effectiveness of information processing depends on the following critical characteristics of information, which are availability, accuracy and speed.
"And media information (that is) flying around is not substantiated and difficult to substantiate. Although occasionally, it is quite representative but no one is able to really conclusively say that this is the right information." (Robert, Vice President)

"The critical aspect with information is three things really, for me, is one: availability, two: accuracy, three: speed, in that order." (Victor, General Manager of Group)

With the availability and increasing amount of electronic and distributed information, executives are compelled to use more of the formal information systems rather than the informal information systems, such as face-to-face, meetings and networking. The executive’s information processing behaviour has changed in the last decade especially with the advancement of distributed information technologies. These formal information systems enable executives to access and share information quickly, widely and conveniently. The need is to design formal information systems that are capable of handling the uncertainty of executive information due to the over-abundance of information, the heterogeneity of information attributes, the ambiguous value of information and the diverse use of information.

Cognitive-oriented, Process-oriented and Strategy-driven

The findings suggest that executives’ information processing behaviour is less driven and influenced by the thinking efforts of resolving problems (cognitive-oriented, the systematic stages of information search and process (process-oriented), and the organisational strategy (strategy-driven). Cognitive-oriented refers to human attempts to find information and bridge the situation gaps (cognitive gaps) when he or she recognises an inability to act or understand a situation because of a lack of information (Dervin 1992; Choo 1998). Dervin’s (1992) sense-making framework identifies a number of generic information gaps (situation stops) and suggests 'help categories', such as creating ideas, finding directions or ways to move, acquiring skills, getting support or confirmation, getting motivated, getting connected to others, calming down or relaxing,
getting pleasure and reaching goals. The findings suggest that executives tend to seek human connection and support in the ways he organises and analyses the information cognitively.

"...you know we are intuitive about information we get through the relationship we have in the market." (Oscar, Chief Executive Officer)

"And also a lot of the information is much, I feel, with people's connection. Without the human connection, it all means absolutely nothing, so you got to have that connection." (Victor, General Manager of Group)

Process-oriented refers to the systematic stages of information search and process. Ellis (1989a,b) and Ellis et al. (1993) derive a process-oriented model of information process from an analysis of the information-seeking patterns of social scientists, research physicists, and chemists. The model describes eight categories of information process activities: starting, chaining, browsing, differentiating, monitoring, extracting, verifying and ending. However, the findings do not support this systematic behavioural model. Executive's information processing behaviour is ad hoc and does not follow particular patterns or stages. Nevertheless, executives do occasionally use some sort of systematic processes in his information search and process. For examples,

"We locate, obtain and disseminate information that we pass on to our products."

(Victor, General Manager of Group)

"I would say that most of the time we will use our logical or systematic approach first and then at the end of it will have to base on experience, that's what we are paid for..." (Robert, Vice President)

The previous findings confirm that the executive's information processing behaviour is mostly driven and influenced by executive's work and organisational contexts (situational-driven). Executives are more concerned with current information and typical
issues (problems) that require their attention. As the executives’ information processing behaviour is largely driven and influenced by the typical concerned problems, the findings suggest that executive’s information search and process is fairly driven by business strategy. For examples,

“We have our own strategies, longer term and short term strategies. ... So we are very sensitive because we can easily feel whether the specific piece of information has any impact on my overall strategy, whether is short term and long term.”
(Yann, Director)

“We got key performance indicators in the business. And it’s obviously those we focus on when we try to understand how to make them better or from getting worse.” (William, Operations & Systems Director)

6.3.1 Implications for improving executive intelligence activities
Similar to most of the studies of information behaviour, this study confirms that information behaviour is shaped and influenced by multiple factors. Key factors that influence executives’ information processing behaviour are the people who work with the executives, the executive’s work and organisational contexts and the affective feelings of executives. Other factors that influence and shape executives’ information processing behaviour are the use and reliance of information technology, the nature of executive information, the systematic stages of information search and process, the organisational strategy and the thinking efforts of resolving problems. Understanding these factors that influence executive’s information processing behaviour provides implications of the following additional and/ or complementary support on executive intelligence activities.

a) Additional human support of processing intelligence
The study suggests that executives with time constraints tend to rely on the people around them or a specialised organisational unit for information seeking, gathering, scanning, refining, and analysing support. This specialised organisational unit is often addressed as information processing unit or intelligence processing unit, that consists of “information
workers”, “knowledge workers” or “intelligence specialists”, who assist executives in information search and process. They need to have a wide knowledge of information sources and skills in exploiting and organising information, coupled with analytical skills in evaluating and interpreting information (Xu & Kaye 2002). Stacey (1990) states that organisations need “Intelligence Services” that seek and analyse information which help providing insights of internal and external business environments. Beer (1972) suggests the need for an information role in an organisation. Tyson’s (1990) “wheel of information” argues the need to coordinate the gathering and disseminating of information without leaving information unused. Stacey, Beer and Tyson all contribute to our understanding of the need for human support of processing intelligence. Market research, corporate planning, competitor intelligence, and competitive intelligence are examples of current human support of processing intelligence. All these human supports of processing intelligence are often viewed as a function rather a process. They provide information based on predetermined information criteria and needs, thus are incapable of coping changes of strategic issues (problems).

The study also reveals that executive’s information processing activities is greatly influenced by the executive’s work and organisational contexts, such as their problem dimensions and work settings. For example, the study suggests that executives are concerned with typical issues (problems) at particular situation, context and time. These concerns may change as the issues (problems) change. This alters their attitudes towards information needs and information process. Another example is the work settings, organisation culture, structure and style, domain of interest, perceived accessibility of information and confident in history and experience influence executive’s attitudes towards information needs and information process.

The implication of this study is that there is a need to provide human support of processing intelligence for two reasons. First, executives often lack the time to process information that is difficult to be supported by computer-based systems, such as interpreting information for decision making. Second, executive information is situational-driven, whereby some of their works and concerned problems are difficult to
be supported by computer-based systems. Nevertheless, the human support of processing intelligence should be viewed as a process – continuous learning activities of organisational members concerned with executive’s work and organisational contexts. Besides having an agent-based EIS for supporting executive intelligence activities, this finding implies that additional human support of processing intelligence could improve the overall support on executive intelligence activities. Future research would examine how the additional human support of processing intelligence should take place in agent-based environment for improving executive intelligence activities support.

b) Additional affective support of processing intelligence

Research in neurobiology indicates that emotions play an important role during information searching and processing (Damasio 1994; LeDoux 1996). The study suggests that executives’ information processing behaviour is often governed by the affective feelings and judgment through intuition and experience, rather than just the logical and systematic process. The systematic approach helps executives to verify their information. The affective approach helps to reduce uncertainty and increase confidence, thus increase the executive’s ability to construct meaning or make sense of the information (Choo 1998). The implication of this study suggests that there is need to support affective responses for two reasons. First, executives’ incremental training and experiences lead them to trust more on their gut feelings and intuition in the information search and process. Second, as the information search progresses, affective responses are able to shift toward increased confidence and expectations. Technically, it may seem impossible to understand and identify user’s affective states, but Picard (1997) argues that if computers will ever interact intelligently with humans, then they need the ability to at least recognise and express affect.

Affective computing is a very new area of research, primarily in the recognition and synthesis of facial expression and voice inflection. But Picard (1997) describes over fifty possible applications in learning, information retrieval, communications, entertainment, and human interaction where affective computing would be beneficial. One feasible example to recognise user’s affect is by extracting facemarks (emotions) in text and
classifying them into some emotional categories (Tanaka et al. 2005). This may support information search and process intelligently, for example, by building user’s information profile with affective categorisation. Even though the affective support in processing intelligence is still a long way to go, at least we must recognise how the affective states influence executive intelligence activities. The future research can look into how affective computing can possibly be incorporated into an agent-based environment for supporting executive intelligence activities.

c) Improved technology and information support of processing intelligence

Evidently, this study aims to meet the goal of having an improved technology, thus improved information support of processing intelligence. With the advancement of information technology and the increasing amount of distributed information, the finding suggests that there is need for developing a more rational executive information system for two reasons. First, executive information is uncertain due to the over-abundance of information, the heterogeneity of information attributes, the ambiguous value of information and the diverse use of information. Second, the development of agent technology offers intelligence solutions and contributes to knowledge based intelligent systems development (Janca & Gilber 1998; Sycara et al. 1996; Klusch 2001). This system would allow executives to access and share information quickly, widely and conveniently. The next section will build on the first empirical focus group study and explore more in-depth on how an improved technology and information support of processing intelligence can be designed. An agent-based design model is proposed as a more rational approach for supporting executive intelligence activities.
6.4 Findings and Discussion: Agent-based Support for EIS

This section examines further on the usability-adaptability-intelligence trichotomy in detail, as proposed in Chapter 5. Section 6.4.1 and 6.4.2 describe and discuss the findings on usability criteria, which is considered as the most critical and value-added design criteria in agent-based EIS. Section 6.4.3 and 6.4.4 reports on the adaptability criteria. Lastly, Section 6.4.5 and Section 6.4.6 reports on the intelligence criteria.

The interview findings confirm the focus group findings on executive criteria of agent-based support EIS. The interview findings provide further insights on *value-added attributes* for each design criteria, as depicted in Table 6.2. *Value-added attributes* are functional requirements needed for an agent-based system to support executive intelligence activities. Later, the interview discussion also suggests implications on *value-added processes* for each design criteria. *Value-added processes* are specific activities performed by agent-based system that add value (i.e. support, enhance) to the executive intelligence activities. The interview findings will also refine the initial agent-based EIS design model as suggested in the focus group study.

Table 6.2 Percentage of interviews coded at three executive criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value-added Attributes</th>
<th>Percent</th>
<th>Total Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability</td>
<td>Personalisation</td>
<td>≈ 16%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Controllability</td>
<td>≈ 14%</td>
<td>≈ 47%</td>
</tr>
<tr>
<td></td>
<td>Manageability</td>
<td>≈ 9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
<td>≈ 8%</td>
<td></td>
</tr>
<tr>
<td>Adaptability</td>
<td>Coaching</td>
<td>≈ 11%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contextual Support</td>
<td>≈ 10%</td>
<td>≈ 33%</td>
</tr>
<tr>
<td></td>
<td>Learning</td>
<td>≈ 6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semantic Support</td>
<td>≈ 6%</td>
<td></td>
</tr>
<tr>
<td>Intelligence</td>
<td>Autonomy</td>
<td>≈ 7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proactivity</td>
<td>≈ 6%</td>
<td>≈ 20%</td>
</tr>
<tr>
<td></td>
<td>Reactivity</td>
<td>≈ 4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>≈ 3%</td>
<td></td>
</tr>
</tbody>
</table>
Table 6.2 depicts the percentage of total interviews coded at different value-added attributes (nodes) for the three executive criteria. The percentages are not the main mode of qualitative analysis, but to provide the overview idea of relative importance of each criteria and value-added attribute in an agent-based EIS design. The results show that usability design (about 47 percent) is considered the most critical and value-added criterion in agent-based support EIS, followed by adaptability design (about 33 percent) and intelligence design (about 20 percent).

6.4.1 Level 1 – Usability

Usability refers to the extent to which a system can be used by specified users to achieve specified goals of information processing in a specified domain of work and information. From the focus group study, three value-added attributes contributing to usability criterion are recommended: ease of use, personalisation and controllability. These attributes serve as the initial themes (nodes) for explanatory analysis. The findings, however, suggest that manageability is another key value-added attribute for usability design, as illustrated in Figure 6.2 and Figure 6.3.

![Figure 6.2 Value-added attributes in usability design](image-url)
Overall, the interview findings suggest and confirm four key value-added attributes contributing to usability design. Personalisation and controllability are perceived more important than ease of use and manageability, as depicted in Table 6.3. This percentage is based on the number of each attribute (node/theme) coded from all participants in comparison to the overall value-added attributes (nodes) of the three design criteria. Here, the percentage is not the main mode of qualitative analysis, but to provide the idea of relative importance of each value-added attribute in an agent-based EIS design.

Table 6.3 Percentage of value-added attributes of usability design

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value-added Attributes</th>
<th>Percent</th>
<th>Total Percent</th>
</tr>
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</tr>
<tr>
<td></td>
<td>Ease of use</td>
<td>≈ 8%</td>
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</tbody>
</table>

Figure 6.3 Agent-based EIS Model: Level 1 – Usability (generated from Nvivo)
Figure 6.3 illustrates the value-added attributes of usability raised by different participants. This model suggests three preliminary insights:

a) **User’s perception of attributes** – The model depicts that 23 out of 25 (92 percent) participants had raised the different issues related to usability design. Both middle and senior managers have contributed opinions and suggestions for designing usability. From the managers’ perception, this implies the criticality of usability design in an agent-based EIS.

b) **Significance of attribute** – The significance of attribute can be viewed from the concentration of lines (documents) that emerges from each attribute. Personalisation and controllability consist of more lines than ease of use and manageability. This implies that personalisation and controllability have greater significance than ease of use and manageability in designing usability.

c) **Relationship between attributes** – The relationship between attributes can be seen to a certain extent by examining the frequency of different related attributes or issues raised by the same participant. Many intercepts can be seen in this model, whereby 17 out of 23 participants who raised about the usability issues (about 74 percent) state more than one issue related to usability design. The model shows that virtually all attributes are associated with one another. The strong interrelatedness of attributes suggests that participants are able to communicate the need for usability design with greater insights and perspectives.

**Value-added Attributes in Usability Design**

**Personalisation**

Personalisation is the ability to manage and customise information for specific executives for specific purposes based on individual executives’ profiles and interests. Many participants had expressed the need for a personalised system, rather than a generic system that produces too much generic information. Personalisation and customisation are often used interchangeably. According to participants, the main objective of
personalisation is to produce information of user interest and as little generic information as possible.

"Absolutely, it should be customisable. Or else, it will be too much generic information being in there, which is what I don’t want. My perception is the whole point of this kind of intelligent agent that you are talking about is my personal assistant. It delivers me the most meaningful information and cuts out all the irrelevant one. As little generic as possible." (Larry, Head of CEO)

"And the other problem is because it is not personalised, it is actually generic system that serves within the company, so even if it’s stuff that I’m not interested in but there will be other people who are interested in it..." (Eve, Chief Operating Office)

The concept of ‘personal assistant’ is well understood by senior executives. Participants see the potential of having the software agents to act as their ‘personal assistant’ in their information searching and processing. The role of an agent-based personal assistant must depend on individual executive, providing a personal approach to users in accordance to their preferences, interests and needs. This includes the type of assistance an executive want and how the executive wants to be assisted in different context. It is also critical that the role of an agent-based personal assistant does not prevent information from coming to executives as what sometimes happen in the role of a human personal assistant.

"Very much depend on individuals. Some managers are very controlling, so their parameters would be ‘send me everything’, some managers would be ‘send me the top ten percents of information relevant to me’, or ‘I just want the flavour of what is going on in the businesses’. It’s a personal assistant, so it should have personal way to enable how the system should operate for you." (Ford, Service Director)
"If the software agent is my personal assistant, I think it is the same with that, it shouldn't become a barrier to information flowing to me." (Oscar, Chief Executive Officer)

Three modes of personalisation were identified from the interviews. Firstly, the system is able to personalise according to the nature of the business and the subject areas of the business that are interested to the executives – the **domain-related personalisation**. This encompasses the industry specific as well as departmental specific.

"I think you have to make sure that it can interpret in the light of your own subject matter. For example for travel insurance, somebody who's interested in the implications for tourism would have a very different spectrum compared to somebody who's interested in airline investment." (Eve, Chief Operating Officer)

"Well, everybody who uses it will have slightly different requirements so the ability to personalise it will be useful because then people could focus on specific areas and critical areas. So if you take pricing for instance, it is critical and importance to the people in the businesses who price our products, they would probably want to focus on pricing whereas other people who were looking at market share and sales penetration would want something that is slightly different, so some personalisation would be useful." (David, Managing Director)

"I'd like geographical information on where the application is coming from; I'd like demographic information on the nature of applicants on a regularly basis; I'd like information on module enrolments on weekly basis; I'd like information on the structure of the students' cohort in terms of age, well demographic information." (Ken, Deputy Director)

Besides the industry-related personalisation, the ability to personalise according to the role of executives is likewise critical – the **role-related personalisation**. This includes the hierarchical roles and the different managerial roles as identified by Mintzberg
(1973). For examples, a senior manager who is concerned primarily with interpersonal roles will gather and process information different from those who are involved in making significant changes.

"If I am using this tool, I would want to be reasonably exclusive. Maybe it depends on the role that I am involving in. My personal requirement that I would use such an agent, I would be very specific about the kind of things that I am searching for ..." (Nelson, Customer Centre Manager)

"I think the key feature is getting to understand what you regard as relevant information. That's all about personalising it to your role ..." (William, Operations and Systems Director)

"It would be very much about target the information relevant to the role of individuals playing within the organisation. It will save a lot of time, effort and energy, if there is some capability within the system to target information at certain level. The financial director would like something different from the middle manager." (Ford, Service Director)

Thirdly, the system is also able to personalise according to the preference of executives – the preference-related personalisation. This focuses on information presentation and dissemination which could affect their speed of decision making process. Some senior executives prefer information to be presented in texts, quotes, paragraphs, pictures, graphs or tables. The system must provide different options for executives to choose and adopt the way information is presented and delivered to them.

"... and in some ways your way of taking on board information, some people like say on board information on pictures, other people might like text. So, it's the learning to give it in a way that we would like to see it." (William, Operations and Systems Director)
"I think that you could, within the user profile, you could actually break down, what type of users they are and whether they want in streaming texts, in pictures, in quotes, or in a small chunks.” (Victor, General Manager of Group)

In summary, the goal of personalisation is to design a user-centred and user-driven system. An EIS must be personalised according to user’s domains, roles and preferences. This implies that the system has to be customised according to identified user profiles – domains, roles and preferences, which reflect the individual user needs and specific industry sectors.

**Controllability**

Controllability is the ability to exhibit control over executive’s information profiles and work profiles. Firstly, the findings suggest that it is important executives can personally define specifically the information search criteria based on their needs and requirements. System developers are unlikely to know the specific information request of executive because executive’s information requirements are changing over time and over different issues. Many participants had stressed the need of having control over their specific information requirements.

"It depends on the nature of question that I ask, I can pose a question, for example, “I want to know the range of business related courses, let say half dozen of the geographical competitors”, quite a specific request that can be dealt with. That would be helpful. ...If the announcement comes from HEFEC about the enrolment this year, that shows what’s really happening in the league table of universities. That again, if you could specify, that could be useful information that feeds into the system for decision making.” (Chris, Director)

Secondly, the executives must be able to determine the information process criteria based on their needs and preferences. This creates the flexibility of information acquisition and processing. Executives are allowed to give instructions to the system, rather than depending on system developers. For examples,
"In order to pick up information on the content, and you can specify to what you know, for example, to pick up a phrase, which is entire phrase or you can say anywhere within where it has at least that word anywhere in any proximity." (Ian, Strategic Planning Manager)

"It's not just a word search but the whole series of instructions that you can give, and perform the searches, takes out the rubbish, and present it to you for the course of action. That would be very useful." (John, Managing Director)

Thirdly, it is important that executives can change and redesign their information domain and their work profiles without depending on system developers. The system should not be a fixed system, but a flexible system that allows changes to be made.

"We always customise, but, after you customise, the user should have certain capability of redesigning it, but a lot of system today allow that (customisation) but they do not allow certain major definition change. ...I think one final thing would be system flexibility and to allow user to change if they need to change." (Robert, Vice President)

"You need to be easy to establish what the filters are, and get to use it. And allow people to change their criteria, i.e. how much information they are getting, how often, the relevance, more specific or more general." (Tim, Middle Manager)

Hence, this implies that an EIS requires more flexibility with more user control over what and how executives want information to be acquired and processed. It suggests that the more control over the system, the more likely executives are going to use the system.

**Manageability**

From the findings, most participants recognised the problem of information overload. Senior executives are constantly bombarded with more information than they can
possibly absorb and digest. The participants emphasised the need to reduce information to a digestible, manageable and appropriate amount at appropriate interval. Clearly, senior executives have little time that is available for information processing.

"I think the key to it is it does come out with relevant information, and it comes out with probably a digestible amount of relevant information." (William, Operations and Systems Director)

"We don't want too much. It has to deliver an appropriate amount of information at appropriate interval." (Tim, Middle Manager)

"As the volume of information is exploded on the internet, obviously we recognise we need to reduce to something manageable." (Peter, Chief Operating Officer)

According to participants, manageability is the ability to cut down and cut up (break apart) information to the appropriate amount for efficient process. Key points, headings, paragraphs and summary are more manageable and digestible. However, users are still able to drill down into the content details for more information explanation if needed.

"As I said earlier, the ability to produce an appropriate amount of information. So ideally, you want key points from an article on a subject, and then you want to be able to drill down into that if you find a particular area that is particularly useful or interesting. ...I am looking for is to cut down to the bare minimum information I have to process." (William, Operations and Systems Director)

"I think it has to be simplified, it should be one set of information that allows a human to digest ..." (Robert, Vice President)

Participants are aware of their information processing ability. Different individual will have different processing power in making sense of information. Executives find that it is
easier to process or make sense of one or a few key sets of information at a time. Here, manageability is positively associated with the ability of information processing.

"I think it has to be simplified, it should be one set of information that allows a human to digest, because every brain is different size with different ability of processing power."

"...a dozen key drivers of business is manageable... I just can't cope with that because I have small brain." (Chris, Director)

It is also found that manageability is strongly linked to the decision making process of senior managers. For them to make quick decision, they need only few key indices of information that is readily processed and available. Ideally, the system should not present too many decision points in one set of information. Information comprises many decision points should be broken into smaller pieces for quicker decision making.

"If you want to make decisions very quickly, that's what tactical and strategic decision based information, you want minimum amount of information, readily processed, so that you can click on." (John, Managing Director)

"I think to set a criteria for any kind of system that one can really use it, you need only few key indices for decision making which means those information must be always readily available ...Information should be presented in very simplified form. Lots of time people present too many decision points in one set of information. (Robert, Vice President)

Manageability is also associated with the quality of information. The assumption is that by providing more data and information, the better for executives to find solutions to their answer. This is, however, incorrect. According to the participants, the quality of information decreases if information is beyond what they can manage.
"...a dozen key drivers of business is manageable, anything more than that ends up lower quality. (Chris, Director)

...on the average I think you don’t want to be crowded more than a certain numbers handful of information if too much then it’s poor presentation even though you know you got good information." (Robert, Vice President)

However, manageability does not mean the reduction of information to the minimum with overly critical specification and definition. It needs a balance in between the specific and broad definition of information search. The goal of manageability is to increase the information processing ability and decision making process.

"If you make it far too specific, you might not get what you are looking for. Somewhere between the two, there’s a balance. If you define far too critically, you never know what you’ll get it. If you define too broadly, how many millions of references you’d likely to get.” (Chris, Director)

To sum up, manageability refers to the ability to provide appropriate and digestible amount of potentially useful and relevant information at appropriate interval in accordance to individual abilities of processing. This implies the need for a more intuitive information filtering and refinement process.

**Ease of Use**

Ease of use aims to reduce the difficulty of using the system via relevant interface in order to increase the accessibility of information. Executives are impatient users due to daily time constraints, thus, unlikely to devote much time in computer-based information support systems. The ease of use is associated with the frequency of using the system interface for information processing. The easier to use the system, the more likely the executives would engage with the system. Several participants had raised the need of having a simple and user-friendly interface.
“Firstly, a very simple interface, make the whole interaction with the site much easy. Usually, the more easy the more you’d like to use it. ... My answer to that would be easy functionality. ...(Ford, Service Director)

“You need to make this simple, you make it more user-friendly ...” (Victor, General Manager of Group)

Senior executives are more accepting if a system that leads them quickly to the information they want with minimum steps. For example, a few steps of navigation and selection will lead them to information they want. Any complicated systems are likely to hinder them from using the system. This suggests the importance of accessibility in ease of use design.

you just want to click, and click, and click, and yes, that’s what I want. Anything more than 4 levels will switch people off. So anything you design, maximum is 4 levels.” (Ford, Service Director)

“We try to keep things very simple and basic. The business users can still understand what’s going on and how technology works. It needs to keep things simple even it has advanced technology behind it.” (Peter, Chief Operating Officer)

The browsability is strongly associated with the ease of use. Executives prefer an environment that is not too busy and congested, yet focus on key issues. Executives are fine with the combination of different information format, such as graphic, tabular and textual information on a single screen, as long as not overdoing it. The key factor of browsability and formatting are to increase the speed of information processing, such as easy reading, and easy spotting of critical information.

“Not too busy, not too congested. If you don’t see the most important message because there are so many other pop-ups, don’t do that, just let it focus on the
main issues. You can combine a few things in one screen, that's fine, don't overdo it. Easy reading, that's crucial, I would say.” (Smith, Chief Finance Office)

In summary, senior executives desire a user-friendly support system with simplicity, browsability and accessibility. The implication of ease of use attribute in EIS is so that minimal training is required and users can still understand how the system works for them.

6.4.2 Discussion and implications for usability design

The definition of usability has been derived from different viewpoints. The definition given in the ISO standard for software qualities (ISO 1991b) is product and user-oriented, "a set of attributes of software which bear on the effort needed for use and on the individual assessment of such use ...". Another definition from ISO ergonomics is usage, user and contextually oriented, “the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments” (ISO 1991a). Eason’s (1988) definition is ease-of-use oriented, “the degree to which users are able to use the system with the skills, knowledge, stereotypes and experience they can bring to bear”. Here, usability refers to the extent to which a system can be used by specified users to achieve specified goals of information processing in a specified domain of work and information. The specified goals involve the design for ease of use, personalisation, controllability and manageability.

Usability is rarely discussed in the conventional views and guidelines of EIS design. The relevant areas discussed in the conventional EIS studies of usability design are mainly ease of use and value added presentation of data via user-friendly interface such as graphical, tabular, and/or textual information presentation (Watson et al. 1991, 1997; Warmouth & Yen 1992; Nord & Nord 1995; Young & Watson 1995). Data is mainly processed (i.e. summarised, aggregated, analysed), prepared and reported to executives using friendly and colourful interface. It has long been pointed out that the features of the interface determine usability, and hence the interface becomes a critical determinant of
acceptance and use of an executive support system (Zmud 1986; Young 1987). Some of
the noted interface-related characteristics include (Young 1987):

a. **Portability**, due to the executive style of peripatetic interpersonal interaction.

b. **Multi-media input provision**, including voice recognition, notebook and
   scratchpad entries, due to the executive style of using verbal text messages as
   well as symbols and numeric data.

c. **Natural language recognition**, for the same reasons above.

d. **Ease of control and use**, to avoid barriers to usage by busy executives who
   probably would not stop their normal activities in order to figure out how to
   use the EIS.

Conventional guidelines also emphasized that the system should require minimal or no
training and operate without user manuals or any form of instruction other than what is
available on the screen or immediately available through a ‘help’ function (Jordan 1993;
Young & Watson 1995). This is akin to Zmud’s (1986) emphasis on the importance of
simplicity in exercising control over the selection and manipulation of system functions.
Other than that, there is little research on the usability design of EIS.

The above findings that provide quotations and their extractions serve to highlight the
critical importance of the usability criterion and value-added attributes in usability
design, and some of the concerns that underpin that criticality. The usability criterion is
perceived as the most critical in an agent-based EIS design. Four attributes are identified
as value-added attributes in usability design of an agent-based EIS. Overall, the findings
suggest that there are relationships between the usability criterion, and executive’s
problem identification and decision-making process. The personalisation attribute and
controllability attribute increase the frequency of using the system and the manageability
attribute and ease of use attribute increase the speed of information gathering and
processing, thus, contribute to the increase of the speed with which problems are
identified and decisions are made. Leidner and Elam (1994) examined the relationship of
EIS use to the executive’s decision-making process. They found that EIS use was
positively and significantly associated with problem identification speed and decision-
making speed, as well as with the extent of analysis in decision-making. Therefore, an EIS system must consist of attributes that can foster executives to use more of the system with efficiency, satisfaction and effectiveness in problem identification and decision making. The following four attributes are identified as value-added attributes in usability design of an agent-based EIS. Although these are key attributes identified, personalisation and controllability are perceived as more value-added than manageability and ease of use. For each value-added attribute identified, the findings also suggest implications for value-added processes, which are specific activities that could support and enhance executive intelligence activities.

**Personalisation**

The first and primary value-added attribute in usability design is the personalisation attribute. According to Riecken (2000), personalisation is motivated by the recognition of user’s needs, and aiming to meet those needs which are likely to result a satisfying relationship with the user. Bonett (2001) states that personalisation is a process of gathering user information (profile) during the interaction with the user, which the user profile will then be used to provide appropriate assistance or services, customised to the user’s needs. Although there is a distinction made between customisation and personalisation (Bonett 2001), here, we assume personalisation is possible to occur in an active or passive mode. An active mode of personalisation (customisation) means that the user configures the profile according to his or her interests and needs through an explicit interface, which is user-driven. A passive mode of personalisation is rather system-driven, which involves the system to figure out user profiles, hence, suggest appropriate assistance or services. This is more likely to involve the learning capability of the system, which will be discussed under the adaptability criterion. Blaylock and Rees (1984) and Watkins (1984) argued that decision makers with different cognitive styles prefer different sets of information. The value and usefulness of information cannot be evaluated effectively without considering who uses that information. Hence, the executive’s expressed need and preference for specific information should be critical factors that determine the design of EIS.
The importance of personalisation according to senior executives lies on its potential to provide information of user interest and as little generic information as possible. Executives would accept an agent-based personal assistant, as long as the agent does not prevent information from reaching them. The findings suggest that personalisation allows executives to manage and customise information for specific purposes based on their individual domains, roles and preferences. This suggests a user profile that contains domain-related information, role-related information and preference-related information. Schiaffino and Amandi (2004) have empirically studied a set of personalisation issues that agents have to take into account, such as the type of assistance a user wants, learning when (and if) to interrupt the user, and how the user wants to be assisted in different context. They suggest a user profile that contains application-dependent information, application-independent information and user-agent interaction information. An application-dependent information includes mainly personal information about the user, such as name, job, hobbies and roles. Application-independent information includes a user’s interests, preferences, needs, knowledge, priorities and goals. User-agent interaction information consists of user’s interaction habits and behaviours, such as his assistance needs in different contexts, his reactions towards different assistance actions such as suggestions, warnings and interruptions and about his styles of delegating tasks to the agent. The above user profile will enable software agents to enhance and personalise not only the information gathering and processing activities, but also the interaction between the user and the system.

**Controllability**

The controllability attribute that allows executive to exhibit control over their information profiles and work profiles is essential. Since the introduction of management information systems (MIS), Ackoff (1967) has pointed out that an MIS should not be implemented unless the managers for whom it is intended are trained to evaluate and thus control the MIS rather than be controlled by it. In one of the Scapin and Bastien’s (1997) ergonomic criteria of designing human-computer interfaces, *explicit control* concerns both the system processing of explicit user actions and the control users have on the processing of their actions by the system. They argue that when users explicitly define their inputs and
when these inputs are under their control, it favours learning and thus diminishes the probability of making errors, making the system more acceptable and predictable. This explicit criterion consists of explicit user action and user control. Explicit user action refers to the explicit actions requested by the users, while user control refers to the control capabilities the user should have over the ongoing processing of the system.

Jones and McLeod (1986) demonstrated that executives can manage information to some extent by controlling the choice of information sources and media. Empirical studies have shown that searches are actively interested in their search and are keen to feel in control over what information is included or excluded and why (Ellis 1989a, b). Our findings suggest that executives want to have control over their information profiles, such as sources, types and contents, as well as their work profiles. Executives reject the idea of depending system developers to determine their information needs and requirements. The explicit user action criterion applies to this context, where executives define their own input according to what they want and need. The rationale is as the system processing generate results from explicit executive input, executive would learn and understand better the application functioning and thus generate less irrelevant information. Hence, it is necessary to design a flexible EIS that allow users to determine their information process criteria based on their personal needs and requirements. The findings also imply that executives must be able to make changes on their information process criteria because their information needs and requirements are changing over time and over different issues. This applies to the criterion of user control, in which executives are able to exhibit control over the ongoing processing activities of the system. The rationale is control over the interactions favours learning and thus making the system more acceptable to the executives.

Manageability
From the findings, manageability attribute is the ability to minimise information density to a digestible, manageable and appropriate amount at appropriate interval. The over-abundance of distributed and heterogeneous information has created an environment in which executives are pressurised to spend more time scanning through potential
information sources in order to identify information of their interest. Ackoff (1967) argued that “Unless the information overload to which managers are subjected is reduced, any additional information made available by an MIS cannot be expected to be used effectively” (Ackoff 1967, p. 148). Likewise, Scapin and Bastien (1997) argue that the less users are distracted by unnecessary information, the more they will be able to accomplish their task efficiently. It is essential to minimise the information density, that concerns the users’ workload from a perceptual and cognitive point of view with regard to the whole set of information presented to the users. They argue that users’ performances are worsened when information density is too high or too low. The manageability attribute is very closely related to information filtering (Belkin & Croft 1992; Foltz & Dumais 1992). The goal is to screen through large volumes of information and to present users with information likely to satisfy their information needs and requirements.

From the findings, manageability increases the information and decision making process of executives. Executives find that small set of information is easier and quicker for them to process or make sense, thus, increase the overall quality of information. However, it is important to avoid too many decision points in one set of information. To do so, key points, headings, paragraphs and summary that highlight the imperative messages are useful to minimise information density to an appropriate amount for efficient process. Nevertheless, the option for users to drill down into the information details for more explanation and understanding must be made available. The findings also imply that manageability is not so much about leaving things out with overly critical specification and definition of information search, like traditional information filtering but instead dissecting (i.e. cutting down and cutting up) information for efficient information process.

**Ease of use**

According to Taylor (1986), ease of use has to do with system elements that are able to reduce difficulty in using the system. These elements include browsing, formatting, interfacing and accessibility capabilities. *Browsing* is the capability of the system to
allow user to scan information and find information of value quickly. Formatting concerns the visual presentation and organisation of information in ways that allow more efficient processing. Interfacing is the capability of the system to interpret itself to users in order to help users to get good answers from the system or to help users understand and gain experience with the system. And, accessibility refers to ease of access to information.

Based on the above elements, ease of use in conventional EIS design mainly refers to the formatting element, in which information is presented via visual presentation and organisation of information such as graphical, tabular, and/or textual information (Watson et al. 1991; Warmouth & Yen 1992; Nord & Nord 1995; Young & Watson 1995). From the findings, executives raised the issues related to simplicity, accessibility and browsability. According to senior executives, simplicity can increase the use of EIS with easy functionalities and user-friendly interface, similar to the interfacing element. Accessibility can reduce time and steps needed to gain access to information needed via simple or minimum steps needed to find answer from the system. Browsability can increase the efficiency of information process via uncluttered information presentation and organisation. This can be combined with appropriate formatting element as long as it increases the speed of information processing, such as easy reading, and easy spotting of critical information.
6.4.3 Level 2 – Adaptability

Adaptability refers to the extent to which the system fits the specified and right context of work and information, with the ability to strengthen the responsiveness of system in coping with the uncertainty of executive information. The adaptability criterion aims to increase the level of relevance and contextualisation of information, with the appropriate semantic and contextual support. From the focus group’s findings and discussions, value added attributes contributing to adaptability design are learning, coaching, contextual support and semantic support mechanisms. These attributes serve as the initial themes (nodes) for further explanatory analysis, as illustrated in Figure 6.4.

Overall Findings

Overall, the interview findings suggest and confirm four key value-added attributes contributing to adaptability design. This percentage, as depicted in Table 6.4, is based on the number of each attribute (node/theme) coded from all participants in comparison to the overall value-added attributes (nodes) of the three design criteria. The percentage is not the main mode of qualitative analysis, but to provide the idea of relative importance of each value-added attribute in an agent-based EIS design. Coaching is perceived more important than learning, in which executives are more willing to provide feedback to the system than having the system to learn about the executives in the background. This implies that executives trust their own evaluation and feedback more than the system.
Nevertheless, the executives are not against the self-learning capability of the system. Contextual support is perceived more important than semantic support. This suggests that the provision of richer information is more essential than the allocation of meaning to the information. In addition to this, executives prefer to use natural language to acquire information, rather than identifying appropriate keywords for information searching.

Table 6.4 Percentage of value-added attributes of adaptability design

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value-added Attributes</th>
<th>Percent</th>
<th>Total Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptability</td>
<td>Coaching</td>
<td>≈ 11%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contextual Support</td>
<td>≈ 10%</td>
<td>≈ 33%</td>
</tr>
<tr>
<td></td>
<td>Learning</td>
<td>≈ 6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semantic Support</td>
<td>≈ 6%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.5 Agent-based EIS Model: Level 2 – Adaptability (generated from Nvivo)
Figure 6.5 illustrates the value-added attributes of usability raised by different participants. This model suggests three preliminary insights:

a) **User’s perception of attributes** – The model depicts that 20 out of 25 (80 percent) participants had raised the different issues related to adaptability design. Both middle and senior managers have contributed opinions and suggestions for designing adaptability. This implies that managers perceive adaptability as the second importance in an agent-based EIS design.

b) **Significance of attribute** – The significance of attribute can be viewed from the concentration of lines (documents) that emerges from each attribute. In comparison to Figure 6.3, the model generated on usability criterion comprises more lines (documents) than Figure 6.5. This confirms the focus group findings and recommendation that usability criterion is more essential than adaptability criterion. In terms of adaptability design, the issues related to coaching and contextual support were raised more than the learning and semantic support. This implies that coaching and contextual support have greater significance than learning and semantic support in designing adaptability.

c) **Relationship between attributes** – The relationship between attributes can be seen to a certain extent by examining the frequency of different related attributes or issues raised by the same participant. It is noted that less intercepts are depicted here in comparison to usability design (see Figure 6.3). In this case, 12 out of 20 executives (60 percent) state more than one issue on the need for adaptability design. Most of the attributes are relatively associated with one another. The less interrelatedness of attributes suggests that participants find it not easy to communicate the need for adaptability design with greater insights and perspectives.
Value-added Attributes in Adaptability Design

Coaching

Coaching is the capability to train the system in order to increase its robustness, thus, to support the user in successfully achieving their objectives in the work domain and information domain. Coaching is considered the most important attribute in adaptability design. One way to coach the system is to provide explicit feedback on the relevance of information acquired, hence, gradually build the individual user profiles that contain user's work domain and information domain. Participants had expressed their desires of having the ability to coach the system by giving feedback, monitoring, revising and thus improving the information process.

"Be able to provide feedback to the system, that will be good. ... Some functionality that allows you to go back to the agent and say 'it should be more like this', and then it will go away to find more information on that subject, on the issue, whatever it is. That would be useful." (Larry, Head of CEO)

"You have to give feedback to the system to increase the relevance of information." (Ken, Deputy Director)

"I think the ability to revise the filters as you see what you're getting, because very often you don't know what it is you haven't asked for until you see what you have or you see the answers, so the ability to keep track and revising and improving on the filtering would be important." (Eve, Chief Operating Officer)

Participants perceived coaching as an interactive process of assessing information retrieved. The user is able to give feedback to the system whilst the system is able to request confirmation or clarification from the participants. One of the reasons is that relevance assessment of executives can be relatively subjective. Participants are willing to give feedback to the system by being asked or prompted, as long as it improves its search and filter capabilities.
"The current ware of system is not user-determined effectively, is not interactive ... you need to measure interactivity ... for example, "you say that, do you really mean what you just said? Do you really want to do that?" ... be able to say 'this is not the right answer', 'that's not I want', or 'that's not what I asked for'." (John, Managing Director)

"The other thing to help refine the system is that it can come back to me and say 'Did you get what you wanted? Yes or no.' ... 'is it prioritising this word or that word?'" (Ford, Service Director)

"Refinement is very much saying 'you say that, and I can get this or that, which you prefer?"'

According to the participants, the interaction between the system and the user will help refine the information process.

"If filtering and refining were interactive and intelligent, we can use the feedback to improve refinement." (Peter, Chief Operating Officer)

The coaching mechanism has to be very simple and straightforward, according to the participants. For examples, users just select from the options given in order to update and refine his user profile. Clearly, senior managers are unlikely to commit to a complex mechanism.

"And also, you want the agent to learn the information that's given to it. It's about feedback, but I believe the feedback mechanism has to be as simple and straightforward as possible." (Nelson, Customer Centre Manager)

"Giving options, such as 'don't show the screen again', or 'don't give that again unless I specify request for it' ... or you got to have a function, to be able to say
'this is not the right answer', 'that's not I want', or 'that's not what I asked for'.

(John, Managing Director)

"... if you put in a request, may be 10 percent of information is really relevant, then you can tick a box just on the relevant one to say this is relevant." (Peter, Chief Operating Officer)

However, one participant, David (Managing Director) expressed that "providing feedback would be useful if only you are not convinced that the system can give you what you want." This implies that the coaching process will possibly and eventually become easier and less demanding as the user's confidence towards the system capability increases.

To sum up, coaching is an interactive process of refining information through simple explicit feedback mechanism and interaction from both the system and the user. The coaching mechanism is built by the user in order to refine his user profile and to cope with his changes of information needs and requirements.

**Learning**

Learning is the capability of the system to improve its information process by observing executive's information processing behaviours and information preferences without the feedback from the user. The system can learn about the user's information needs and processing behaviours over time in the background, thus, suggesting more relevant and useful information for the user. Learning attribute is much less significance than coaching attribute, however, in general participants feel the possibility for the system to learn about their interests and behaviour. In return, they expect the system to suggest appropriate information or actions, such as personalise the information for the executive.

"What I hope it would do, and that would be very useful, if the agent was able, for a short while, spot the trend of information I am picking up. So, it could almost predict what I was going to look for on a day or hourly basis. (John, Managing Director)
"...again you want a system that is capable of learning about you, and after what you after, and tailoring its response to that." (Tim, Middle Manager)

Participants recognised that the learning mechanism has to be intuitive, in which the system is capable of learning about the user's interests and behaviours independently. Users do not provide input or feedback to the system. However, this self-learning and intuitive capability will take time for the system to learn about individual executive.

"I guess in an ideal world, the system would be intuitive. And it would learn about you as a user. ... over time, it would know exactly what sort of information you are after. Something like that would obviously be useful. (Tim, Middle Manager)

"Self-learning system is very important... I really think it is about learning, the way it learns what my requirements are and what really trigger my interests, it becomes intuitive in learning what my requirements are and respond it to the system. It depends on time we spend on information." (Oscar, Chief Executive Officer)

According to the executives, the ways of intuitive learning can be achieved through history, observation and imitation of executive's behaviour of information processing. The system could model the executive's behaviour based on the previous record, i.e. how many times a particular piece of information is selected for viewing; or by observing executive's processing behaviour, i.e. how information is selected, browsed and used; or by mimicking executive's behaviour, i.e. following the similar steps or choice of information process.

"...When you put certain words down, it knows what it means because it learns from you a number of times before." (John, Managing Director)
"I think the things that will actually learn as they work, something that will actually build its own understanding of what it has to do, through looking at what you actually do." (Eve, Chief Operating Officer)

"Yes, mimicking the behaviour is a good way of learning, it works in relevance to each individual." (William, Operations & Systems Director)

In summary, the learning mechanism requires time to learn about individual executive through history, observation and imitation of executive’s behaviour of information processing. Over time, the system builds the executive profile that improves user’s information domain and information process and eventually become more intuitive in coping changes of information needs and requirements.

**Contextual Support**

Contextual support refers to the capability to provide information in the right context for the right user. Many participants had raised the need for system to retrieve information in the right context, rather than information that just match the search keywords. For example, one senior executive stated that “our old information services had “Lloyds” included in it, so any article that had the word “Lloyds” in it would be automatically put forward. Now that meant that anything that has Lloyds Bank mentioned would also come through, also it meant at that time there were a lot of scandals going around “Lloyds” name whether it would be a story that is completely unrelated to insurance or just a little footnote with the “Lloyds” name, say if someone lost a lot of money at “Lloyds” or something like that, those would also come through.” Clearly, what executives want is a more advance search and define feature that will acquire information that matches the context rather the keywords.

“...The current systems do not allow you to do that, all you can do is you can put in specific words and it just builds along. Generally it just builds on words so you can get the words there but the articles maybe completely nothing to do with what you want. So it is the sophistication of defining exactly what you are looking for
and then getting the system to deliver it in the right context." (David, Managing Director)

"...the only thing that can be useful would be a more refined article selection process because if you have keywords, there is always the danger that the story itself is not about that keyword, it is just a word that gets mentioned." (Eve, Chief Operating Officer)

According to some participants, the context of information can possibly be improved by knowing more about the associative events of information or information background, such as information sources. For example, executives find that by knowing the information sources will help them to justify the quality of information better.

"I probably would like to see the context that the piece of information is being taken from, so that I can judge for myself whether I agree whether it is fairly presented or not." (Eve, Chief Operating Officer)

Contextual support can also be improved by knowing the history of information, for instance, how the word or information has been processed and used before, and how executive made sense of that information.

"The ability to put a word in the context. For example, the word is used in a particular way. That will be based on how you've used it and how you've specified the search and understand that." (Ian, Strategic Planning Manager)

Ideally, the system is able to monitor the contextual development of the information and related events, for example, what causes the emergence of that information, what is the implication now and who else is involved in this information.

"I think it needs to provide the contextual information to support it, why that happened, how that developed to this day, others are adding information to this
situation as well, remember there is a phenomenon in the industry and therefore, one must take into account that contextual situation otherwise you will make the wrong decision.” (Robert, Vice President)

To conclude, the above findings suggest that information processing is not about keywords searching but the ability to retrieve information in the right context. Executives are not asking for another search engine, but a system that is capable of providing richer information through contextual support, such as information background, information development and associative recall of related events.

Semantic Support
Semantic support refers to the capability to assign meaning to the information with the availability of an ontology – an explicit, declarative and representation of a domain. Although semantic support is not perceived as important as contextual support, participants recognise the challenges of semantic content. They are aware of the different meanings apply to the same word.

“We use terminology we know, we want, ...one word in one language means one thing and another language means another thing. ...Let say, what ‘passenger’ means? Whole bunch of people or consumer. In my context, consumer means airline passengers.” (John, Managing Director)

“It’s misinterpreting, when people write ‘sea’, they don’t mean ‘sea’. Lots of words like that. So when people type common words, which word do they actually mean?” (Ford, Service Director)

Several participants had expressed the need for system to transform distributed documents into documents that are enriched with meanings. The semantic of information can possibly be improved by knowing more about the associative meanings.
“Being presented with information is one thing, understanding what it means, is another.” (Adam, Deputy Managing Director)

Some participants also perceived the need for natural language processing, in which the system is capable of categorising natural language texts into predefined content categories. The system thus knows what the user means.

“The ability to define the natural language, what it is and what I want the system to do for me is very useful.” (Ken, Deputy Director)

“You have this agent who was built in such a manner that it is speaking your language and knew exactly what you wanted, that’s the key.” (Victor, General Manager of Group)

In summary, semantic support is useful for the system to assign associative meaning to the information needed, and to provide natural language support to the information process. This implies that irrelevant information can be discarded as early as possible in the process of information.

6.4.4 Discussion and implications for adaptability design

In Taylor’s (1986) value-added model, adaptability is one of the user criteria and values added in information systems. According to Taylor (1986), the adaptability is “made up of those measures provided by and investments made by the system which will strengthen the responsiveness of the system to problems that users have in their working or living environments” (Taylor 1986, p. 65). Value-added attributes under this criterion are closeness to problem, flexibility, simplicity and stimulatory. Scapin and Bastien (1997) also consider adaptability as one of the ergonomic criteria of designing human-computer interfaces. The adaptability of a system refers to its capacity to behave contextually and according to the users’ needs and preferences. They subdivided the criterion adaptability into flexibility and user experience. Here, we refer adaptability to the extent to which the system fits the specified and right context of work and information, with the ability to
strengthen the responsiveness of system in coping with the uncertainty of information. One of the major limitations of current information processing systems is that they are designed to serve predefined sets of people and problems and to identify and produce results based on predefined information needs and requirements. This is, however, not applicable to design an EIS that serves executives with dynamic and heterogeneous needs, interests and problems. An agent-based EIS, hence, should be able to respond to the environment in which the executive works. The appropriateness or relevance of information acquired depends largely on how information is needed, and why, and how well the system can respond to the uncertainty of executive information. Therefore, the coaching and learning attribute would aim to respond to the concern with how information is needed and why. The contextual support and semantic support attribute would aim to respond to the concern with how well the system can respond to the uncertainty of executive information. In summary, adaptability is concerned with the capability to adapt as much as possible to the dynamic of user’s information needs and requirements, information processing behaviour, working context and knowledge of language.

Adaptability is hardly seen in the conventional views and guidelines of EIS design. The slightly related areas of adaptability are probably the improved analytic and modelling capabilities, such as statistical analysis tools and advanced report generation, and enhanced functionality for decision support, such as query function and what-if analysis, which can be integrated into an EIS (Rockart & De Long 1988; Watson et al. 1991, 1997; Nord & Nord 1995; Young & Watson 1995). These improved and enhance features aim to increase the effectiveness of the executive’s information scanning and improve executive’s understanding of the business situation. This can probably provide some sorts of contextual support, but has very little to do with the above attributes mentioned in the findings.

The above findings that provide quotations and their extractions shed light on the critical importance of the adaptability criterion and related value-added attributes, and some of the concerns that underpin that criticality. Overall, the adaptability criterion is considered
the second level of importance in an agent-based EIS design. Four attributes are identified as value-added attributes in adaptability design of an agent-based EIS. Although these are key attributes identified, coaching is perceived more value-added than learning. This means that executives are more willing to train the system rather than allowing the system to learn about the executives in the background. This also implies that executives trust their own evaluation and feedback more than the self-learning capability of the system. Nevertheless, the executives are not against the self-learning mechanism of the system. And, contextual support is perceived more value-added than semantic support. This suggests that the provision of richer information is more essential than the allocation of meaning to the information.

**Coaching**

The most important value-added attribute in adaptability design is the coaching attribute. The concept of coaching is similar to the explicit relevance feedback approach in the study of information retrieval (Roccio 1971; Salton & Buckley 1990). User's explicit relevance feedback is used to reformulate query and also is used to create and refine user profiles in the information retrieval and information filtering research (Korfhage 1997; Quiroga & Mostafa 2002; Singh & Dey 2005). User profile is strongly associated with learning from user feedback. The user can provide explicit feedback for the information recommended by giving ratings on its relevance. The results are two-fold: one, it creates new user profile; and second, it changes the robustness of the user profile. Here, the coaching attribute enables executive to train the system by giving explicit feedback in order to increase its robustness. This is achieved by gradually building individual user profile that contain executive's work domain and information domain. Nevertheless, many researchers argued that the explicit relevant feedback can be costly in time and resources, and often increase the cognitive load and burden on the user because they need to explicitly mark the relevant ratings on documents or simply unable to justify the relevance of documents (Beaulieu & Jones 1998; Urban 2003; Fox et al. 2005; White et al. 2004).
Our findings suggest that coaching allows executive to give feedback, monitor and revise his information needs and requirements, thus update and refine his user profile. Traditionally, explicit relevance feedback applies to a non-interactive environment that requires searchers to assess the relevance of information or documents through ratings techniques that have a binary value, i.e. relevant or non-relevant (White et al. 2004). Subjective assessment is not taken into account, for example, a document may not be completely relevant to the topic of the search or the searcher is uncertain about its relevance. The findings confirm that the coaching process should be an interactive process of assessing information between the user and the system. The user can give feedback to the system, and the system can request user for more confirmation or clarification especially on strategic information. This will enable the system to learn better and thus improve its information retrieved. Although there is a concern of increasing cognitive burden to executive in the coaching process, in contrary, the findings suggest that executives are willing to provide feedback to the system. To overcome the increasing cognitive workload, the coaching mechanism has to be very simple and straightforward. As the executive becomes more confident on the system’s information processing ability, the coaching activity will eventually become more manageable and less time consuming.

**Learning**

The concept of *learning* here is based on the *implicit relevance feedback* approach in the study of information retrieval (Morita & Shinoda 1994; Kelly & Belkin 2001; Fasli & Kruschwitz 2001; Hijikata 2004). Basically, *implicit relevance feedback* observes and monitors user’s information processing behaviour, such as reading time, scrolling, browsing, without requiring user’s explicit feedback on retrieved information or document. This removes the cost, time and cognitive load needed as in explicit relevance feedback approach. Hence, the implicit relevance feedback approach is more favourable than explicit relevance feedback and has been employed extensively to retrieve and filter information from distributed information sources. Here, the *learning* attribute refers to the capability of the system to improve its information processing activities by unobtrusively observing and monitoring executive’s information processing behaviours.
and information preferences. It is also considered a passive mode of personalisation, as mentioned earlier, which involves the system to figure out user profiles, hence, suggest appropriate assistance or services. The goal of learning from implicit relevance feedback is to adapt to changes of user's needs and interests. However, this can only be appropriate when changes happen gradually rather abruptly.

From the findings, learning attribute is much less significance than coaching attribute. In general, executives would allow system to learn about them intuitively, in which the system learns about the user's interests and behaviours independently. Executives recognise that the self-learning and intuitive capability is expected to take time for the system to learn about them. This means that whenever changes of needs and interests take place, the adaptability of the system would take sometime for it to become effective. Conventional implicit relevance feedback approach assumes searches exhibit stereotypical search behaviours around relevant information (White et al. 2004). One of the most widely used behaviours for implicit modelling is the reading time of the entire document, which is considered too simplistic, other factors such as user, topic and task characteristics are not taken into full account (Kelly & Belkin 2001; White et al. 2004). A more effective implicit relevance feedback approach must construct models that are personal to the user, his specific topic of interests and tasks. Our findings suggest that the learning attribute has to consider the search history and model the executive's behaviour based on the past characteristics. Learning can also become effective by observing and tracking executive's processing behaviours and mimicking those behaviours as closely as possible. For examples, a longitudinal study of search behaviours as conducted by Morita and Shinoda (1994), and searcher's interaction with the results interface as conducted by White et al. (2004).

**Contextual Support**

Contextual support refers to the capability to provide context-aware information to the information retrieved in information processing activities. The goal of contextual support is to reduce the ambiguity of information and increase the richness of information according to the user's context. Context is defined as the circumstances in which an event
occurs. The concept of contextual support attribute is taken from context-aware retrieval (CAR) approach, which retrieve context-aware information that is pertinent to the user's current physical (location, device, application) and organisational context (role, activity, shared process) (Brown & Jones 2001; Chanana et al. 2004; Kirsch-Pinheiro 2005); and ambient computing intelligent environment (AmI) approach, which executes context-aware distributed tasks (Munoz 2003; Murthy & Krishnamurthy 2005). In this case, the context-aware information is part of the executive profiles. Although CAR applies more to mobile applications, i.e. a user whose context is changing, it is strongly related to information retrieval or information filtering technology, which aims to retrieve relevant information for users. In AmI, an object possesses context-awareness if it can react to information arising due to events that occur in its environment. The organisational context-aware information, such as user information, activity information, and social information is more relevant to this study. Contextual support can also occur in active or passive context. In an active context, the system can directly trigger an action as in an involuntary action; while in a passive context, a user is prompted and is made aware of the action to do as in a voluntary action (Murthy & Krishnamurthy 2005). For example, the system can automatically adapt to new changes (active context) or the system can inform the user about the changes (passive context).

Our findings suggest that executives desire a context-based information retrieval system than the traditional keyword system. According to executives, contextual support is more critical than semantic support. This implies that assigning context to information or document is more important than assigning meaning to a word. Besides having the context-aware information, executives find that the context of information can be improved by knowing more about the associative information, such as information sources, information history, and emerging information. An ideally, executives hope that the system is able to monitor the contextual development of the associative information. Executives also find that the provision of associative information will help them to justify the quality of information better. In an agent-based EIS, software agents can contain information objects and associated scripts that know what to do with the information and
how to deal with the environment. As a result, the quality and richness of information increase.

**Semantic Support**

One of the challenges of information processing is to transform distributed document into a semantically enriched document. Semantic support refers to the capability to assign meaning to the information or document in the information process, thus, retrieve the semantic content of a document in relation to the user context. Semantic support occurs with the availability of semantic-aware information, also known as ontology—an explicit, declarative and representation of a domain. Relevant approaches to semantic support are text categorization, also know as text classification or topic spotting, the process of labelling and assigning natural language texts to predefined categories based on their content (Lewis & Ringuette 1994; Sebastiani 2002). Machine learning techniques are widely used for automatically extracting semantic information in text categorization, as reviewed by Sebastiani (2002). There are also attempts to merge information retrieval with ontological models by proposing a text processing system for building ontological domain (Velardi et al. 2001; Cesarano et al. 2003). This suggests that the integration of agent technology and ontology is potential for building a semantic support technique in an agent-based EIS. The goal of semantic support is to enhance the information process by retrieving the semantic content of a page, rather than the matching of particular word/s.

From the findings, executives perceived the need of semantic support less than contextual support. However, they are aware of the need and challenges of semantic-aware information. They are also aware of the current search engines that return the information search with a huge number of irrelevant pages and not useful links due to the lack of semantic recognition and support. Knowingly, the semantic of information can be improved by knowing more about the associative meanings of information. Insofar, executives perceive the current need is to transfer the knowledge conveyed by natural language into format that a computer can understand and interpret. Lewis and Jones (1996) argued that for end-user searching, the indexing language should be natural
language, rather than controlled language oriented that is indexed by professional intermediaries who build the databases. However, natural language processing involves complex knowledge-based techniques because it requires the understanding of meanings of words and the knowledge about how the concepts described by the words related to one another (Jacobs & Rau 1988).

6.4.5 Level 3 – Intelligence

Intelligence refers to the extent to which the system exhibits continuous, self-reactive and self-adaptive activities of acquiring, synthesising and interpreting information for executives, with no or very little executive interaction. The intelligent criterion aims to autonomously, reactively and proactively manage information on behalf of executives or other agents, preferably on the online basis. From the focus group’s findings and discussions, value added attributes contributing to intelligence design are recommended as autonomy, proactivity and reactivity. These attributes serve as the initial themes (nodes) for explanatory analysis in the interview. The interview findings provide greater insights and confirm these three key value-added attributes for intelligence design as depicted in Figure 6.6.

Overall Findings

Overall, Table 6.5 shows that autonomy, proactivity and reactivity are perceived as important in intelligence design, but a few other attributes, such as interactivity and continuity, are considered as not value-added attributes (less than 2 percent each), thus,
will not be discussed in the findings. Autonomy and proactivity are considered more important than reactivity. This percentage is based on the number of each attribute (node/theme) coded from all participants in comparison to the overall value-added attributes (nodes) of the three executive criteria. Again, the percentage here is not the main mode of qualitative analysis, but to provide the idea of relative importance of each value-added attribute in an agent-based EIS design.

Table 6.5 Percentage of value-added attributes of intelligence design

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value-added Attributes</th>
<th>Percent</th>
<th>Total Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>Autonomy</td>
<td>≈ 7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proactivity</td>
<td>≈ 6%</td>
<td>≈ 20%</td>
</tr>
<tr>
<td></td>
<td>Reactivity</td>
<td>≈ 4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>≈ 3%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.7 Agent-based EIS Model: Level 3 – Intelligence
Figure 6.7 illustrates the value-added attributes of intelligence raised by different participants. This model suggests three preliminary insights:

a) **User's perception of attributes** – The model depicts that only 13 out of 25 (52 percent) participants raised the different issues related to intelligence design. Both middle and senior managers have contributed opinions and suggestions for designing intelligence. This implies that managers perceive intelligence design as less critical than usability and adaptability design in an agent-based EIS.

b) **Significance of attribute** – The significance of attribute can be viewed from the concentration of lines (documents) that emerges from each attribute. Overall, there are fewer lines than usability (level 1) and adaptability (level 2) design. This suggests that intelligence design is considered less critical in an agent-based EIS design at the moment. Individually, autonomy and proactivity attribute comprise slightly more lines than reactivity attribute. This implies that autonomy and proactivity have greater significance than reactivity in designing intelligence design.

c) **Relationship between attributes** – The relationship between attributes can be seen to a certain extent by examining the frequency of different related attributes or issues raised by the same participant. Notably, this model depicts the least intercepts among the three levels of design. 7 out of 13 participants (about 54 percent) are able to state more than one attribute related to intelligence criterion. All attributes are fairly related to one another. The weak interrelatedness of attributes suggests that participants find it difficult to communicate the need for intelligence design with greater insights and perspectives.

**Value-added Attributes in Intelligence Design**

**Autonomy**

Autonomy is the capability to operate without the direct intervention of users. The agents have control over their own actions and their own internal state. For example, executive
allows the system to process information continuously in the background, identifying
information that might interest the executive and bringing up to executive’s attention on
what is seemed appropriate. Many participants have perceived the usefulness of
autonomy function in information searching and scanning. Executives’ understanding of
autonomy attribute is that once they set the search criteria, the system can autonomously
scan and search information that are of user’s interest without requiring them to reset the
search criteria.

“It’s not just a word search but the whole series of instructions that you can give,
...like I am looking for this information, the search function on the browser is
doing automatically. ...scanning and searching that could happen without input
probably, that would be far better than if I have to go and recreate. (John,
Managing Director)

“I imagine I could come in to the office each day, and I could, if I choose, I turn
on the tool and I say, ‘Today, I am particularly interested in finding about motor
insurance’, and I put some filters in and it goes away. And after a time, I might go
back let’s say two hours later and see what it discovers. (Larry, Head of CEO)

From the findings, executives prefer semi-autonomy in information process. Autonomy is
more applicable for long term and fixed information needs and requirements. For
information needs and requirements that are dynamic, executives favour the ability to
make changes on the search or process criteria themselves.

“And I think what you probably want is one set of criteria that is always there in
the background, like keep an eye on what this company is doing, or report all
news on this particular type of business. But then you have other things that are
more to do with you know there is something going on, but you are expecting the
news, and you want to hear the news as soon as it comes in, so you might present
it to (the system)...” (Eve, Chief Operating Officer)
“But then again, it will be a difference between continuous information, which you’d want everyday, and ad hoc information, which you’d only want for a temporary period of time.” (Smith, Chief Finance Officer)

According to senior managers, they often have time constraints in information process due to their networking role and decisional roles. It is unlikely that senior executives are able to spend long hours dealing with information process activities. Executives think that the autonomy attribute would enable them to focus on their networking roles and their decisional roles as entrepreneur and disturbance handler as they delegate the information process activities to autonomous software agents.

“I think continuous and autonomous is a good idea. I guess the things for senior management, that they spend majority of day away from their desk. They are not actually there to see news coming in .... They probably spend three quarter of their day in the meeting rooms, in different places around the building or outside with clients.” (Tim, Middle Manager)

“The agents identify everything that could be critical in moving your business forward. I mean this way of identifying that as if nothing come as a surprise to you further down the line. So you can know things very early in the cycle when people are beginning to act.” (William, Operations & Systems Director)

Some basic autonomous functions are perceived as useful by executives, such as summarisation, categorisation and ranking. According to executives, summarisation function allows quick scanning on information received, i.e. “...some sort of summary to allow a quick scan on information (Oscar, Chief Executive Officer)”; and removes redundancy of information, i.e. “I suppose summarising, I mean eliminating duplication, you’ve got five different articles all telling you the same thing (William, Operations & Systems Director)”; as well as saves time for information processing, i.e. “...producing effective summary that is time saving (David, Managing Director)”. Categorisation function can draw information from multiple sources into one place, “...the ability to pick
multiple sources about the same issue (Eve, Chief Operating Officer)”; increase the value of information, i.e. “As far as you know, every document could be important. I do not know how the system can get around it if the information just coming up without the classification. If the source of data can classify 1 is critical, 2 is important, 3 is not important, not mission critical something like that (Chris, Director)”; and provide indication of the relevance and usefulness of information, i.e. “differentiate between news that is urgent and information that you know (Oscar, Chief Executive Officer).” Ranking function enables executives to prioritise their information search and process, i.e. “some ability to prioritise ...if you’re not going to read anything else” (Adam, Deputy Managing Director)”; and helps executives to save time for other managerial activities, i.e. “What would be useful for me is prioritisation ... will save a lot of time, effort and energy (Ford, Service Director), “prioritise the information, ...that would save my time (Peter, Chief Operating Officer)”.

To sum up, autonomy attribute in intelligence design is considered value-added when it applies to the long term and fixed information needs and requirements. Executives want to remain in control of dynamic information needs and requirements. By delegating information process activities to autonomous software agents, autonomy attribute could releases executive for better networking roles and decisional roles.

**Proactivity**

Proactivity is the capability to exhibit goal-directed behaviour by taking the initiative where appropriate without user’s intervention. For example, the system is able to take appropriate decision and action in information process, manipulation and presentation, like rank the relevance and significance of information, recommend executives of new and relevant information and alert executives of information threats. From the findings, participants expressed their needs for proactivity attribute as ability to automatically exhibit actions that are beneficial to the users, such as prompting, suggesting, and recommending information of potentially good value. According to some executives, “…the recommendation feature might be useful (Tim, Middle Manager)”, “I’d say providing recommendation on the related articles (Smith, Chief Finance Officer)”,
"...the agent is going to prompt me with additional information that I might find useful..." (Adam, Deputy Managing Director). Ideally, the proactive software agents are not only providing services in information process activities, but working side by side with the users as a personal assistant.

"...the agent is going to prompt me with additional information that I might find useful, ...an agent which is actually working with you, not only giving you information but also telling you what the relevance of the information is and how you might use that." (Adam, Deputy Managing Director)

"...eventually the system will become an assistant to figure out options for you." (Yann, Director)

Participants suggested automatic query expansion as one of the goal-directed behaviour, which assist and improve information process and manipulation.

"For example I am really focussing on the UK market in property outsourcing. However in the back of my mind I think that there maybe market in US. Maybe the agent could expand your queries into different source of information around US-based through specific criteria. The agent can actually suggest refinement or filters that I might like to apply ...the agent might find another source that might add another value for me." (Garry, Chief Information Officer)

"...for example if you’d ask very specifically about the UK, but they may also say ‘Well, you know there’s an interesting article in relation to another European country is ...’" (Smith, Chief Finance Officer)

Reactivity
Reactivity, or responsivity refers to the capability to perceive user’s information environment and act timely in response to the changes in the environment without user’s intervention. It is information-oriented. For instance, once the system perceives the
arrival of new information, the system would take action on this new information in a timely fashion. This is relatively similar to the concept of adaptability function but without user’s involvement. The difference between adaptability and reactivity is that adaptability focuses on fitting the right context of user profile and information domain with or without user’s involvement, whereas reactivity focuses on adjusting the information domain without user’s involvement. The notification of change presented by the system involves no user interaction. From the findings, reactivity is considered less critical than autonomy and proactivity. Participants raised the value of reactivity as a way to identify changes in information and respond to those changes without user’s command.

“Clearly, an agent that alerts the significant changes of information, particularly information that is new, and recognise which information that has been used or which information is regularly used and then it somehow remember that and update that, that obviously be a useful facility.” (Larry, Head of CEO)

“... any percentage that’s changed you want to know about it. If the system could respond to the change, yes, it will be very useful.” (Chris, Director)

The reactivity attribute is value-added according to executives, but they must be triggered and informed about the change that has taken place, one participant stressed that, “...any percentage that’s changed you want to know about it ... the system could alert” (Chris, Director). This suggests that executives dislike uncertainty or unknown in information process activities. Nevertheless, it is important that the trigger information “should be readily available but should be available with an impact to the manager ... really hit the manager in the head like a gong on the head” (Robert, Vice President). Although the trigger information from alert function is perceived as useful, executives are unlikely to be triggered too frequently. One executive emphasised that, “I wouldn’t want something flashing out on my screen every five minutes to say that the information is there and I wouldn’t want to actually go looking for it myself. I think it would be something if you would notify on a minimal daily basis, maybe twice daily to see whether the system had
updated (Mark, Trading Director)”. This implies a rather semi-intelligence of reactivity is needed in an agent-based EIS.

"...a user should trigger and also be triggered by the information system... they will be triggered to tell them a change had happened ... now the system is going to react differently.” (Robert, Vice President)

6.4.6 Discussion and implications for intelligence design

With the emergence of agent technology (Nwana 1996; Sycara et al.1996; Jennings & Wooldridge 1998; Klusch 2001), software agents or information agents are potential for building intelligence criterion in an agent-based EIS. Software agents are capable of simplifying the complexities of distributed computing and overcoming the limitations of current user interface approaches (Bradshaw 1997). The representation and processing of ontological knowledge and semantic metadata, user profiles and natural language input, translation of data formats as well as the application of machine learning techniques enable software agents to acquire and maintain knowledge on itself and its environment, thus, achieve appropriate intelligence design functions (Klusch 2001). It is important to note that many software agents are still demonstrators only in many universities and research institutes and laboratories, i.e. The Software Agents Group of the MIT Media Laboratory, The Intelligent Software Agents Lab at Carnegie Mellon University, HP Labs, The KMi of The Open University, IBM Research, etc., converting them into real usable applications is a challenge, many of them are still in its infantry stage. Most of the software agent design and development focuses on personal information management and retrieval, e-commerce applications and business process management. Other applications can be found in user interface software, messaging software, development tools, process control, workflow management and network management (Guilfoyle & Warner 1994; Janca 1995; Jennings & Wooldridge 1996). Many types of software agents are constantly developed by software agents’ community, however, interface agents and information agents are considered as relevant to our study and our proposal of an agent-based EIS. The criterion intelligence for this study refers to the extent to which the system exhibits continuous, self-reactive and self-adaptive activities of acquiring, synthesising and
interpreting information for executives, with no or very little executive interaction. The goal is to help manage distributed information on behalf of executives or other agents with the assistance of intelligence design functions or properties, such as autonomous, proactive, reactive, collaborative, adaptive etc. (see Table 3.5 and 3.6: Agent attributes and properties).

Virtually no EIS study is conducted on the integration of software agents in EIS. Although researchers do foresee the use of artificial intelligence systems in the executive information retrieval and processing systems, very little insights or contributions are provided so far (Watson et al. 1997). Hitherto, only Liu (1998a,b) has proposed an agent-based EIS framework that utilises software agent approach for information scanning and interpretation. The study confirms that software agents present a good alternative approach for executive information processing. However, little insights are given on the design of an agent-based support system from the user’s perspectives. This conceptual framework is rather based on the empirical studies of attributes and properties of software agents, organisational strategic information and executive information behaviour. Bui and Lee (1999) also proposed an agent-based framework for building decision support systems. However, the framework is merely based on the attributes and properties of agents that are potentially capable to support different types of decision tasks.

The above findings that provide quotations and their extractions give insights and implications on the critical importance of the intelligence criterion and related value-added attributes, and some of the concerns that underpin that criticality. The intelligence criterion is perceived as the third level of importance in an agent-based EIS design. In many cases, executives are unsure about the capability of software agents, mainly due to the fear of delegating the information processing tasks to the agents without their involvement. Nevertheless, three attributes are identified as potential value-added attributes in intelligence design – autonomy, proactivity and reactivity. Autonomy and proactivity are considered more value-added than reactivity. This suggests that the availability of autonomous function and proactive function are more desirable.
Autonomy

Wooldridge and Jennings (1995) define autonomy as the capability of agents “operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state” (p. 116). It is presented that the autonomy of agent does not blindly obey commands, but has the ability to control and make appropriate changes, such as the ability to modify requests, ask for clarification, or even refuse to modify requests. Hence, the autonomy of agent requires not only autonomous execution, but also autonomous goals (Liu 1998b). From the findings, executives perceive the usefulness of autonomy function as a way to reduce their information process workload, hence, enable them to focus on their networking roles and their decisional roles as entrepreneur and disturbance handler. The executives comment that once their initial tasks are accomplished, i.e. set the search criteria, the systems will autonomously perform the tasks on behalf of them. Similar to Maes’ (1994) argument, software agents are enormously useful in helping users dealing with the information and work overload. For example, agents help reduce the complexity of difficult tasks, agents perform tasks on behalf of the user, agents can even train or teach the user, and agents monitor events and procedures. Nevertheless, the findings also imply that a semi-autonomous function is more appropriate in an agent-based EIS. According to the senior executives, autonomy is more applicable for static information process, for example, long term and fixed information. Executive are not comfortable with the idea of full delegation of tasks, especially when they realise that their information needs and requirements are dynamic. In this case, they favour the ability to make changes on the search or process criteria themselves. This refers back to the controllability attribute in usability design.

Proactivity

Proactivity is defined as the capability of agents to anticipate the environmental changes and exhibit goal-directed behaviour by taking the initiative where appropriate (Wooldridge & Jennings 1995). The agent does not need explicit instructions from the user, but goals that are set forth in the design or given to the agent at run time. With these goals set, the agent is responsible for deciding how and when to exhibit goal-directed process for the user (Liu 1998b). From the findings, executives perceive proactivity as a
way to enhance indirect manipulation of information, thus, improve user's awareness of potentially useful information. For examples, information is proactively manipulated to provide prompts, suggestions and recommendations to user via user interfaces, and query is proactively expanded to reduce the mismatch of information. This indirect manipulation does not require user to initiate all tasks explicitly and to monitor all events (Maes 1994). The findings imply that proactivity attribute is strongly associated with the interface agent’s approaches that provide proactive assistance and support to individual user via user interfaces. Current EIS user interfaces are rather static and provide little or no proactive assistance for complex tasks or for executing actions such as information search and process. The system only responds to direct manipulation, waiting for specified instructions to execute specified actions. In summary, the reactivity attribute aims to provide rather lower level intelligence of data manipulating tools such as ranking and categorising of relevant information, and alerting new or unexpected information threat.

Reactivity

Reactivity or referred as responsivity refers to the capability of agents to perceive their environment and respond in a timely fashion to any changes that happen in it (Wooldridge & Jennings 1995). In this case, an agent is able to dynamically choose which actions to invoke and in what sequences, in response to the state of its environment (Liu 1998b). From the findings, reactivity is not perceived as critical as autonomy and proactivity in an agent-based EIS. This implies that executives are uncertain about the reactivity attribute due to the fear of unknown situation. The findings show that executives want to be informed about changes of information process initiated by the software agents upon changes in the executive information environment. One of the reasons is that executive information can be considered potentially and strategically important. Any changes of information process may lead to the loss of potential and strategic information. Hence, a semi-reactive function is more appropriate in an agent-based EIS.
6.5 Implications for An Agent-based EIS Design Model

The interview findings validate the focus group’s results on executive criteria of agent-based support EIS with deeper insight. The interview findings elucidate value-added attributes and processes for designing and building an agent-based EIS, thus refine the initial agent-based EIS design model as suggested in the focus group study. This section outlines implications for value-added processes in an agent-based EIS design model.

In terms of usability design, the interview findings and discussion suggest implications for value-added processes on the following value-added attributes: personalisation, controllability, manageability and ease of use. First, the results and discussion imply that the personalisation attribute in an agent-based EIS should involve the process of designing and building a comprehensive and specific user profile for individual executives. The executive profiles would comprise individual executive’s information domains, roles and preferences. The goal of personalisation according to senior executives is to customise according to application-dependent information, application-independent information and user-agent interaction information, thus, reduce the generic information. Second, the design of controllability attribute in an agent-based EIS allows the flexibility for executive to take control and make changes of information process criteria. Executive should have explicit control over their respective user profiles via explicit user action and user control. The explicit user action allows executives to determine their specific requirements of information process, thus facilitates executive learning in intelligence processing. The user control allows executives to make changes on the information process criteria as their information needs and interests change over time, thus making the system more acceptable to the executives. Third, the manageability attribute in an agent-based EIS suggests the provision of appropriate information density and the reduction of information overload without losing potentially critical information. The provision of appropriate information density can be achieved through paragraphing, summarising and highlighting imperative messages that are useful. Dissecting information into appropriate units with options for further explanation and understanding can also increase the level of manageability. Fourth, The key elements for ease of use
attribute in an agent-based EIS are simplicity, accessibility and browsability. Simplicity can be achieved through easy functionalities and user-friendly interface. The reduction of steps needed for information access can increase the level of accessibility. And, browsability can be achieved through uncluttered information presentation and organisation.

In terms of adaptability design, the following value-added processes are identified on the following value-added attributes: coaching, learning, contextual support and semantic support. First, coaching attribute in an agent-based EIS suggests that executives can assess the information via user’s explicit feedback. The system can also seek confirmation and clarification from executives. This interactive process can gradually update and refine executive profiles. As a result, an agent-based EIS would adapt to changes of information needs and requirements. Second, the design of learning attribute in an agent-based EIS suggests the intuitive learning on executive’s interests and behaviours based on implicit observation, monitoring and assessment of the system with the intention to understand executive’s interests and mimicking executive’s information processing behaviour. These implicit relevance feedbacks must be personalised to executive profiles. The purpose here is to learn and understand executive’s information processing behaviour and thus conduct continuous, self-reactive and self-adaptive activities of information processing. Third, the design of contextual support attribute in an agent-based EIS involves the ability to increase information richness through the collection and provision of associative information and context-aware information. The system should be able to monitor and update the collection and provision of associative information and context-aware information in the executive profiles. Fourth, the design of semantic support attribute in an agent-based EIS includes the ability to increase information relevancy through the collection and provision of associative meanings of information and semantic-aware information. The process includes complex knowledge-based natural language processing activities and the development of ontological domains.

In terms of intelligence design, the findings and discussion suggest preliminary implications for value-added processes on the autonomy, proactivity and reactivity
attribute. First, the design of autonomy attribute in an agent-based EIS should be a semi-autonomous function that involves executive’s occasional interaction or input. The system is expected to perform information search autonomously on static information but not dynamic information. Executive’s input or feedback is expected on dynamic information. Second, the proactivity attribute in an agent-based EIS should be a proactive interface agent that is capable of performing information manipulation, such as alert notification, ranking and recommendation, with some kind of proactive assistance via user interfaces. The goal is to increase executive’s awareness of information. Third, the design of reactivity attribute in an agent-based EIS should be a semi-reactive function that performs self-determined tasks with executive’s knowledge. The system should be able to trigger executive of any changes in the information process.

In summary, there is a need for a rationale agent-based EIS design model that can support executive intelligence activities through identifying, collecting and processing potentially strategic information in a turbulent environment. This study provides a more vigilant guidance for building a rational EIS using agent-based approaches. The refined agent-based EIS design model is illustrated in Figure 6.8. And, the summary of value-added processes for each value-added attribute is depicted in Table 6.6.
Figure 6.8 An agent-based EIS design model
Table 6.6 provides the list of value-added attributes and summary of value-added processes of each attribute based on the discussion and implications in the previous sections. This table can be considered as value-added models for EIS design. This is similar to Taylor’s (1986) value-added model, in which information systems, products and services are developed as set of activities that add value to the information being processed in order to assist users to make better decisions and better sense of situations, and ultimately to take more effective action.

Table 6.6 Value-added Models for EIS Design

<table>
<thead>
<tr>
<th>Executive Criteria</th>
<th>Value-added attributes</th>
<th>Value-added processes</th>
</tr>
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| Usability          | Personalisation       | • Building comprehensive and specific executive profiles – executive’s information domains, roles and preferences.  
|                    |                       | • Customise according to application-dependent information, application-independent information and user-agent interaction information.  
|                    |                       | • Reduction of generic information.  
| Controllability    |                       | • User control over information process criteria via explicit user action and user control.  
| Manageability      |                       | • Determine and update information process criteria.  
| Ease of use        |                       | • Paragraphing, summarising and highlighting imperative messages.  
|                    |                       | • Dissecting information into appropriate units.  
|                    |                       | • Options for further clarification.  
| Adaptability       | Coaching              | • Assessing information via user’s explicit feedback.  
|                    | Learning              | • Assessing information via implicit feedback.  
|                    |                       | • Assessing information via implicit feedback.  

| Contextual support | • Monitor and identify user’s interests and information process behaviours.  
• Mimic user’s information processing behaviours.  
| Semantic support | • Collection of associative information.  
• Provision of context-aware information.  
• Monitor the development of associative information.  
| Intelligence | • Collection of associative meanings.  
• Provision of semantic-aware information.  
• Natural language processing with complex knowledge-based techniques.  
• Development of ontological domains.  
| Autonomy | • Semi-autonomous function of static information process.  
• User’s interaction on dynamic information process.  
| Proactivity | • Perform manipulation of information, i.e. ranking, categorising, alerting.  
• Provide proactive assistance via user interfaces.  
| Reactivity | • Semi-reactive function of self-determined tasks.  
• Trigger user’s awareness of information process changes.  

6.6 Conclusion

The interview study has met its objectives by, firstly, revealing factors that influence executive’s information processing activities, thus, providing implications of the additional and/or complementary support on executive intelligence activities. Although the study sheds some light that the additional human and affective support of processing intelligence and the improved technology and information support of processing intelligence could improve the overall support on executive intelligence activities, the goal of this study is to utilise the software agent as an improved technology and information support for processing intelligence. Secondly, the interview study validates the focus group study with more insights on value-added attributes and processes of executive criteria that are essential for building an agent-based EIS. The result is a usability-adaptability-intelligence trichotomy of agent-based EIS design model.

The next chapter will outline original contributions of this research and suggest the directions for future research.
Chapter 7

Conclusion

7.1 Introduction

This final chapter concludes the study and outlines the contributions and limitations of the research. Section 7.2 concludes the study. Section 7.3 discusses the original contributions. Section 7.4 offers a critical reflection of challenges and limitations of the research. Finally, Section 7.5 suggests the directions for future research.

7.2 Concluding Remarks

The basic argument of this research is whether the conventional views and guidelines of EIS are still applicable in supporting current executive's information environment and information processing activities, and, whether the current emergence of the intelligent software agent can provide intelligent support for intelligence processing activities. This research has managed to answer this basic argument.

Following the research findings and the discussion provided in Chapter 5 and Chapter 6, it can be concluded that a rationale EIS design model with agent-based support is needed to support executive intelligence activities in coping with the current executive's
information environment and information processing activities. Current executive’s information environment and information processing behaviour are found to be uncertain due to the diversity and dynamism of factors, such as over-abundance and ambiguous value of information, heterogeneity of information attributes and executive’s information processing behaviour, heterogeneity of executive attributes and roles, dilemma of information reduction and constraints of time. These factors pose a number of challenges on conventional views of EIS purpose, functions and design guidelines. For examples, a generic EIS for all executives is impractical and a static EIS with predetermined information process for static performance monitoring and control is inflexible. EIS must be personalised and adaptable according to specific individuals in order to support executive intelligence activities.

The current emergence of the intelligent software agent, as a concept and a technology, with applications, offers the potential for supporting intelligence processing activities in a more integrated and distributed environment of the Internet. Although software agents offer the prospective to support information processing intelligently, executive’s desires and perceptions in judging the usefulness of agent-based support must be elucidated in order to develop a system that is considered valuable for executives. The results of this research suggest an agent-based EIS design model for system developers, managers and researchers in the field of EIS. The agent-based EIS design model provides guidance for developing and utilising software agents for continuous, self-reactive and self-adaptive activities or approaches of acquiring, synthesising and interpreting information for executives to obtain strategic intelligence with a view to determining the course of action. It is an agent-based EIS design model with “usability-adaptability-intelligence” trichotomy that provides executive criteria of value-added attributes and value-added processes for building EIS that can support and enhance executive intelligence activities. Hopefully, with the advance development of software agent and Internet technology, an agent-based EIS architecture for supporting executive intelligence activities can be successfully developed and implemented in organisations in the near future.
7.3 Original Contributions

The study has contributed to knowledge in the following ways:

7.3.1 Adding knowledge to variety engineering process and intelligence-design-choice model
With the increasing amount and complexity of operational and strategic variety (information) in electronic and distributed form, coupled with dynamic variety changes, the search for more variety is becoming increasingly critical for individual executives. Individual executives are seeking assistance in the search of variety that can cope with the organisational environment that continually creates disturbances to them. The search of variety allows executives to have a better understanding and capability to manage and adapt in a complex and dynamic organisational context. Here, the search for more variety in executive’s information environment suggests the notion of “executive intelligence activities”, which is the ability to respond and adapt to environmental changes through continuous, self-reactive and self-adaptive activities or approaches of acquiring, synthesising and interpreting information for executives to obtain strategic intelligence with a view to determining the course of action.

Ashby’s (1956) “law of requisite variety”, Beer’s (1979) “variety engineering” and Simon’s (1965) “intelligence-design-choice” model provides the basic conceptual knowledge for supporting the notion of executive intelligence activities. This study adds knowledge to Beer’s (1979) variety engineering process and Simon’s intelligence-design-choice model in two ways. First, the study affirms the importance of information gathering, reduction and amplification. Second, this study suggests the need for continuous, self-reactive and self-adaptive activities or approaches of collecting and processing information.

This study adds knowledge to Beer’s (1979) variety engineering process, in particular, the System Four of “Viable System Model” (VSM), in which value-added criteria are identified on scanning and filtering process through self-reactive and self-adaptive
approaches. Ashby's (1956) "law of requisite variety" states that only variety can destroy variety, suggesting that managers or their organisations have to demonstrate enough internal variety in order to cope with the external massive variety. Current executive's information environment is complex, dynamic and uncertain due to the over-abundance of information, the heterogeneity of information attributes, the ambiguous value of information, and the diverse use of information. It is, therefore, important to have a series of activities or approaches that can help executives collect and reduce the massive information from the environment, and amplify the potentially useful and relevant information for the attention of executives. Based on the implications of Ashby's "law of requisite variety", Beer (1979) proposes the "variety engineering" process which serves as a preliminary concept for intelligence processing activities. The variety engineering process suggests that variety reducers are used to filter out the massive information and variety amplifiers are used to strengthen the organisations' capabilities in coping with the business environments. The "Viable System Model" (VSM), as introduced by Beer (1979), provides a theoretical basis for supporting executive intelligence activities because it is concerned with planning the way ahead in the light of external environmental changes and internal organisational capabilities. System Four in VSM can act as a "scanner" and "filter" that scans, filters and adapts its internal environment to meet its external environment. The information scanning and filtering process put senior executives in a better position to react to threats and/or opportunities, as well as to anticipate future changes despite the turbulent environment.

Simon's (1965) "intelligence-design-choice" model states that executives spend a large fraction of their time in these three phases of activities. According to Simon (1965), the three fractions sum up most of what executives do. Any information systems that can support the above three phases of activities will reduce the fractions of time needed for information processing. The support for intelligence activity is of particular importance, because intelligence activity precedes design, and design activity precedes choice. The "intelligence" phase is the first principal phase which emphasises the search for variety, occasions or conditions that call for decision. However, Simon only gives a brief illustration on activities that occur in those phases, no guidelines or criteria are suggested
in those phases. This study adds knowledge to the intelligence phase of Simon’s model, through identifying executive criteria of value-added attributes and value-added processes for intelligence processing support.

7.3.2 Adding knowledge to the characteristics of executive information

Mintzberg’s (1973) work on managerial roles describes that executive information is soft-oriented, that are characterised by current, speculative and verbal information. Based on Ackoff’s (1974) “mess management” concept, Young (1987) characterises executive information as mess-processing related information. With the ubiquitous and distributed information infrastructures, the nature of current executive information have changed and thus posed new challenges to conventional views of EIS design. This study reveals the current state of executive information, thus adds knowledge to Mintzberg’s (1973) and Young’s (1987) work on executive information.

The empirical evidence of this study reveals that the current state of executive information is becoming less soft-oriented but is still largely mess-processing related. With the increasing amount of electronic information, a considerable amount of soft information exists in text-based documents such as e-mails, web pages and news. Most of the conventional studies of executive information focus on executive information attributes (sources, types and contents) and executive information needs. Little insights have been provided on the nature of executive information. If value-added information is defined in terms of its ability to reduce uncertainty (Daft & Macintosh 1981), insights on characteristics that contribute to the uncertainty of executive information will be useful for supporting executive intelligence activities. Although many studies have been conducted on factors contributing to the uncertainty of organisational environment, virtually no study has been conducted to explore characteristics contributing to the uncertainty of executive information.

This study reveals characteristics contributing to the current state of executive information. Current executive information is considered uncertain due to the over-abundance of information, the heterogeneity of information attributes, the ambiguous...
value of information and the diverse use of information. These characteristics provide implication for designing continuous, self-reactive and self-adaptive EIS but pose challenges to conventional views of EIS design. Conventional EIS tend to provide largely aggregated, precise and historical information based on existing internal databases and predefined information needs, which is predominantly used for communication, performance monitoring and control (Edwards & Peppard 1993; Nord & Nord 1995; Vandenbosch & Huff 1997). Conventional EIS are also not flexible enough to adapt and meet changing information needs due to the predefined rules for exception manipulation, reporting and control (Young & Watson, 1995; Bajwa et al., 1998; Salmeron 2002).

7.3.3 Adding knowledge to the predominant information behaviour models
The predominant information behaviour models suggest that information processing is shaped by multiple factors, such as the situational contexts, affective feelings and cognitive efforts of individuals (Taylor 1986, 1991; Kuhlthau 1991, 1993; Ingwersen 1996; Choo 1998). This study adds knowledge to information behaviour models by revealing characteristics that contribute to the uncertainty of executive's information processing behaviour, followed by factors that influence executive's information processing behaviour. Characteristics contributing to the uncertainty of executive information processing behaviour are identified as the heterogeneity of executive attributes and roles, the heterogeneity of information processing, the dilemma of information reduction and the constraint of time. These characteristics provide implication for designing continuous, self-reactive and self-adaptive EIS but pose challenges to conventional EIS that are static, inflexible and generic. Key factors that influence executives' information processing behaviour are identified as the people who work with the executives, the executive's work and organisational contexts and the affective feelings of executives. These factors imply the nature of additional support on executive intelligence activities. Although the study sheds some light that the additional human and affective support of processing intelligence and the improved technology and information support of processing intelligence could improve the overall support on executive intelligence activities, the goal of this study is to utilise the software agent as an improved technology and information support for processing intelligence. Future research
can examine how the additional human support and affective support of processing intelligence can possibly be incorporated into an agent-based environment for improving executive intelligence activities support.

7.3.4 Original proposal of a usability-adaptability-intelligence trichotomy of agent-based EIS design model

The empirical evidence of this study reveals that the purpose of using EIS is to support and enhance executive intelligence activities through improved support of processing intelligence, coupled with learning and knowledge updating activities. The functions and design of EIS should be more rational and executive-centred that focus on usability, adaptability and intelligence design. This study suggests a more vigilant guidance for building a rational EIS using agent-based approaches. It is a “usability-adaptability-intelligence” trichotomy of agent-based EIS design model that provides executive criteria of value-added attributes and value-added processes for building EIS that can support and enhance executive intelligence activities.

Under the usability criterion, personalisation, controllability, manageability and ease of use are value-added attributes for building an EIS that can be used by individual executives to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. The adaptability criterion indicates that coaching, learning, contextual support and semantic support are value-added attributes for building an EIS that fits the specified and right context of work and information, with the ability to strengthen the responsiveness of system in coping with the uncertainty of executive information. Lastly, although executives are uncertain about the intelligence capability, the intelligence criterion suggests that autonomy, proactivity and reactivity are potential value-added attributes for building autonomous, self-reactive and self-adaptive activities that perform specific tasks on behalf of an executive, with no or very little executive interaction. This “usability-adaptability-intelligence” trichotomy of agent-based EIS design model provides new guidelines for system developers to develop agent-based systems or solutions for supporting executive intelligence activities.
7.3.5 Bridging the gap between what executives desire from an agent-based EIS and what the system developers need to offer

Mintzberg's (1973) "planning dilemma", argues that the management scientists (i.e. system developers, system analyst) lack formal knowledge of the executive information and information processing issues, conversely executives who have the information and intelligence but they are severely subject to time constraints. Mintzberg strongly postulates the need of collaboration between the managers and management scientists for a successful reprogramming of the strategy-making system. This study bridges the gap between what executives want from their information systems and what the system developers need to offer. Previously, system developers tend to overlook or misinterpret important issues because a more appropriate perspective for understanding particular executive's desires and situation was lacking. This study is based on executives' desires and perceptions in deciding the criteria for a successful reprogramming of executive information system. Hence, the outcome of this system will be a top-down view of desirable system, which is more likely to be adopted by executives and organisations.

7.4 Challenges and Limitations of the Research

Although the research objectives are met in the research, several challenges and limitations exist in this study that should be noted.

7.4.1 Identification of relevant software agents

This study attempted to explore latest development and techniques of software agents that are capable of providing solution to the challenges of interaction between managers and their information world. However, the research and development of software agents are mainly mushrooming in the academic arena and research institutions. Most of the studies are in experimental stages that subject to constant modifications and improvement. And most of the applications of software agents are still in their infantry stage. Hence, the exploration of software agents demands intensive attention and follow up. In addition, most of the applications of software agents are developed for general interface
applications, general information access and browse applications and e-commerce applications. Virtually no software agents are developed for strategic information processing. These pose a challenge to conduct a comprehensive review of software agents that are relevant to executive information processing issues. The review of software agents in this study is only able to provide conceptual understanding of the different attributes and functions of software agents, and some applications and approaches of interface agents and information agents.

7.4.2 Development of agent-based prototype
The study attempted to design an executive intelligence prototype by using software agents available. The prototype was to serve as a representation tool of software agent attributes and application, with the goal to help executives grasp the concept of software agent applications and stimulate executives' thinking and imagination for deeper discussion. The prototype was not built for technological experimentation and evaluation. One the main challenges of designing this prototype was the difficulty to incorporate available software agents’ techniques into a web-based environment for demonstration. Most of the software agent applications are prototype systems designed for experimentation. Hence, a rather simple prototype was designed with some basic built-in databases for retrieval based on the tourism industry. Some executives found it difficult to grasp the concept and relate the applications to their own specific information interest. As a result, there was a need for clarification in the demonstration process. And the demonstration of prototype could only be conducted by the author rather than the executive himself due to the static and limited data repositories.

7.4.3 Human-side of agent-based system
This “usability-adaptability-intelligence” trichotomy of agent-based EIS design model is proposed for improving technology and information support of processing intelligence. The model does not include the human-side of agent-based system, such as human support of processing intelligence through a specialised intelligence processing unit, that consists of “information workers”, “knowledge workers” or “intelligence specialists”, who assist executives in information search and process. The human support of
processing intelligence can be viewed as a process of continuous learning activities of information workers on executive intelligence activities. This study reveals that additional human support of processing intelligence could improve the overall support on executive intelligence activities. Hence, future research can examine how the additional human support of processing intelligence can be incorporated into agent-based environment for improving executive intelligence activities support.

7.4.4 Evaluation of agent-based EIS design model

Although this study proposed an agent-based EIS design model, it did not attempt to evaluate the model. The study was to examine the conventional views and guidelines of EIS in responding to the current executive's information environment and information processing activities, and to identify executive criteria for designing an agent-based EIS for supporting executive intelligence activities. At the end, the study proposed an agent-based EIS design model for supporting executive intelligence activities. It would be valuable for the further research to evaluate the model from the perspectives of executives and system designers. The technological specifications and techniques needed for building and implementing an agent-based EIS are beyond the scope of this study and require substantial work. However, it opens door for future research to follow.

7.4.5 Organisational specific sample and related issues on implementation

The research sample in this study was not industry and organisational specific although all focus group participants comprised middle and senior managers and interview participants comprised mainly senior managers. The managers who participated in this research come from different industry and organisational backgrounds. They are subject to different information intensity and interests. Therefore, the results are rather generic in terms of rich information participants who participate in executive intelligence activities but not specific to a particular industry or organisation. Further research is required to explore the executive intelligence processing activities according to specific industry and organisation. The empirical work also did not attempt to explore the organisational issues on the prospects of agent-based EIS implementation. Further research can examine the organisational conditions needed for the implementation of agent-based EIS.
7.5 Future Work

The following section outlines promising directions for further research:

7.5.1 Further studies on improved human support and affective support of processing intelligence

This study reveals that additional human support and affective support of processing intelligence could improve the overall support on executive intelligence activities. However, the study of human-side and affective-side of agent-based support is beyond the scope of this study. Improved human support and affective support are interesting areas for further research. Research on improved human support could explore the roles of highly specialised information (intelligence) workers that assist executive intelligence activities. Research on improved affective support would be a challenging study as to explore and identify affective states of executives that allow them to construct meaning or make sense of the information. Current research on user profiling mainly focuses on building user’s information profile with attributes categorisation, further research can explore and build user profile with affective categorisation. More insights would be gained if observational field studies can be conducted on specific individual executives of a specific organisation over a substantial period of time.

7.5.2 Design of agent-based EIS architecture

Future study can look into the development and implementation of an agent-based EIS architecture based on the proposed “usability-adaptability-intelligence” trichotomy of agent-based EIS design model. The architecture can consist of a common EIS development platform, a comprehensive and specific executive profiles, and a manager-agent interaction and learning mechanism. The development of executive profiles and manager-agent interaction and learning mechanism involve the design and development of software agents using the appropriate techniques. The development and implementation process will involve system designers and executives to give critique and evaluation for continuous improvement.
7.5.3 Validation of agent-based EIS from information systems vendors

The design model and future development and implementation of agent-based EIS have commercial implications and value. Therefore, it would be valuable for the further research to test and validate the model from the perspectives of information systems vendors who deal with companies and users directly. Insights on the appropriate technological specifications and techniques from information systems vendors would be valuable for the design and development of agent-based EIS. The goal is to work collaboratively with information systems vendors in order to develop value-added agent-based EIS in real-life application.

7.5.4 Validation of agent-based EIS design model through a case study

The agent-based EIS design model in this study is generated from multi-industry sectors, i.e. financial, insurance, travel and real estate. For its validation and application in practice, further research is required to apply and extend this model into more specific domain according to specific industry, company and executive. A case study would be appropriate for further research on a specific domain since it investigates a contemporary phenomenon within its real-life context (Yin 1984, 1994). The case study can explore individual task and situational differences of executives with respect to executive intelligence activities and examine the effectiveness of the assistance of an agent-based EIS design model in a specific company. The case study would also examine the organisational conditions and requirements for the development and implementation of agent-based EIS as well as factors that could obstruct the implementation.

7.6 Final Remarks

This research has been a challenging but enriching process for the author. The outcome was rewarding as valuable experience and knowledge were gained and original contributions were added to the IS field of research.
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FOCUS GROUP 1 (n=7)

QUESTION 1: In your opinion, what are the challenges of today’s executive information processing activities?

P1: From my perspective is the sheer volume now, the number of sources you have to refer to, filtering that down, to get something meaningful out of it. The other problem is you tend to see things now on multiple locations, for as before the newspaper article, you see it once. But now you see it on the newspaper, on the Web, the report you get, so you are wasting time reading things three four times from different sources. That is very frustrating.

P2: The other is also time, by filtering data from lots of different sources, because if you have one place that comes through, then you got one place where the information meets, and then it’s a lot easier than scouting from lots of different sources.

P3: Ya, I agree with that time and research time, waiting through all the bits as we always talk about, deciding what is useful, what is not useful. You have to read through almost all, or scan through at least. That takes up enormous amount of time.

P4: I am quite interested in the Intranet information as well, imagine that would be the real time information about key performance indicators, things like that, the organisation might be very powerful. But at the end, obviously it comes back to the database of information they have as well.

P1: I come back to my original one. That’s very good, it’s put on the Intranet. But if it’s put on the Intranet and send it to you as an email. This needs time for the email system, is going to be, to bring this in, to have it successfully worked in the senior level. It’s going to go through the whole organisation to understand it. Otherwise, you’re still going to get an email, and you’re going to get it all up on the agent system. At the moment, most ... or rather I speak on my organisation, Intranet is a mess. It’s a dumping ground of policies, procedures, files. It’s unstructured and it’s boring. So people, I have the option I don’t have to look at it. Your system could actually force me to look at thing I don’t want to look at because I have seen it in another environment.

P2: I agree with P1. I think again is the credibility of information you have that, and the sources providing the information. If you just generally search from the Internet, then you are going to get back lots of lots of information. You need to restrict the sources where it comes back. But at the same time, the balance with that is information that you don’t get back by being too restricted, you can miss things as well. So, there’s a real sort of balance that has to be the context within the context of the organisation.
P5: I would say that the big issue is different types of information. As a manager, the way which you receive and the way you interpret different types of information is different. I would say you need to look at that, segregation. So if it’s financial data, the way which you receive, supposed to be different way, has to be associated with the finance business. Information associated with the internal Intranet, it should be even utilised by executives in different ways. I think that should be simple for recipient.

P1: There’s also the complexity of language. What am I looking for, if I am looking for something in my business, there might be, in my head, ten or eleven different words, which mean the same thing. But in various filter to get them, I have to put all those in. And then I might be missing something, because somebody else might call it something else. That’s particularly difficult because it’s not just the specialist knowledge of your environment, as a senior executive, you also want to maintain your current thinking on management practices. New theories come along, and because you do not know about them, how are you going to search for them. That’s the difficulty to me.

P6: Another challenge could be the value of information in terms of, whether it’s the truthful information that come across, or is someone’s perception of information, or any deception as well; because you know that it could be somebody maliciously bring something into the system just to cause corruption and separation within organisation. So that’s actually the liability for the executive to find out what is the truth of matter from the information.

P5: Everything with credibility is assessed.

P7: I do not know the definition for executive information used in the executive level. Because system likes that need to work in different levels in the organisation. Perhaps, agents work in organisational level as well.

P7: I think it might be more, perhaps, of a cultural challenge for some of the topics in the executive environment of the organisation as well. You are told this is the work environment, here is your information detail and so I work for you. Or you need to do is screen. I think is a cultural challenge for them.

P6: Which the agent that needs to deposit the information in a way that is produced for the executive as well. It’s going to deposit in a report format, even is a citation format, then the information for the executive is going to be concise.

P3: I think the object will be in the setting up of the agent. I think that’s where the work would be, making sure the agent knows very clearly what it’s that the executive is looking for and what structure or format he or she would like it.

P5: Basically is to deliver what the executive wants.

P2: The key driver is time, because the time you need to spend on the system. You only spend that time if it’s key information that you need firstly according to your role, or added
it credible information. The time that you could spend on this is supposed to do other things.

P4: I think it comes back to trusting the information services.

P6: Also, I think the experience on other systems may work against this system you know is the frustration with natural language, like searching through the Internet. Conventional searching is giving you too much information, not the right information or whatever. It’s actually convinced something that the set up of this agent that actually learns and improves, it’s got to have the relevance interface, may be not overcome.

P2: By spending time on this, would you be taking time away from other manuals you use to help the job, to find information? So though this doesn’t show something above beyond what you’re doing already, then you have to ask yourself, if you are taking time away from other things, would you be losing something by using this as well?

P4: Again, if the executive hasn’t got free time at the moment, what is the point?

P7: Just to build on that a little bit, if information agent is covering on all areas, the area that you are looking on certain subjects, or the area that you want to view based on the answer to the questions you put in there, that actually you want probably for yourself other areas around that. So then the agent needs to be transferred from somewhere considering all that approach. So the information is available to questions to counteract.

P6: One last point I want to make is in regards to information processing, is also where you place that information once you have it. I think sometimes when you’re talking to executives, they know they got some information somewhere, but they haven’t managed the way to put that information, and they can’t find it again very quickly to decision making process.

P3: Ya, storing files.

P1: Going through this, I should like the approach of giving up other things, like somebody knows newspapers are effectively unreliable lesson, I think it will be a step forward. But right at the back of my mine is, and is come true several times as I look at it, would this system actually limit the development of senior executives? They become relying on this, they don’t broaden their knowledge. And how accurate reliable is it? It’s a two-edge sword this one. It is going to be a time-lag between the information getting on the Internet because you are relying on the external being on the Internet, rather than been published in an article. Or conversely, you can speed things up because it goes on the Internet, you see it before it is held up on the journals.

P4: With some life-feeds there. If it’s top information, perhaps the executives also want it to predict, forecast as well.
P3: This is like the next level. That’s goal achievement. That’s James Bond.

**QUESTION 2: If software agents can play a part, to what extent do you desire and expect software agents to contribute in your current information processing activities?**

P6: Already on search engine, on the Web, it got the ability of web search agent which starts recording information at the background, what you are looking for. And then when you type in four or five terms into the search box, you click on it, and it will actually suggest things to you on what you are trying to look for.

P7: What you are suggesting is different from something that’s already on the Web.

P2: How is it different from search engine?

P1: I have great concern about this element of language. The more you refine it down, the more you may miss out on information. The second element is most search engines, any way, on the Internet miss most of the sites. So, if you are relying on this, you got to have the credibility. First time you miss a key article that your competitor has, or you call it second next door, because you rely on it, it’s going to be the last time you use.

P2: Absolutely, that’s reality.

P5: My other concern is the software does the, can do the decision-making. One concern is decision making must be based on rules. You have a set of rules, and so and so, all depend on the credibility of the rules you set up. Secondly, I think instinct. A lot of decision making is intuitive. You got the fact and then you make a decision from some instincts. That’s one thing that software doesn’t have this intelligence instinct.

P6: So, it is a decision support tool, isn’t it? It’s not a decision make up. That’s the difference.

P1: It can be both. But the difference here is you sold it to us is going to have interpretation function as well. Now I have extreme concern about that because that interpretation function will be written by software designer, not senior executive and they all come from various organisations. What I am looking for is going to be different from what P6 is, and we are relying on one software developer, or a team of software developers to be able to meet that vast different set of requirements.

P2: Yes, have you seen a lot of CRM, ERP sort of packages introduced to the company? The bigger mistake they made is one usually driven by the software developer to drive what the rules are, exactly what P1 is saying, but also the danger is then initially having rules around the context of the organisation of what we want to search, how you want to search, how you use it, and it almost needs to be tailored into the context of the organisation. So you need a strategy in terms of ethics, in terms of how you, what you
want to see, what you don’t want to see. So you need control over it to this. Ya, there’s a lot of mistakes made by just dropping a little bit of software in.

P6: Talking about mistakes, what happen when an executive’s recent decision based on some information from this software? He could turn around and say, ‘I have this software that indicates this information for me to make the decision but it was wrong.’

P2: That’s a good point.

P3: But look at the other round, you could make a decision based on information which is successful. Then you could say that the software assists me.

P1: What protection is going to be built into the system? Because Web sites, Web pages disappear. You could look back in sourcing information, if it’s current information or transitional information that you base your decision on, how are you going to be able to capture? That’s going to be built into this process, which goes back to what P6 said about the recording, what do you do with it? You could extract this report down, and now you’re going to use it. Is it held on the system? Do you have to print it out? Because that Web page may be gone in the future.

P2: Yeap, when you have done that, in terms of IT, you then need to store this information somewhere, something being opened to this vast amount of information, you want to save just in case, are you going to get into information pouring, one step down, when you end up pouring so much information where you store it or what’s the cost of storing.

P5: One reality is our information needs change daily. You want to actually have the agent to be aware of that daily change. Today, priority for me is one thing. Tomorrow, it’s something completely different. Now if I define within the agent, this is what I need now, tomorrow could be something completely different. How is it going to react to that? It’s a will side decision.

P7: It’s just real time information.

P6: It’s the effort of coaching your agent.

P1: I think P5 has a good point because this is based on system being learning. If our requirement keeps changing, I suppose invalidate the learning process of the agent because as P5 said one day you might be interested in one thing, next day you ignore that because you are not interest anymore. The agent is gearing himself up to learn how to do that. And may be it’s too fast moving. As a big conclusion, it’s a big step further.

P3: But in terms of the profile of the agent, presumably it can retain some of your interests and thoughts of yesterday as well as what you’re thoughts are today, may well then ask you to give you an option to act to this, or you want to get rid of others. So I reckon it must have a sort of flexibility within it to retain as well as to develop.
P2: You are actually focusing very much on senior executive as well. What I can see is minimum management. How are you going to get them to look at it on a regular basis? They are not looking at their computer, their emails or anything today already. How do you get them to then go a step further on this? What goes on it does help them in their job?

QUESTION 3: What would be your concern if software agents act as your ‘personal assistant’ in your information processing activities?

P7: I think you will be becoming more and more dependent on the software and not thinking for themselves, reducing creativity.

P1: It’s basically, the concern is this limiting development kept coming back to me. You always pick up something new, may be is unnecessary something you are looking at. If this is filtering and scanning, you are not going to be doing it, you are going to get what you want, what you know now, so you are not going to expand for the future arises.

P5: You know the PA can make a judgment whether or not that piece of information is important to you, i.e. what if the company will go bankrupt. That sort of specific information the finance manager needs for the organisation, PA can make judgment.

P2: Senior executives like to see them probably having more of a system which would be linked to this, may be link to their mobile phones, where there’s a minimum amount of information. Each stuff they need to know which is sent to them, or may be linked to a paging system of the mobile phone. So it would actually pick up the fact that competitors just made a decision and senior person would need to make that decision, need to know when that’s happening. A little buzz on the mobile every so often. But it wouldn’t be a continuous information flow, but just key and small amount of information which is critical.

P7: Some communication between people I tend to agree upon. You receive information, where else you may pick something else from another source, you may engage some discussion via another colleague, formal opinion is to be important and relevant of that information, and you take that on board and act upon it. If you just receive it from an agent, it may not be a two way communication. It’s different.

P6: I think from the plus site of the software, I am thinking the financial institutions may be benefited from the system. You got the share information there, you got lots of news information which financial stock exchange, stock brokers base their decision on.

P4: If it is a very successful top executive, and people were developing a personal assistant agent, it would be quite interesting to know or it’s just something working professional capacity, you got have high sophisticated personal assistant, they put a lot of effort into developing it. Is it like other software which can be copied?
P2: Ya, it's intellectual property, isn't it?

P4: I mean working as a professional, you may able to take that with you.

P2: If you are taking certain information that company has given you, then it does become the ownership of having interpreted it.

P5: For me, one of the Sun Tzu's art of war, mainly the information sourcing and searching could be more aggressive in its nature. You know there's some general comment, if it's the art of war about competitors' position of strengths, then may be the search capabilities would focus or tackle on specific industry, as supposed to general information.

P1: What I see now, there is an immediate need for this filtering mechanism because of the volume of the workload. If you overcome this bit, your search is going to be incredible, that would be taken. Taking that a bit further saying to interpret all that is one step too far. I think you need to introduce it, get the credibility on the concept before you actually start bringing in interpretation element because that is a cultural change. Certainly for me, I interpret the data myself. I don't like other people to interpret for me.

P2: There is another concern here. By setting up your individual agent, does that information on how you set your agent up becomes exposed to the company being able to judge you by the information you look at. For example, if a marketing director sits there purely looking at competitors all the time, can you then judge that his marketing policies are only being based on competitor type knowledge? In another word, can you then judge the executive by the information he is looking at? It could be used by company to understand their weaknesses in their own executive by what they are not looking for.

P3: I don't think is an appraisal tool.

P2: I would see senior executive using it in terms of the end of day's KPIs, profit and loss statement, end of month's appraisal. Those sorts of things coming up to say at the end of the day, this is what I got to report on.

P3: All sorts of stuff, isn't it?

P1: I disagree with that. I think senior executives would use it more as gaining background knowledge and keeping up-to-date. The work relying on internal processes still have to carry on.

P7: It could be nice to integrate with external as well as internal sources.

P3: But the key driver for the executive is you got to say what the executive's role itself is before you could decide how you could use a system like this.
P5: Executive’s search of information is from outside, getting from elsewhere.

P2: Ya, you have Intranet as well. It’s not just outside, internal information as well.

P6: We were talking about where the information comes from, that can come from friends at the golf course. That is the key information. How do you bring that to the software application? If you got executives from various companies, you meet together playing golf, you are exchanging information. How do you actually bring that the value of information into the software application?

P3: What I want to say is that knowledge though is the knowledge this will do is information that people want you to know, rather than not what they don’t want you to know. I mean most information that I want to keep to myself, I wouldn’t put on the Internet. Do you know what I mean, is pulling information.

P6: You are talking about internal information.

P3: I mean the golf field that I have revealed, the thing I said to you what I am planning to do in my company, nobody would know unless we publish it. So this is more about information that’s available.

P6: This is the question then. If this agent works across different companies, so for example, I got the software, I got the agent here. I trust P1, what I am going to do is to allow my profile works with other agents. They can then exchange information. Because people are already doing it in the trading market, Reuters, they got the messenger 2000 software which you can talk directly, but not publicly with other traders.

P3: I’m just going to say you need obviously something to be defendable. It needs to defend itself from attack.

P1: If this is successful, and I think eventually would be successful. Would it by its nature change the WWW? Would people stop putting on information, which is freely accessible and can be used? And if you are charging for it, I want my information on the Internet to turn into money form.

Thank you.
the sheer volume of information
if you just generally search from the Internet, you are going to get lots of information
the number of resources you have to refer to
conventional searching gives you too much information, but not the right information
I am agreed with the information overload, the quantity of information pour into my consciousness
there are more and more sources of information
if all the information passes on to me, if I start reading it will completely destroy my life
there's plenty of super fluid material that is coming to me that there is no filter I between
it's really the extra information overload burden which might be a challenge
there is problem of having too much data which is irrelevant

you tend to see information on multiple locations
information is put on the Intranet and send it to me again as email
the amount of different systems that provide information

the sources that provide the information
newspapers are effectively unreliable lesson
the challenge is not so much to get information to the desk, but is actually to go and get it from the shop floor level
you have to rely on people where the information comes from
difficult to identify sources of data
the way of getting of information is through people, the immediate middle manager

the big issue is the different types of information
difficult to quantify information in an appropriate format
how do you bring that (friends at the golf course) to the software application?

there's a real sort of balance of the context of information within the context of the organisation
you have to be careful of those information that are fall on fact and those that are fall on opinion
it depends on whether they will actually tell you the context, justification where about the information are coming from
it depends on what is relevant on what they say
it could be factual completely and yet relevant to your business in the time you are making the decision
executives are looking only for factual information rather than opinion
you might get the wrong representation of information from unpublished information

the complexity of languages
if I am looking for something, there might be in my head ten or eleven different words which mean the same thing
somebody else might call the words something else
despite putting all possible words in the filtering system, I might still be missing something
the frustration of natural language through the experience of search engines
I have great concern about this element of language

to get something meaningful out of information
credibility of information
every information with credibility is assessed
sometimes we rather spend all the time looking the information ourselves, information that is understandable to us
executives have to have right kind of input
the information collected can deal with the project that I am working on
relevant and up-to-date
for each transaction, the raw data needs to be processed in a meaningful way
the challenge is to make sure that it conveys your meaning that provides needed information

the value of information in terms of the truthfulness of information
that's actually the liability for the executive to find out what is the true matter from the information
it could be somebody maliciously bring some information into the system just to cause corruption and separation
information that wasn't relevant has become relevant after you read the whole document
I am thinking actually how reliable information is in terms of sourcing bit
the information may be distorted when the requested information is not effectively communicated and collected
processing information through so that executives can have every single thing covered
incomplete information is another problem
most search engines on the Internet miss most of the sites
it comes back to the database of information we have

in regards to information processing, it's also where you place that information once you have it

need to store this information somewhere, something being opened to this vast amount of information

the agent needs to deposit the information in a way that is produced for the executive

it's going to deposit in a report format, even as a citation format

communicate effectively between executives and staff

you are wasting time reading information three four time from different sources

time and research time needed to decide what information useful

it's time consuming

this needs time to have the system successfully worked in the senior level

it's about time constraints

we are talking about using executive time effectively and efficiently

to meaningfully look at everything that is available is a job itself

the information to be searched is up to me in ways that I don't really want to act on it if it demands putting on my time

I think that skills (information scanning) are necessary for executives because apart from that, they don't really have time

there is no way you can spend time absorb everything for a senior post

timely information

due to lack of time, it should be manageable, with a small amount of information

you have to read through almost all information

takes up enormous amount of time

meaningfully look at everything that is available

the key driver is time, because the time you need to spend on the system

you only spend that time if it is a key information that you need

the time you spend on information processing in comparison to the time you could spend on other things

by spending time on this, you would be taking time away from other manuals you use to help the job

if the executive hasn't got free time at the moment, what is the point?

good executives would have a good team around them, well-organised, and seek feedback themselves in the shop floor

poor executives being somebody not organised, not very good in time management, needs facilities to help them out

the challenge is simply using the hardware because the more senior the executive, the less convenient they are with technology

my finance director is very up to speed with the hardware and software

executives are not specialist in every single thing

information that you need according to your role

executives have to rely on various experts so they can feed

there is specific occasion that I will probe for information

certain types of issues that are particular receptive to information, I would likely to search for it

the information to be searched is up to me

my executive just scans through information which regards is relevant or not

the capturing criteria involve executives being clear about what they want to search

as a manager, the way you receive and the way you interpret different types of information is different

information associated with the internal stuff, it should be utilised by executives in different ways

as a manager, the way you receive and the way you interpret different types of information is different

by being too restricted, you can miss things as well

if you are using an IT-based package, the programmer was the filter

there's a great possibility that you are actually filtering out fringe of information that could be probably more beneficial to you

the information that the executive will learn how to re-filter

the more you refine it down, the more you may miss out on information

filtering is a grey area, you could end up filter out pretty important information

I think filtration will work for you rather against you is 50-50
### Coding of Sample Raw Data Themes - The Challenges of Executive's Information Processing Activities

<table>
<thead>
<tr>
<th>Raw Data Themes</th>
<th>First Order Themes (by the author)</th>
<th>Second Order Themes (by the author)</th>
<th>First Order Themes (by colleague 1)</th>
<th>Second Order Themes (by colleague 1)</th>
<th>First Order Themes (by colleague 2)</th>
<th>Second Order Themes (by colleague 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 as a manager, the way you receive and the way you interpret different types of information is different</td>
<td>heterogeneity of information searching</td>
<td>heterogeneity of information processing</td>
<td>executive attributes and roles</td>
<td>heterogeneity of information searching</td>
<td>heterogeneity of information processing</td>
<td></td>
</tr>
<tr>
<td>2 by being too restricted, you can miss things as well</td>
<td>risk in information filtering</td>
<td>Dilemma of information reduction</td>
<td>risk in information filtering</td>
<td>Dilemma of information reduction</td>
<td>risk in information filtering</td>
<td>Dilemma of information reduction</td>
</tr>
<tr>
<td>3 by spending time on this, you would be taking time away from other manuals you use to help the job</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td>time needed for information processing</td>
<td>constraints of time</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
</tr>
<tr>
<td>4 difficult to identify sources of data</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
<td>sources of information attributes</td>
<td>heterogeneity of information attributes</td>
<td>sources of information attributes</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>5 difficult to quantify information in an appropriate format</td>
<td>types of information</td>
<td>heterogeneity of information attributes</td>
<td>types of information attributes</td>
<td>heterogeneity of information attributes</td>
<td>types of information attributes</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>6 due to lack of time, it should be manageable, with a small amount of information</td>
<td>time needed in information processing</td>
<td>constraints of time</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
</tr>
<tr>
<td>7 every information with credibility is assessed</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
</tr>
<tr>
<td>8 filtering is a grey area, you could end up filter out pretty important information</td>
<td>risk in information filtering</td>
<td>dilemma of information reduction</td>
<td>risk in information filtering</td>
<td>dilemma of information reduction</td>
<td>risk in information filtering</td>
<td>dilemma of information reduction</td>
</tr>
<tr>
<td>9 good executives would have a good team around them, well-organised, and seek feedback themselves in the shop floor</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
</tr>
<tr>
<td>10 I am agree with the information overload, the quantity of information pouring into my consciousness</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
</tr>
<tr>
<td>11 I am thinking actually how reliable information is in terms of sourcing bit</td>
<td>reliability of information</td>
<td>ambiguous value of information</td>
<td>reliability of information</td>
<td>ambiguous value of information</td>
<td>sources of information attributes</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>12 if I am looking for something, there might be in my head ten or eleven different</td>
<td>semantic of information</td>
<td>heterogeneity of information</td>
<td>semantic of information</td>
<td>heterogeneity of information</td>
<td>semantic of information</td>
<td>heterogeneity of information</td>
</tr>
</tbody>
</table>
words which mean the same thing

13 if the executive hasn't got free time at the moment, what is the point?
justification of time needed for information processing
constraints of time
justification of time needed for information processing
constraints of time
justification of time needed for information processing
constraints of time

14 if you are using an IT-based package, the programmer was the filter
risk in information filtering
dilemma of information reduction
risk in information filtering
dilemma of information reduction
risk in information filtering
dilemma of information reduction

15 in regards to information processing, it's also where you place that information once you have it
information storage
diverse use of information
information storage
diverse use of information
information storage
diverse use of information

16 it comes back to the database of information we have
information storage
diverse use of information
sources of information
heterogeneity of information attributes
information storage
diverse use of information

17 it could be somebody maliciously bring some information into the system just to cause corruption and separation
reliability of information
ambiguous value of information
risk in information filtering
dilemma of information reduction
reliability of information
ambiguous value of information

18 it depends on whether they will actually tell you the context, justification where about the information are coming from
context of information
heterogeneity of information attributes
context of information
heterogeneity of information attributes
context of information
heterogeneity of information attributes

19 it's really the extra information overload burden which might be a challenge
sheer volume of information
over-abundance of information
time needed in information processing
constraints of time
sheer volume of information
over-abundance of information

20 my executive just scans through information which regards is relevant or not
heterogeneity of information searching
heterogeneity of information searching
heterogeneity of information searching
heterogeneity of information searching
risk in information filtering
dilemma of information reduction

21 need to store this information somewhere, something being opened to this vast amount of information
information storage
diverse use of information
information storage
diverse use of information
information storage
diverse use of information

22 obviously, it's the availability of information
information storage
diverse use of information
information storage
diverse use of information
information storage
diverse use of information

23 poor executives being somebody not organised, not very good in time management, needs facilities to help them out
executive attributes
heterogeneity of executive attributes and roles
executive attributes
heterogeneity of executive attributes and roles
executive attributes
heterogeneity of executive attributes and roles

24 sometimes when you are talking to executives, they know they got some information somewhere, but they can't find it
information storage
diverse use of information
heterogeneity of information searching
heterogeneity of information processing
executive attributes
heterogeneity of executive attributes and roles

25 the amount of different systems that provide information
duplication of information sources
over-abundance of information
duplication of information sources
over-abundance of information
heterogeneity of information attributes
<table>
<thead>
<tr>
<th>26</th>
<th>the big issue is the different types of information</th>
<th>types of information</th>
<th>heterogeneity of information attributes</th>
<th>types of information</th>
<th>heterogeneity of information attributes</th>
<th>types of information</th>
<th>heterogeneity of information attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>the capturing criteria involve executives being clear about what they want to search</td>
<td>heterogeneity of information searching</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>the challenge is not so much to get information to the desk, but is actually to go and get it from the shop floor level</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>29</td>
<td>the challenge is simply using the hardware because the more senior the executive, the less convenient they are with technology</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
</tr>
<tr>
<td>30</td>
<td>the challenge is to make sure that it conveys your meaning that provides needed information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
</tr>
<tr>
<td>31</td>
<td>the complexity of languages</td>
<td>semantic of information</td>
<td>heterogeneity of information attributes</td>
<td>semantic of information</td>
<td>heterogeneity of information attributes</td>
<td>semantic of information</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>32</td>
<td>the credibility of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
</tr>
<tr>
<td>33</td>
<td>the frustration of natural language through the experience of search engines</td>
<td>semantic of information</td>
<td>heterogeneity of information attributes</td>
<td>heterogeneity of information attributes</td>
<td>heterogeneity of information attributes</td>
<td>heterogeneity of information attributes</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>34</td>
<td>the information may be distorted when the requested information is not effectively communicated and collected</td>
<td>reliability of information</td>
<td>ambiguous value of information</td>
<td>reliability of information</td>
<td>ambiguous value of information</td>
<td>reliability of information</td>
<td>ambiguous value of information</td>
</tr>
<tr>
<td>35</td>
<td>the information to be searched is up to me in ways that I don't really want to act on it if it demands putting on my time</td>
<td>time needed in information processing</td>
<td>execuive constraints of information attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td>executive attributes</td>
<td>heterogeneity of executive attributes and roles</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>the key driver is time, because the time you need to spend on the system</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td>time needed in information processing</td>
<td>constraints of time</td>
</tr>
<tr>
<td>37</td>
<td>the sources that provide the information</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
<td>sources of information</td>
<td>heterogeneity of information attributes</td>
</tr>
<tr>
<td>38</td>
<td>the time you spend on information processing in comparison to the time you could spend on other things</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
</tr>
<tr>
<td>39</td>
<td>the value of information in terms of the</td>
<td>reliability of</td>
<td>ambiguous value</td>
<td>credibility of</td>
<td>ambiguous value</td>
<td>credibility of</td>
<td>ambiguous value</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>there is no way you can spend time absorb everything for a senior post</td>
<td>time needed in information processing</td>
<td>constraints of time</td>
<td>time wasted in information processing</td>
<td>constraints of time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>there is problem of having too much data which is irrelevant</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>there's a great possibility that you are actually filtering out fringe of information that could be probably more beneficial to you</td>
<td>risk in information filtering</td>
<td>dilemma of information reduction</td>
<td>risk in information filtering</td>
<td>dilemma of information reduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>there's a real sort of balance of the context of information within the context of the organisation</td>
<td>context of information</td>
<td>heterogeneity of information attributes</td>
<td>context of information</td>
<td>heterogeneity of information attributes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>there's plenty of super fluid material that is coming to me that there is no filter I between</td>
<td>sheer volume of information</td>
<td>over-abundance of information</td>
<td>reliability of information</td>
<td>ambiguous value of information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>they haven't managed the way to put that information, and they can't find it again very quickly</td>
<td>information storage</td>
<td>diverse use of information</td>
<td>information storage</td>
<td>diverse use of information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>this needs time to have the system successfully worked in the senior level</td>
<td>time needed in information processing</td>
<td>constraints of time</td>
<td>Others (trust of systems)</td>
<td>time needed in information processing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>to get something meaningful out of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td>credibility of information</td>
<td>ambiguous value of information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>we are talking about using executive time effectively and efficiently</td>
<td>time needed in information processing</td>
<td>constraints of time</td>
<td>time needed in information processing</td>
<td>constraints of time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>you only spend that time if it is a key information that you need</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td>justification of time needed for information processing</td>
<td>constraints of time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>you tend to see information on multiple locations</td>
<td>duplication of information sources</td>
<td>over-abundance of information</td>
<td>heterogeneity of information processing</td>
<td>duplication of information sources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL PERCENTAGE OF MATCHING**  
70% (35/50)  
80% (40/50)  
66% (33/50)  
74% (37/50)
Date:

Dear Manager,

**Interview on Executive Business Intelligence Activities**

Today, the current business environment would seem extremely challenging making it increasingly difficult for executives' to monitor the situation effectively. With the proliferation of electronically available information from a variety of different, distributed, or heterogeneous sources, the developments in software agent technology seems to represent one of the solutions with great potential to provide guidance and assistance on where executive should focus their attention.

We hope to arrange an interview with you to discuss on the following topics:
- Your current executives' strategic information processing activities
- Suitable agent-based systems for supporting executive's information processing activities

The focus of interview questions is not on the technological and architectural details of executive intelligence support systems, but what executives want, do not want and expect from these systems. Since there are not many examples of highly intelligent software agents yet, we believe your participation and contribution can provide valuable insights for the future development of these new technologies.

We further confirm that the information we collect will not be attributed but treated with strict confidentiality. We would be very grateful if you could agree to be interviewed on these topics. We can come to your office or any location decided by you at your convenient time. The interview will last for 45 minutes. I will either call you or email you sometime in the beginning of January 2004 to confirm your availability.

Thank you for your time and co-operation in advance. We look forward to hearing from you.

Yours sincerely,

Vincent Ong
Researcher
Luton Business School
University of Luton
E-mail: vincent.ong@luton.ac.uk
Tel: 01582 743495
Appendix A.5 Interview Questions with Follow Ups and Prompts

1. Thinking of strategic information that you use, can you tell me how it is collected and processed?

Follow up questions:

a) How do you scan and search for your strategic information?

Prompts:
- Non-computer support
- Computer support

2. How do you choose which information to be examined further?

Prompts:
- Filtering approach/techniques
- Refining approach/techniques

a) How do you go about combining information from different sources?

Prompts:
- Systematic approach
- Rigorous approach
  - Matching with similar cases
  - Map with familiar experiences
  - Talk to more people
- Map with corporate strategy

b) How do you make sense of the significance of information?

Prompts:
- Logical thinking and analysis
- Look for cues
- Focus on details
- Look for relationships
- Gut feeling
- Examine issues more thoroughly

(DEMO PRESENTATION)

3. In terms of scanning and searching capabilities, what would be the minimum criteria or requirements that you would set for the system for you to consider it to be useful?

Prompts:
- Why?

Follow up questions:

a) How do you want potentially relevant information to be picked up?

Prompts:
- Specific vs non-specific
- Wide sources vs particular sources
- Refined vs unrefined
- Real time

4. Imagine you have an ideal software agent that assists you in information scanning and searching, how would your criteria or requirements differ?

Follow up questions:

a) Any other features that could be included for a more advanced scanning and searching system?

Prompts:
- Continuous scan and search without human intervention
- Autonomous scan and search
- Response to information changes
- Adaptive to changes in business environment
- Understanding of word concept and meaning

5. In terms of filtering and refining capabilities, what would be the
minimum criteria or requirements that you would set for the system for you to consider it to be useful?

**Prompts:**
- Why?

**Follow up questions:**

a) How do you want the information to be screened?

**Prompts:**
- Content
- Context
- Matching with user profile
- Customise the criteria

b) How do you want the information to be refined?

**Prompts:**
- Matching with other's user profile
- Query expansion
- User feedback

6. Imagine you have an ideal software agent that assists you in information filtering and refining, how would your criteria or requirements differ?

**Follow up questions:**

a) Any other features that could be included for a more advanced filtering system?

**Prompts:**
- Continuous filtering without human intervention
- Autonomous filtering
- Response to information changes
- Adaptive to changes in business environment
- Understanding of word concept and meaning
- Learning capability
- Working with other agents

7. In terms of interpretation capabilities, what would be the minimum criteria or requirements that you would set for the system for you to consider it to be useful?

**Prompts:**
- Why?

**Follow up questions:**

a) How do you want the information to be analysed?

**Prompts:**
- Provide summary of information
- Highlight the essence of information
- Classify information into clusters

b) How do you want the information to be explained?

**Prompts:**
- Alert notification
- Indicate the relevance of information (ranking)
- Provide recommendation of related information

8. Imagine you have an ideal software agent that assists you in information interpretation, how would your criteria or requirements differ?

**Follow up questions:**

a) Any other features that could be included for a more advanced interpretation system?

**Prompts:**
- Ability to choose among alternatives
- Response to information changes
- Adaptive to changes in business environment
- Understanding of word concept and meaning
- Learning capability
- Working with other agents
Appendix A.6 Sample of Interview Transcript

Interviewee: John (nickname), Managing Director

Q1 Information Processing Activities

1A Current

**Thinking of strategic information that you used, can you tell me how it is collected and processed?**

- The airport operates, or the TBI PLC, we operate on a number of levels. I am going to draw this because it helps me talk about it. The levels we operate on are all strategic. But in between each strategic level, there's this PLC level, there's the UK level, there's the airport level, and I am sure my department has its strategic things as well. There are also tactical systems, or tactical measures, or tactical understanding that help persuade, help develop strategic development are all these phases. So I sit as the operation director for TBI PLC, but I am also the MD of the airport.

- How we get information that makes us change our plan? Well, we are seeking to shape our strategies to match our market. And the market is dictated by several factors. Market shaped by what people want, what products are on the product, how we can develop our products, which is that piece of concrete out there, or the piece of concrete on the picture there to land airplanes on it, of course we have to understand what our customers are doing, how they are managing their business, how their business models are developed. We use a whole series of means to understand that. We use Web-based information systems, so we go onto their Web sites, we have a market intelligence system whereby we fire in, or we join the sort of agency via specific intelligence, relevant to your market.

- Now that's what I call the strategic business development level, there is another level that we operate at, I think, which is the strategic operational level. So things that we do in our business on a day-to-day basis, we are looking at the strategy, how we move up data from the operational level. So, there's a market level (I know this drawing doesn't translate well into tape recorder), a market strategic development of operation. Well, you might say operation is more tactical. Well, it is. But the two, we require information that comes from a whole variety of sources that helps us make operational strategic decisions. We are having one of those today, we are having what's called action planning meeting today at lunch time. People will bring forward all the ideas, all the research they have got into the meeting. We will say, 'Ok, presume the market is doing that at that level, that's our response for, what are the strategies we need to put in place now in order to deliver that. And then what goes out from that are the tactical steps we have to take to achieve that. So, it happens in many levels. It's a variety of source, typically is intelligence from Web, intelligence from articles, intelligence from regulatory organisations.

**Are those information sources mostly computer-based? (follow up questions in Bold)**

- Well, we use computer in terms of hmm... what we are seeking today is actually changed from paper-based systems to computer-based. For example, we use stand planning software. So everyday, the tactical decision regulates aeroplanes to certain expand, the strategic decision that we take for the next 6 months to look ahead and say what would be the likely impact in the market, how do we need to program into the software to look at what's going to happen and how we can manage whatever comes along, that will be six, twelve months whatever on a daily basis. The software will then marry the tactical situation. What I will do is show you how we get some of our advice from our operation
centre down stair before we leave today. You can have a look to that. And that operating between some strategic stuff that we do, and some tactical. Now, you might say many are tactical, but the micro stuff that we are doing are significant for a longer time.

- Now, we’ve done with the operation centre is feed in all sorts of Web-based and technology-based, is all IT-based information processing to allow workers to make decision on tactical basis. They have the airport manager at the airport on a day-to-day basis. And what comes out of that feedback into this strategic decision making process up here.

- But before that, we used to do it manually. Everything is manual. Very slow and laborious. We used to have sort of culture here that people operates in working solos. So that information that’s happened down in the organisation, they were gate-keepers in a way store information and let it through for control purposes. What we saw when we came in three years ago was to break down the barrier but horizontal down across the organisation, so people can take information perhaps strategically and apply it for common purposes.

- When you mentioned about Web-based, besides the external information provider through subscription, do you mean you have an internal sort of Intranet?

- We are developing an Intranet, we are at the very early stages. We do a number of things on Intranet type. We have a risk management facility, where we manage. We look at our business, all things going on the business to access the risks. And that done through all the airports in the UK. And it’s held centrally in our South Wales office in Cardiff. And it forms the database of the strategic threats of business or risks of business. We have to mitigate those risks. So using that technology called AirCheck, sort of we developed in-house and also allow some decision making because what happen is all those risks, all the airports going there, there’s an output the business team bring forward to the main board once every six months. I may present to them, using powerpoint presentation, the current risks that we are facing. And we make decisions based on that. That’s relatively new for us. It has been going on for two years. We’ve been trying it but it’s providing us with the decision making tool, how we run the business and what risks we see in the business. For example, such a risk is what if Easyjet fails? What is the risk? What are the steps we need to take? And we then get back to our business plan. That has been the tool. But we are seeking all the time to bring in technology to help us work smarter. We don’t want things to work harder because people work a lot number of hours. We just want to work in a different way. Where we can, we will apply technology to improve the way the output, the information.

- How do you personally scan and search for potentially relevant information?

- Well, what happen is, I personally can go on, obviously PC, or just scan the Web. But our market intelligence people who are providing information, they’re using whole series of things. They’re using the Internet, they’re using the … or a lot just read the material from organisations, usually comes in paper, now they come in CD-Rom. So they can then put all these together, that search various combination of stuff they want, or stuff is not necessary on the line, not necessary online tool that would search very specific bespoke, hmm Web organisations that we have an account with. So the actual authority is more of them. And we pay through the research they do. We hold that research and manipulate it as we see fit, and the output that, then present to the team, in an old fashion way because we’re all sitting around in the room looking at those papers.

- So, do you have a particular approach when you look into all the information that you receive from different sources?

- I don’t know I do. I liken our management here to a ‘super-tanker’. A captain of the super-tanker, you can’t have your head down the radar screen, you may have a glance on it but you leave that for another navigating officer or radar officer. The key that the way we operate our business in TBI is that we delegate down to the organisation decision making plan, decision making power to the operative directors or operative managers. And what we expect them to do is to make decision based on the informal level of delegated responsibilities. It doesn’t mean you can make a decision of a million pounds, you’re
examining it. And you would know the consequences in taking the decisions in the impact of the organisation through the important network. So, if you’re dealing contracts with EasyJet, I will be involved in it. If you are dealing contract or trying to attract a new airline in, let’s say from Poland, there’s one route today, our executive manager can make decision on that, and the decision then supports that in terms of how the responsibility, check the financial system, the accountability and they decide what is going to the board. So this formal system and informal system are in parallel. Now, what I get to do, like most senior managers in TBI tend to do, is not to get bogged down in detail. Rather giving me the detail, they flag it up and I am able then to deep in and deep out, and pick almost in random basis information that may be personal to making decision. What I expect, what I want for my organisation is to bridge the enterprise, so when I arrive here at the airport, when I got to the operation centre. The person in charge can have tactical information, but also strategic information. The tactical information that appears a lot form the trend and that trend becomes strategic information. That sort of capturing that information is something that we are still in the process of going up the learning curve. You learn the pitfall in the line. So I think in terms of collating, understanding information, that yearning is what thing out there shows us tons of information, or turning information into format that you can interpret appropriately and make decision on it. I think that is the key, yes that we can collect what information but can we process what we process. And that still comes down to one man’s brain.

- **How do you go about browsing and scanning information from different sources, like the email and the Web?**
  - All my emails are split, my secretary is on the email. She can filter, I know if it is the dates of meeting, I wouldn’t bother that, she will confirm with the guys by using Microsoft Calendar. I will tend to respond on emails where come to me, something that requires my action, or if the information within there is potentially important that I might need to respond or forward it on. The aviation industry is full of many organisations, the regulatory and non-regulatory, providing information. And it’s just the case of recognising. It will be great, it will be great, if we have an intelligence system that knew who is responsible, so when the email comes in, it will channel it to right person. That will be very good. But we are not there yet.

- **How do you choose which information to be examined further?**
  - I guess it’s just relevance. Airports are very simple business. When the aeroplanes fly here, we place them into the box, which is the terminal building. We have particular words and phrases that we use and make it very complicated, but it’s a simple business. People go to the box, from car, or bus or train onto their airplane. We apply particular process to it. The key thing for us is we know the business that we are in, we know the sort of physical strengths that we got on our runway. So we know the market that likely to be in the next one, two, three years. But if I have ten years, that’s where it becomes more complicated, which relies more on the forecasting and the direction we take. But because of the strategic nature of the business to UK economies, government now interfacing are making decision on your behalf, in terms of setting the planning work to bring forward or setting the framework for growth plan. So, the things we need to bring in for us is, for example, to extend the runway or build the new runway, which is very strategic for us, because a high amount of capital is required and strategic to the economy of UK. Government will set that framework, we would respond, we would respond on what we have to do by gathering information on fauna, flora, market, and transport systems, you name it, the whole thing, very prescriptive. And these will put into the planning document. So, our decision making process is actually, should be very simple.

- **Is there any filtering approach towards all the incoming information?**
  - There is no such a system other than getting rid of spam and rubbish. All the viruses and that garbage are taken away. And you are left with real email. My secretary looks at them manually. I still have my machine, I know if it is unimportant, I will just click on and just clear it. Where if it is important, I will read it and take action or whatever. Our financial
management information team gets a lot of information because they understand number, working out passenger flow, etc. They analyse its statistic and find out its performance, which is actually very useful for us in terms of taking to the Board.

- **How do you go about combining information from different sources?**
- Again, it’s down to manager’s concern. In my level, I am a receiver of information. Only passing it up to the chain of Plc, where I do the filtering exercise. So when the raw data comes in to the middle manager level, they will look at it and pass it to their boss. Each time, a layer is taken out. So you are getting a purer and purer information may be in one sentence or two sentences statement. Because we do not have time to read every page. We produce every month an information pack like that. What relevant is the first line, whether we are working on budget or we are not. If we are not on budget, how can we get back to budget. So, the filtering process is still done on a good old fashion. Human element is making decision on what they feel is important. Now, if there is sufficient information around, if the human filter mechanism has taken out too much, you can still spot trend in the data you receive in this level. Just like, you pick the data yourself and make a further exception. The filter mechanism of the top is also supporting data below it, and again it comes back to the intuitive process. If you have been doing it month in and month out, you should see a trend happens and therefore you know what is significant and not significant. The mechanism of PLC, we are now talking of eight airports in plenty of locations around the world. The management accounts produce something like that, and the management reports are produced for the chief executives, the non-executives and chairman to read. Again, the interpreted process is done by managers or by man. What would be good if we have a filtering system that manages that, and pull out certain information in detail.

- In Plc, we set the business plan once a year. We have five years view of the world. We are a capital intensive industry, the big drive of our business is our passion on airplanes and concrete. If we think the growth is going to be 20 percent better, what we look at is information from the Bank of England, from the treasure, the growth, the GDP, also information from the CAA, BAA. In view of what we think we can do and recognising the market of the world is, we will scale accordingly. From the five year plan of what think is going to be, we bring it back to one year, and that would be the next year. Now what are the assessments we need to make given that, what are the numbers are, what decision making we need to make to achieve that, recognising what we do achieve the following year plan. The key is to understand information we get.

- **What if one of the airlines announces particular news that might affect the business?**
- We have a formal network with the airlines. If the airlines, or the business partners of the airlines are going to make some news or say something, it is not usual a surprise. If that happens, it is unusual until we have an agree format. What we regularly do, because our main customers are serving the consumers, they got information systems that put up news for the consumers, we also get that as well, so we monitor that everyday with the Ryanair website, the Easyjet website etc. Our marketing intelligence team monitors that currently.

1B Improvements

**In what ways and to what extent your current information gathering and processing activities can be improved?**
I think we can systemise a lot more than what we did. I think what we did is an ad hoc basis. It is very much with what we want the strategic information but we do it from a tactical point of view. So we gather it here, we gather it there. But what we should be doing, if all of us look at the website everyday, we should be spent live. There is a big picture. What do we need to feed into that, what can be put into that, like a master database, which is a live document, or a live system that we can feed in, and can explain how the consequence to what I now know it here, is that X, Y, or Z. And if it get changed the input here, this is unlikely to be here. Somehow if we could find out what is happening in the market, a live basis that feed into our airport management systems, feed into our stand planning software, or to our administration work and operative engagement, that would be very helpful. Often, we have the situation we can't make decision because we don't have enough information. With a live piece of software, it will be able to give the outcome. I am not sure feasible yet, but in the business sense, to get all those tactical inputs, to look how it impacts the strategic direction of the company. It will be very useful. What we need is almost a simple process of managing our information and allows us to take out the emotion from decision making, which leave us pure answer or pure information from which people with more experience perhaps or people who can take more risks can act on that. Because what you tend to find people don’t like to tell people bad news. Therefore, they would filter the bad news or they would condition somewhere and you can go down with that course of action because people don’t like to tell people what the bad news is. And if you are going for a particular course of action, because of what people provide and because of the culture as well, we hope the culture isn’t wrong here, you could end up with the wrong output based on the right input. How’s going to be improved? Well, I think we can systemise our market intelligence in a better way. I think it is very much scanning newspapers, going through websites, or perhaps we can have an interrogation system on our web, on our host that went out scan, like I am looking for this information, the search function on the browser is doing automatically, collating from all different websites and to be present. It’s not just a word search but the whole series of instructions that you can give, and perform the searches, takes out the rubbish, and present it to you for the course of action. That would be very useful. It shouldn’t be something predictable. Donald Rumsfeld made a crazy statement that is absolutely right: “what we know we know, what we know we don’t know, what we don’t know we know , what we don’t know we don’t know.” I think that “what we don’t know we don’t know” you could laugh at it, but actually what he said was absolutely right. Because the things you don’t know about, that still come and hit you from that field, presumably they are there, you could take a completely different direction. If you could have some sort of intelligent systems that filtering all the time from the Internet. You would know it, or you have a better chance to get it alier. And that would be a way forward. But I guess the issue for an organisation is whether they could afford that, because I am sure that’s concerning leading edge that we have to recognise first of all either the internal result, the risk profile we got. It is an extra optimal position from the predictable fashion of Internet rather than something which is perhaps not yet available commercial.

Q2 Suitable agent-based systems for supporting information acquisition

2A Desired acquisition properties

In terms of scanning and searching capabilities, what would be the minimum criteria or requirements to be considered as useful?

- I don’t know how technology does it. What do I concern is the output. Three or four times a day, I would probably go onto the Web to just look for pieces of information. What I hope it would do, and that would be very useful, if the agent was able, for a short while, spot the trend of information I am picking up. So, it could almost predict what I was going
to look for on a day or hourly basis. So, I will continue to present to you, a search, the same soft of thing. Because I think most people look for easy life. Most people want the ads taken out and the information presented to them in the clearest form, and therefore, scanning and searching that could happen without input probably, that would be far better than if I have to go and recreate. May be we have a whole series of ... Monday look at one thing, Tuesday look at another thing, Wednesday or different hours during the day. It was recognised that, first in the morning, check market prices, or check airlines’ news based on the day, check television on DVD, or check for industry coming out of the government, stuff like that. And it would go to a picture and store the information as well, so that I can go back. Because it is not very well having information life and then wonder what do I do with that later. To have some archives and all sorts of archive of intelligence.

2B Intelligence acquisition properties

Imagining you have an ideal software agent that assists you in information scanning and searching, what would be your desirable criteria or requirements?

- I think we both are talking about the same thing. This is an agent that is proactive. It sits there. I think we shouldn’t change that much, very similar. But I would say proactivity ...taking the biggest problem is the volume of information out there and its relevance. So if it was an intelligent system, it knew what is wanted, and ideally, one would probably talk to the computer, and say ‘find me information on” And more on a business tool rather than something which is, and the Web’s intelligence basis are good, but it is just so huge, you know it keeps building. And therefore, scanning that was neat, efficient and targeted.

Q3 Suitable agent-based systems for supporting information filtering

3A Desired filtering properties

In terms of filtering and refining capabilities, what would be the minimum criteria or requirements to be considered as useful?

- It’s all very well having this is 40 percent relevant, this is 60 percent relevant like current systems do. Sometimes because of the way, and this is about the user interfacing with it. We use terminology we know, we want, if it could be interpreted over the browser, it should interpret the way ... one word in one language means one thing and another language means another thing. Let say US English and UK English. You might put a word in, and get hold on something totally different. You actually try to use the US word as well. The context of the word you expect, there are other words as well. So must know that, that word that you put in cannot mean all this rubbish because the other word you put in as well are related. I think that would make the intelligence tangible. The other thing is often, you know sometimes you put inverted comas on, it still comes out garbage. Or if you don’t put the things in, you put the words you are looking for, you then got seventy, eighty pages. In actual, what you want is on page 9. The problem I got in terms of filtering, most people don’t go beyond that ... How do you get the system to recognise what you are really looking for is on page 7,8,9 or page 100? The way some organisations manage to get their sponsor pages or whatever to the top of the search profile and actually make your search slow down. Or may be you put the wrong word in and the supporting words you put in the advanced search. There is a mixed match. It will still give you the top one.

- Do you mean having some customisation in the system?

- Ya, which you could refine. When you put certain words down, it knows what it means because it learns from you a number of times before. So again, it’s rather a more efficient intelligent based system would be far better. I think if we look back in 50 years time, things will be seen very old fashion. And wonder how much would have come on. I think the
future of MD could have a completely different conversation than they are having because the current filtering mechanism will be seen as too old fashion.

- **Why the understanding of the meaning of the words is important?**
- Even in UK English vs American English, contextually, the word can mean different things. That’s why, the filtering must recognise the context in the airport business. No point giving information on roads or rails or whatever. Let say, what ‘passenger’ means? Whole bunch of people or consumer. In my context, consumer means airline passengers. That’s why, I hope the system would learn from … you have to train it somewhere. Even that should be minimised because it should learn from experience.

- **In terms of refinement, what would be important to you?**
- The current ware of system is user-determined effectively, is not interactive. So you need to measure interactivity. For example, you say that, do you really mean what you just said? Do you really want to do that? That’s intelligent system. The current system will do what it says. If the system could be interactive, and that refining process challenge you and also challenge the system. If that’s intelligent one, it would say, and do it in such a way that adds value, rather just put a flag up, and saying here is the things you need to do. Refinement is very very much saying ‘you say that, and I can get this or that, which you prefer?’, giving options, such as ‘don’t show the screen again’, or ‘don’t give that again unless I specify request for it’ or something like that. Or research it, recognise the background. And if you almost anticipate what I am going to say because you persist to be agent recognise there is a connectivity here. You present this new information and there is a text cause of action.

3B Intelligence filtering properties

**Imagining you have an ideal software agent that assists you in information filtering and refining, what would be your desirable criteria or requirements?**

- I think we have covered most of them.

**Q4 Suitable agent-based systems for supporting information interpretation**

4A Desired interpretation properties

**In terms of interpretation capabilities, what would be the minimum criteria or requirements to be considered as useful?**

- The biggest annoyance for any search is all the spam and flashing up. No matter how many controls you have, you still to get. We don’t want that. What would be good if, first you could do is to take out all the websites that have the advertising on, forget the advertising, filters out. And in terms of how it shows it cleanly, keywords, rather than whole paragraph. You might not want the whole paragraph, you might just want a sentence, with the words saying ‘aviation slumps by 25%’. In very simple blocks, not too cluttered. And at the bottom, you have more information on this or more information on other subjects related to this. I am very keen on seeing as little as possible, very clean approach rather a cluttered approach. I think current web is very cluttered, too busy. If you want to make decisions very quickly, that’s what tactical and strategic decision based information, you want minimum amount of information, readily processed, so that you can click on. If you want more information, you must have a box we can go and blow the screen up. So, I think clean, clear or clarity of information.

- **How about the idea of giving alert or notification to the user?**
- I expect that to be automatic. I actually like the computer, if I am doing another applications, like Excel spreadsheet, almost like my children doing their messenger, they can hop in and hop out, something like that, it’s important to that, and set the level of
importance, can pop up and say ‘do you such a such thing happens’, that would be very useful. Sometimes you are in the meeting, talking about certain thing, something could pop up and change the whole way you do thing. The classic was we are doing our contract of negotiation with Easyjet, we got the news that two aeroplanes crashed into World Trade Centre. All that can give an impact in a minute, by far in the evening, the whole world change and so the way we run our business. So ya, alert, alarms, false true, so that when you are working on one project, or if you can say ‘false true’, something flash up saying ‘do you know this is happening’. But again, it almost like alert phase, so if you get point five, you know what I mean, like the security indicator. So the system can have some alert phases, which are appropriate to your business, which you can set, but also the impact and marry the two.

**Earlier on you mentioned on information categorisation, would you like to explain more?**

**What did we do before we have email?** There is a fundamental question. Now the question is that we have too much information. And because of too much information, and our brain takes thousand years too developed, although we are getting brighter, our brain can only process information the same speed 30, 40 years ago. But we are getting far more information. I think the average person living in 16th century, 17th century in England, for the one year of information you get, you can get it on the front page of newspaper in a day. And they travelled not more than five or six miles, and now we travel hundreds and thousands of miles. We have newspaper, we have the Web, we have telephone, we have PDA, we have all those things in place. How do you process it? How can you make it and therefore what this system should do is saying, ‘I know the business surely, I know what is important, I will filter for you and I will get rid all the gross. But I know for you is gross, for you is not important, but for your organisation, it may be important to the organisation. I will make sure someone else will get it still.’

**How about the idea of providing relevance ranking or recommendation?**

**I think as I have said before, what you get on the Web today is substantial repetitiveness. It comes out 90 percent is actually not relevant. Relevance is important. I don’t want to have many options, I want one, two, three really good points, something specific targeted. I like it to recognise sponsored Web site, therefore I will discounted because I know you are looking for.**

**How about the idea of providing explanation or summary?**

**I think one line, or two lines. We tend to do that with our emails, you have the subject, or the first line, or the urgency. So I think that is important, but no more than one or two lines. When you get to BBC Website, for example, you have the information with picture layout, sometimes you click again across the top, you have information flashing in. It’s like watching Bloomberg. You have the presenter there, you have option shares there, you have news clicks from the bottom. And you think, where do I look. Now, I used to be a traffic controller, I looked at radar screen, and I was always moving things, managing things. I find it difficult, how do the average, non-traffic controller, non-Bloomberg expert follow that. I think the Web if give you too much information, you can miss it. And if you slightly blind in one part of your eyes, whatever, you miss things. Therefore, less is more. Sometimes you become word-blind. You see a sentence and the word ‘NOT’ is missed. You think is positive but in fact is negative. That’s my personal point of view. I scan so quickly. I tend not read the whole sentences . . . The key thing is to deliver, to crystallise the key issues or key attributes on what they want to tell you rather than the whole sentences. And if you want more things, yes, you can click on the options, but bang bang bang. It will be great actually, the words you are looking for are highlighted. That interpretation came useful, few words, bang bang bang.
Imagining you have an ideal software agent that assists you in information interpretation, what would be your desirable criteria or requirements?

- I think we have covered that.
- Any concern if agent fails to interpret the right answer?
  - You are right, it might not be the right answer. But you got to have a function, to be able to say ‘this is not the right answer’, ‘that’s not I want’, or ‘that’s not what I asked for’. Go away and do this, and this, and this. So you need to give feedback, as long as it’s learning from what you do through feedback. I think it got to be far better than what we currently got. It’s actually a dumb system. Eight times out of ten you would get the right answer. What they should do, is give you the right answer ninety-nine times out of hundred. That is the level of efficiency, ninety-nine times out of hundred. And if it’s not right, it should learn why is not right. It’s learning again, the learning mechanism.
- From what you have shared so far, what are the key reasons for you to have the above criteria?
  - To save time or to reduce information overload. I think you can save time. We have an awful lot of saving devices. We are on the rush. Fifty years ago, my mother used to wash clothes manually. Today we have washing machine, tumble dryer, everything is now so fast. Are we in danger of having too much information so we become lack of ability to make decision? I think some people, because of information out there, want more information. But they get to the point where they have so much information, and they are not going to make a decision. Therefore, while searching the Web, it’s going to provide information which is relevant, appropriate which you can make a decision. The worst thing is you can do is not make a decision.
  - So, the ultimate goal for the system to do for you is to fasten your decision making process?
    - Sharpen, I don’t think it makes it fast. I can make a decision now, let says, that’s a very good point, have you thought of this, this, and taking a different direction. So, I think it doesn’t need to be very fast, but it needs to provide relevance. So that you can then come up of what decision going to take. So, I think that’s what the system for is to create opportunity. Why search if you get the same answer. If you look for some more, is going to get the same answer. Stop searching now. Give the instruction that you have done it.