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WHAT DO I NEED TO KNOW AND WHERE DO I FIND IT? - AN EMPIRICAL INVESTIGATION OF INFORMATION NEEDS IN ENTERPRISE INTEGRATION PROJECTS

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by

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ABSTRACT

Enterprise Integration can be briefly stated as the capability of an organization to integrate different system functionalities for enhanced operation of its business. In reality, this is a complex process because it attempts to integrate multiple aspects related to the enterprise, existing information technology, organizational data, people and business processes, which are dynamic entities often dealt with in isolation. Teams of individuals engaging in enterprise integration possess varied knowledge and skills catering to one or more of these avenues.

Each task within an enterprise integration project requires access to considerable amount of information and to information sources that may contain the information. Our understanding of what kinds of information is needed for performing these tasks, and when and where individuals engaged in enterprise integration projects access this information remains poor. I report on a study that describes the information needs encountered by teams of individuals engaging in enterprise integration projects. Weekly data on tasks completed, was collected from a set of 19 student project teams for a period of ten weeks across which they participated in the projects. The data, comprising of over a 1000 task descriptions, was analyzed using quantitative methods in an attempt to characterize task impacts on information sources consulted and information sought. My interpretation of the results using task-oriented information seeking theory suggests that information needs encountered in the process, are satisfied in specific ways influenced by the type of the task triggering the need. The results hold implications for practice in enterprise integration projects and for organizations to better serve the information requirements of related teams.

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1. Introduction

Enterprise Integration can be defined as the capability of an organization to integrate different system functionalities (J. Lee, Siau and Hong, 2003), including those provided by legacy systems, that may be spread across multiple organizational units, in order to align business processes and organizational data. An enterprise integration project deals with the achievement of specific objectives to this end. These projects are quite different from and complex compared to traditional information management systems projects, in that they involve wider scope (at the level of the enterprise) and higher costs in terms of time, money and resources (Sumner, 1999). This requires the development of a good understanding of the current business situation or business problem, which gives rise to requirements for the enterprise integration activity. Clearly, the process involved in enterprise integration is information-intensive, considering that it requires knowledge about multiple aspects of the enterprise, business processes, organizational data and the technology (Linthicum, 2000). A project team engaged in the enterprise integration activity thus requires information on these diverse aspects for successful completion of tasks with in the project.

With this understanding of the information requirements behind enterprise integration, we have limited knowledge of information needs and information seeking within teams (Detlor, 2003; Freund, Toms and Waterhouse, 2005) that engage in enterprise integration projects. Where do these team members go to get information needed for completing their project-related tasks and what information do they seek? The objective behind this thesis research is to find an answer to this piece which is an important part of the enterprise integration activity. I elaborate more on the importance aspect as part of the motivation for the study in section 1.1.

I use the task-oriented information seeking perspective (Bystrom and Jarvelin, 1995; Vakkari, 1999) to explore the information needs of teams engaged in enterprise integration projects. This theoretical perspective is applied as it precisely uses the constructs of information and information sources, which map directly to our objective behind the study. Task-oriented or task-based information seeking theory purports that information needs of individuals are directly linked to the tasks being performed by them. The theory looks at three principal constructs underlying human information seeking behavior – *tasks* being performed, *information* used and *information sources* consulted. Using these constructs, we examine the information needs encountered by teams of individuals engaged in enterprise integration projects. In order to make generalized inferences on information needs for task performance, I deal with these constructs, at an abstract level, in terms of categories of tasks (i.e. task types), information types and classes of information sources.

1.1. Motivation, Research Focus and Research Questions

As we recognize that enterprise integration is an information-intensive process, I note that the research community lacks a clear understanding of the nature of information needs confronted by teams engaged in this activity. It is useful to develop this understanding for the following reasons.

We know that organizations are increasingly spending more on acquisition and development of information and communication technologies (ICT) for management, storage and retrieval of organizational information (Tuomi, 1999). Given that individuals possess certain preferences for information sources, which affect information seeking necessary to satisfy their information needs (Stefl-Mabry, 2003), the question now arises if the ICT expenditures really overlap with these individual preferences. In order to answer this question, it is useful to find out where people in an organization go for

information. This also encompasses teams of individuals within the organization engaged in enterprise integration.

Although we are aware of the knowledge requirements behind enterprise integration in that individuals engaged in the activity need to know about a multitude of aspects – enterprise, organizational data, technology, the business process, etc. – there is lack of empirical evidence on what information is actually being sought by these individuals within an enterprise integration project.

To this end, the focus of this research is to understand and characterize the information needs confronted by teams of individuals, engaged in enterprise integration projects. As I adopt a task-oriented information seeking perspective, this calls for the identification of tasks involved in the process, information sought and information sources consulted. The characterization of information needs is explored as relationships between categories of tasks, information types and information sources.

With this vision, this research intends to seek answers to the following research questions:

- For an enterprise integration project, what is the relationship between task types involved and information sources consulted?
- What information is sought for completing different types of tasks, within an enterprise integration project?
- What patterns of information seeking, if any, of task completion are prominent within the process?

Some of the potential benefits of the outcome from my research include:

- takeaways for better design of knowledge management systems or corporate intranet web portals, in terms of publishing information that is useful for enterprise integration teams and making these resources available for consumption

- research findings are likely to hold promise for project planning, in terms of planning training needs of team members
- inputs for further research in the field of Task-oriented information seeking

Further, from the viewpoint of research communities, the contribution of this research is non-trivial in that my findings can potentially inform two distinct research areas – Enterprise Integration (or Information Systems Development) and Human Information Behavior.

1.2. Approach and Research Methodology

My research questions and research context (i.e. enterprise integration) shape my epistemological approach for this thesis. LeCompte and Schensul (1999) discuss different qualitative research paradigms or research approaches - Positivism, Critical Theory, Interpretivism and Ecological Theory. Previously, Orlikowski and Baroudi (1991) identified that positivist, critical theorist and interpretivist approaches are popular in information systems research.

This research aligns more closely with the *interpretive* paradigm considering the exploratory nature of the study in examining the social phenomenon of information needs and information seeking for task performance within the context of enterprise integration projects. In studying a social phenomenon *as it happens*, the researcher is immersed in the study context. This establishes the lack of isolation of the researcher from the study context (that is the social phenomenon). This is likely to create some room for potential researcher biases in the study and hence I negate the positivist view of discovering the reality as if it were independent of the researcher. Reflecting on the principles proposed by Klein and Myers (1999), the fundamental principle of the hermeneutic circle is incorporated as part of data analysis in that initial inferences (related to the *whole*) from the data (that comprises the *parts*) are validated through deeper analysis of the data aiding

in further refining the inferences. Some of the findings are interpreted against the contextual factors of the study setting like temporal and organizational context.

The research form that is being followed is based on the case-study method which suits the exploratory nature of the research (Eisenhardt, 1989). Weekly project tasks data was collected from multiple teams engaged in enterprise integration projects as part of a senior-level undergraduate class. My analyses treats each team as a case providing data about the phenomenon of information needs with in enterprise integration projects. I use both within-case analysis (categorizing task episodes using task categories, information types and information sources) and cross-case analysis (comparing across cases for understanding task impacts on information and information sources) to arrive at research findings. Finally inferences made from findings are compared against existing literature.

1.3. Overview

This research is an effort at understanding the information needs encountered by teams engaged in enterprise integration projects. The ‘information needs’ are viewed as a behavioral tendency exhibited by project teams and this term is used in the sense of ‘seeking information for task completion in a chosen context’. It is operationalized in terms of information sources consulted and information sought. This thesis is organized in the following manner. Chapter 2 gives background information on enterprise integration; the constructs used (tasks, information and information sources) for conducting the research; and task-oriented information seeking theory including prior work in the field; it also presents a conceptual framework for the research, chosen from existing models in information seeking. Chapter 3 outlines the research methodology and describes the sampling and data collection approaches. Chapter 4 elaborates data analysis and presents findings that answer the research questions; it also includes a discussion of inferences made from the results. Finally, chapter 5 provides a summary of the thesis, along with implications and directions for future research and concluding remarks.

2. Background and Conceptual Framework

This chapter is intended to give the reader background information (from academic literature) pertinent to the convergent themes that form the basis of this research. These themes are namely (1) enterprise integration (domain of this work), (2) tasks, and information, and information sources (core concepts underlying this research) and (3) task-oriented information seeking theory (the perspective selected for analysis). The section on task-oriented information seeking also speaks about prior research i.e. empirical studies in information seeking to highlight the flavor of the study. Finally, a conceptual framework for the study is described to help situate the research context.

2.1. Enterprise Integration

The term enterprise integration refers to the capability of an organization to bring its various organizational resources closer for enhanced functioning of the business. According to Smith, O'Brien, Kontogiannis and Barbacci (2002), “the goal of enterprise integration is to provide timely and accurate exchange of consistent information between business functions to support strategic and tactical business goals…”. More commonly enterprise integration is also said to deal with integration between business processes, organizational data or integration between the two.

Chalmeta, Campos and Grangel (2001) define enterprise integration as the focus on the enterprise’s organization as well as its functioning including activities, decisions and information flow in a coordinated manner for enhanced business performance. This reinforces the fact that the focus of enterprise integration lies at an organizational level covering the whole enterprise, rather than assuming only a technological level of attention. To this end, we note that it is important for an organization to achieve behavioral integration along with technological integration (commonly labeled as

Enterprise Application Integration) in order for it to attain the agility and flexibility (J. Lee, Siau and Hong, 2003) needed for the enhanced business performance.

Enterprise integration projects typically consider one of two approaches - *bottom-up* or *top-down*. The bottom-up approach tries to integrate already existing functions and/or systems using some kind of bridging mechanism (e.g. middleware, web services). On the other hand, the top-down approach tries to realize enterprise integration by utilizing an enterprise-wide system (e.g. ERP) to align and manage all the individual pieces of the organization. Such is the nature of enterprise integration in that it does not start with a clean slate unlike information systems (IS) development. For this thesis, I define IS development as an organizational activity that involves the conception, design and development of a computer-based system to address an organizational problem or need that is well-understood.

Any IS development activity or project always starts with a set of system requirements that speaks for an organizational or business problem (Chung, Katalagarianos, Marakakis, Mertikas, Mylopoulos and Vassiliou, 1991). It has been re-iterated often (Castro, Kolp and Mylopoulos, 2002; Wand and Weber, 2002) that requirements gathering and analysis is a very time-consuming and important stage in IS development. Even though requirements are very much a part of enterprise integration projects, I note that they are least obvious or evident to the analyst. One is required to consult with paper, people and systems (Linthicum, 2000) in order to decipher the enterprise integration problem and hence the requirements.

Another aspect that differentiates enterprise integration projects from IS development projects is related to the methodology. Fitzgerald (2000) highlights some of the popular methodologies in IS development like the Systems Development Life Cycle (SDLC), Structured Systems Analysis & Design Method (SSADM) and the Object-oriented Analysis and Design methodology (OOAD). Each of these methodologies is process-driven in that they are accomplished in sequential phases. Alternatively, there are no

standardized approaches for performing enterprise integration. Linthicum (2000) advocates a comprehensive 12-step program that includes project phases ranging from understanding the enterprise, business process and data to applying the technology, testing and maintenance; his prescription is based on concepts drawn from database schemas, requirements gathering, object-oriented modeling & design and design patterns. Schmidt (2002) argues for the importance of laws and principles in thinking about a methodology for enterprise application integration. Scott and Vessey (2002) provide examples of implementation methodologies of enterprise systems in organizations – Big Bang, phased, pilot or a combination thereof. Wing Lam and Shankararaman (2004) describe an approach for enterprise integration projects in e-business consisting of the following steps – understanding the end-to-end business process; planning the integration; producing the architecture; deriving the requirements; and mapping the process onto components.

An important distinction between enterprise integration and IS development is related to the time factor among others. IS development is clearly bound by time and scope in that it deals with implementation and maintenance of discrete systems. Whereas, enterprise integration is considered a journey (Purao and Cameron, Forthcoming) due to the interplay between the scale of the activity and the dynamism associated with the organization – the scope encompasses multiple systems, multiple stakeholders and alignment with organizational processes. Table 2-1 summarizes the aforementioned distinctions between enterprise integration and IS development (sometimes referred to as IT projects).

Considering enterprise integration as a large puzzle, an enterprise integration project can be thought of as a manageable chunk of effort that attempts to assemble just a few pieces together at a time. Thus in enterprise integration projects, the challenge is two-fold. First, the right pieces of the puzzle need to be identified for integration. Second, the project team has to figure how to perform the actual integration of the pieces (i.e. in what manner

to assemble the pieces together). This is exactly the context of enterprise integration projects in which the study is taking place. With this level of understanding of enterprise integration projects, I now switch over to describing tasks in general and how tasks have been characterized.

Characteristic	**Enterprise Integration**	**IS Development**
Objective	To integrate existing systems and people to achieve enhanced business performance	To solve a discrete organizational need by building/altering an artifact
Trigger	Sound understanding of the enterprise and business is needed to identify the requirements behind enterprise integration	Requirements are clearly derived from the organizational need
Methodology	No standardized approach	SDLC, SSADM and OOAD are popular methodologies
Project scope	Involves multiple stakeholders and subject to the dynamics of enterprise level concerns	Usually limited to one stakeholder's requirements; clearly bound by time

Table **2-1**: Distinction between enterprise integration and IS development

2.2. Tasks

Tasks have been extensively studied as part of research in the areas of human computer interaction and organizational behavior. In human computer studies, focus on tasks has been received from task analysis and related techniques (Kirwan and Ainsworth, 1992) for enhanced systems design. Here tasks are looked at from the perspective of a work domain. Attention to the study of tasks in organizational behavior has informed different areas related to work design, decision making and individual/group performance among others.

Another area, where tasks have been studied is related to business process management and modeling (Melao and Pidd, 2000) and more specifically workflow management (WFMC, 2008), which describes a workflow (synonymous to a business process) as a set

of coordinated tasks performed to achieve a business goal. In this context, a task is defined as, “an elemental process that represents a logical unit of work within a (business) process” (Basu and Kumar, 2002). From a process view, this conceptualization of a task is appropriate in our context of an enterprise integration project.

Kim and Soergel (2005) provide an excellent review of task classifications based on different task characteristics. Their review originates from a human information behavior perspective (Sonnenwald and Iivonen, 1999; Wilson, 1999), by considering a framework made up of intrinsic task characteristics, extrinsic task characteristics, task performer and the relationship between task & the performer. For this research, we will consider the intrinsic task characteristics dimension as it is more suited to the exploration of information behaviors associated with tasks. Task complexity or simplicity is one of the chief intrinsic characteristic of a task that directly impacts the information needs accompanying it.

Characterization of tasks based on task complexity have been documented and used by empirical studies (Bystrom and Jarvelin, 1995). Based on perceived task complexity, Bystrom and Jarvelin (1995) classified tasks into automated information processing tasks, normal information-processing tasks, normal decision tasks, known genuine decision tasks and genuine decision tasks (described in Table 2-2); where task complexity is often seen to depend on the degree of a priori uncertainty about the task inputs, process and/or outcomes. In simpler terms, their classification stretches the simple dichotomy between structured and unstructured tasks, providing intermediate anchor points between the two extremes.

Campbell (1988) based his classification (described in Table 2-3) on objective task complexity and arrived at different types of tasks viz. decision task, judgment task, problem task and fuzzy task. He operationalized objective task complexity as a function of four basic parameters viz. path multiplicity, goal multiplicity, interrelated subtasks, and presence of probabilistic linkages in the solution path. Another common distinction

that is made between tasks is well-structured versus ill-structured, commonly applied in problem-solving.

Task Type	**Characteristics**	**Example**
Automated information processing tasks	Outcome is completely determinable; In principle they can be automated	Net Salary computation
Normal information-processing tasks	Requires case-based or rule-based problem-solving; Accompanies sufficient information for task completion	Tax Calculation which is straightforward, but needs case-based analysis for special cases
Normal decision tasks	Routine and quite structured, but mostly case-based arbitration has a major role	Hiring an employee or evaluating student's term paper
Known, genuine decision tasks	Have some sense of structure with no permanent or fixed procedure; Time required to complete the task is never easily determinable.	Deciding about the location for a new factory
Genuine decision tasks	Unexpected, new and/or unstructured tasks; Accompanies minimal information; Performer has no idea of outcome or procedure to be followed; First concern is to bring in structure	Collapse of a business due to external factors

Table **2-2**: Task classification scheme by Bystrom and Jarvelin (1995)

Task Type	**Characteristics**	**Example**
Decision Tasks	Multiple desired outcomes to attain; conflicting interdependence among outcomes	Choosing a house; selecting a building site; employee selection
Judgment Tasks	conflicting and probabilistic nature of task information	Intelligence analysis; stock market analysis
Problem Tasks	Multiple paths to a desired outcome; Conflicting interdependence among paths	Chess problems; personnel scheduling
Fuzzy Tasks	Outcome multiplicity; conflicting interdependence; path multiplicity	Business ventures

Table **2-3**: Task classification scheme by Campbell (1988)

With prior research devising different kinds of tasks to study different things, my interest is to study different tasks as they naturally occur in enterprise integration projects, by employing a suitable classification scheme. Considering that tasks accompany information requirements, the following section qualifies the term information.

2.3. Information and its Characterizations

My interest lies in learning about what information is sought by teams engaged in enterprise integration projects, for performing their tasks. With information being conceptualized in different ways, it is useful to understand these conceptualizations in order to situate my interest along this line.

The term “information” has been overloaded with a variety of meanings (Bates, 2005; Hjørland, 1998). There is contention over the right answer to the question - what is information? Buckland (1991) provides three conceptualizations of information based on an analysis of its principal uses – *information-as-process, information-as-knowledge* and *information-as-thing*. This can be understood well from a *communication* view of information. Information-as-process is the act of informing or communicating or even being informed of something. Information-as-knowledge can be called meta-information – what is the communicated-information about. Lastly, information-as-thing denotes that “object”, which communicates the information (e.g. a text document or person).

Cole (1994) projects an alternate view of information as a subjective construct. His conceptualization of information deviates from Buckland’s view of information-as-thing. Cole claims that information is a subjective construct, by arguing that information that does not alter the knowledge structure of an individual is not “informative” to him/her and hence not information at all, there by discounting the objective view of information. This brings us to the idea of information relevance, which is closer to Buckland’s observation that information-as-process is situational.

With the existence of varied interpretations of information, it is important to clarify what *data* and *knowledge* possibly mean. Traditionally, the term "data" has been used to refer to raw facts. This includes just symbols or statements with no significance beyond its existence (Bellinger, Castro and Mills, 2004). As regards knowledge, Alavi and Leidner (2001) do not really differentiate between information and knowledge in terms of structure, content or utility. Their view point is that "knowledge is personalized information…". Their review highlights several other conceptualizations of knowledge as – an individual's state of knowing; an object that can be stored or manipulated; a process of applying what is known; and the capability to use information for human action.

Information has been characterized differently based on varied characteristics and contexts. In his study of achievement goals affecting information seeking, Butler (1993) differentiated three kinds of information viz. *task information* (about task requirements and strategies), *objective information* (about the relation between performance and task demands) and *normative information* (about performance levels for some reference group) based on the usefulness of the information in solving novel problems among competing groups of people. Bystrom and Jarvelin (1995) adopted an expert systems view of information and categorized it into *problem information*, *domain information* and/or *problem-solving information* as part of their study to understand task impacts on information seeking among employees in public administration.

Vakkari (2000) classified information as *background information*, *faceted background information* and *specific information*, in his investigation of information relevance judgment in task performance in the thesis proposal writing process undertaken by Masters' students. Freund, Clarke and Toms (2006) developed a taxonomy of document genres (or information formats) that can be employed by information retrieval systems for task-appropriateness of information sought in a software engineering workplace. Their genre classification scheme for documents included the following - product documentation, cookbook, technical article, discussion threads, manual, presentation,

design pattern, best practice, FAQ, product page, whitepaper, technote, tutorial, engagement summary, problem report and demo.

The above mentioned classifications of information (Butler, 1993; Bystrom and Jarvelin, 1995; Freund, Clarke and Toms, 2006; Vakkari, 2000) are concerned with the characteristic of *usefulness* or *utility* of information. With my intention targeted at finding out what information is useful for task performance within enterprise integration projects, I adopt the conceptualization of information-as-knowledge for the study.

2.4. Information Sources

Coming to the idea of information sources, we can roughly equate it to Buckland's (1991) conceptualization of information-as-thing – that which is informative. In this sense, an *event* could also be informative; thus it is useful to put a constraint by thinking of information sources as tangible objects.

Nilakanta and Scamell (1990) analyzed the extent to which different information sources (Table 2-4) and communication channels facilitate the diffusion of database design tools and techniques in the context of database systems development in organizations. Their findings revealed no direct correlation between information sources and diffusion of innovation, with the former influencing the latter minimally.

Information Sources	**Specific instances/examples**
Books	Reference, text, handbooks, professional
Periodicals	Business (e.g. Infosystems); newsletters (e.g. Computerworld); professional (e.g. Communications of the ACM); trade (e.g. Datamation)
People	Work group, inside experts, external consultants
Electronic	Audio/video, data banks
Other	proceedings/reports, memoranda

Table **2-4**: Information sources considered by Nilakanta and Scamell (1990)

In her study of the relation between information and information sources, Bystrom (2002) considered a classification of information sources based on the type of the resource - *people* (People concerned with the matter at hand, experts and meetings), *documentary sources* (Literature, Official documents, registers) and *visits*. Her definition of visits as an information source lacks clarity though. Stefl-Mabry (2003) inspected the information source preferences of individuals in information seeking and decision making, in order to understand the satisfaction derived from information obtained. Of the six information sources viz. *word of mouth*, *expert oral advice*, *Internet*, *books*, *print news* and *radio/TV news* that were analyzed, she found that oral expert advice made the largest contribution towards information satisfaction.

The term information channel has been used sometimes and it refers to a slightly different idea. Bystrom and Jarvelin (1995) use the term information channel to refer to a guiding factor towards an information source, which ultimately provides information for an individual. In this sense, a channel is considered as either *internal* or *external* to an organizational boundary, based on its location (Bystrom, 2002). Shannon (1948) refers to information channel in a related, but different sense. From an information communication perspective, he refers to a channel as a (physical) medium that transmits signals from a transmitter to a receiver.

It can be seen that prior researchers have identified different instances of information sources that mattered in different contexts. In a similar manner, my attention to information sources in this study is find out which sources are being consulted by individuals, as they seek information for completing project tasks.

2.5. Task-oriented Information Seeking

This section on task-oriented information seeking connects the individual constructs of tasks, information and information sources that have been explored so far.

Bystrom and Jarvelin (1995) make the statement that “information needs and information seeking processes depend on the worker’s tasks”. This forms the premise of task-oriented information seeking theory. The fact that tasks accompany information requirements stems from the worker’s perception of information needs created by the tasks. Bystrom and Jarvelin (1995) conducted an empirical study to generate hypotheses concerning relationships between tasks, information and information sources. Their analysis included a one-dimensional classification of tasks based on perceived task complexity. Details about the classification are described in section 2.2 on task classifications. Their findings, among others, revealed that as task complexity increases, the need for domain and problem-solving information increases and the internality of information sources decreases.

Vakkari (1999) contributed to theory development in task-based information seeking through his empirical and theoretical study on tasks and problem-solving. He proposed that task complexity affects information actions of the individual. Further, task complexity and the level of structuredness of the problem to be solved, determine the types of information people look for, the kinds of search strategies they employ and their relevance assessments on information. Bystrom’s (2002) study of municipal administrators found that there was a strong relationship between the types of information sought and information sources consulted. Her study uncovered that people are used as information sources, when information acquisition involved more effort. Further, as more information types were being acquired, more information sources were being consulted. Vakkari’s (2003) chapter on task-based information searching establishes that tasks warrant information seeking/searching for task performance or task completion and that the information seeking activity can be considered as a sub-task, as they are crucial to the task it self.

2.5.1. Prior empirical research in information seeking

Many studies of information seeking behavior exhibited by individuals in different professions have been conducted over the past decade.

In a study of the ways in which securities analysts obtain, manipulate and disseminate information, Baldwin and Rice (1997) found that institutional resources significantly affected their choice of information sources and hence the outcome of their activities. Wicks (1999) investigated the information seeking behavior of the pastoral clergy in Ontario, Canada to understand how the information seeking behavior is affected by combinations of their work world (theological, denominational and congregational) and roles (preacher, caregiver and administrator). He observed that different types of information sources get used for performing duties related to different roles.

Ellis and Haugan (1997) studied information seeking among engineers and research scientists engaging in research and development (R & D) projects and found that both internal and external sources of information were used a lot. Further they discovered that initial phases of the projects witnessed extensive information seeking with researchers becoming more selective later on in their project phases. Hertzum and Pejtersen (2000) held case studies in two product development firms, to understand the information seeking practices of engineers. Their inferences were related to the ways in which engineers search for documents to inform their search for people and vice-versa. Individuals used documents to search for people to obtain information as contextual information was lost in the documents.

Recent studies continue to inform task-oriented information seeking. Landry (2006) examined the effects of different roles assumed by dentists and of associated tasks on their choice of information sources. Information needs of the different dentist roles (healthcare provider, student, administrator and researcher) were addressed by text books, healthcare vendors and colleagues. Her study spotted that dentists preferred traditional

sources of information more compared to the Internet, which is an interesting find. Serola (2006) conducted a study of city planners – planning architects and engineers – to identify what kinds of tasks are core to the function, what type of information get used and what information channels were consulted. Through interviews, he found that planning and surveying were core tasks, with Internet usage out-numbering print media.

Along this series of studies that have explored information seeking behavior of individuals in different domains and professions, my research is targeted at uncovering the kinds of information needs encountered by teams of individuals engaged in enterprise integration projects; and further to understand the impacts of project tasks on information sought and information sources consulted, by adopting a task-oriented information seeking perspective.

2.6. Conceptual Framework

With the constructs (tasks, information and information sources) ironed out, I proceed to describe a conceptual framework to situate the context of my research. The primary reason for doing this is that it helps to add validity to the study. Different models in information seeking are reviewed prior to describing the selection of the one that fits my study best. The conceptual framework for the study is then illustrated diagrammatically.

2.6.1. Review of Information seeking models

In order to fit the constructs for the research into a valid framework, it is useful to review existing models in information seeking for making the judgment on a suitable one.

Human information behavior as a discipline has been studied for a long time now. Wilson (1999) defines information behavior as referring collectively to those activities a person may engage in when identifying his/her own needs for information, searching for such information in any way, and using or transferring that information. Each of these areas

viz. information needs, information seeking behavior and information use have been studied extensively (Ellis, 1989; Taylor, 1991; Wilson, 1981). Detlor (2003) provides a good review of the many of the dominant models of information seeking.

Many models of information seeking have been proposed. Wilson (1981) devised one of the pioneering models in the field that spoke about an information need (which is secondary to physiological, affective and cognitive needs) as a trigger for the overall information seeking behavior. His second proposition said that a person seeking information is likely to encounter certain barriers in the effort. Dervin's (1983, 1992) sense-making theory has received good amount of attention within the domain. She views information seeking as a sense-making process used by an individual to construct a *bridge* that fills a *gap* arising due to a difference between a contextual *situation* and a desired situation.

Wilson's (1997) model is an extension to his earlier model in that it includes activating mechanisms (that influence the choice of information sources), more intervening variables (representing the barriers), specific information search behaviors (passive attention, passive search, active search and ongoing search) and a feedback mechanism based on information use. Sonnenwald and Livonen (1999) propose an integrated framework for human information behavior research. Their framework outlines five facets - personality, matter, energy, space, and time – as shaping information behavior itself.

The work of Ellis (1989) and Kuhlthau (1991) can be considered as instances of research in information searching, which is a subset of information seeking research. Ellis (1989) proposed a process-oriented model of information searching consisting of several stages, or features as he calls them - starting, chaining, browsing, differentiating, monitoring, extracting, verifying and ending. Kuhlthau (1991), in addition to identifying different activities in information searching - initiation, selection, exploration, formulation,

collection and presentation – also associated feelings, thoughts and action with each activity.

Work in the information retrieval (IR) domain has been performed (Ingwersen, 1996; Saracevic, 1996; Spink, 1997) to specifically address the interaction between users and information retrieval systems that serve to satisfy human information needs. Ingwerson (1996) put forward a cognitive model of IR involving information objects, the information retrieval system and the individual's cognitive space that dictates information needs. Saracevic (1996) emphasized that the information search process is an interplay between three levels of interaction – *surface* interaction between the user and an information retrieval system, *cognition* of the system output to evaluate its utility on the problem at hand and *situational* interpretation of the system output in light of the problem. Spink's (1997) model of interactive IR incorporates the idea of interactive feedback between the user and an information retrieval system in the information search process which is said to consist of judgments, search tactics and cycles. The idea of interaction between a user and an information retrieval system integrates human information behavior with system design.

Hansen (2005) provides a framework addressing the information seeking and retrieval processes embedded in work tasks that are undertaken as part of work environments. His framework focuses on tasks at three levels – the work task that triggers the need for information, which itself is embedded in a larger context (e.g. organizational); the information seeking task(s) that may be embedded in the work task; and the information retrieval task(s) that may be part of the information seeking task.

2.6.2. Conceptual framework for the study

For this study, I focus on understanding information seeking for task performance within the context of enterprise integration projects. With this in mind, I examine each of the models described above, to arrive at the most fitting model for this research:

- Models by Wilson (1981, 1997) – focus of these models is on the barriers and interventions to information seeking, apart from information seeking and the context, and this is not relevant to the study.
- Ellis (1989) and Kuhlthau (1991) – these models deal predominantly with the information searching process and don't lay any focus on the context of information seeking or information needs.
- Ingwerson (1996), Saracevic (1996) and Spink (1997) – the models are related exclusively to information retrieval and user-system interaction, with very narrow focus on other potential information sources that may matter in our context.
- Dervin (1983, 1992) – Dervin's model of sense-making deals with somewhat broad concepts like knowledge gap, situation, outcome and bridging mechanism. The fit of this model to the current study is hence likely to be loose.
- Sonnenwald and Livonen (1999) - Their human information behavior framework is over-rated for this study as it accommodates other factors of personality, time and access to information that are not being addressed by the study.

I adopt the work tasks framework suggested by Hansen (2005). I justify this choice by arguing that the components of this framework overlap well with the constructs (tasks, information and information sources) chosen for my study. I note that the conception of an information seeking task (which is said to be embedded in a work task) within his framework is based on the view held by Bystrom and Hansen (2005). According to Bystrom and Hansen (2005), "…*information seeking tasks focus on the satisfaction of an entire information need (consisting of different types of information, subject topics, etc.) through…consultations of channels and sources…*". This interpretation accommodates well the constructs of information and information sources in exploring information needs accompanying tasks embedded in the larger context of enterprise integration projects. Figure 2-1 highlights the adaptation of the Hansen framework to the context of our study.

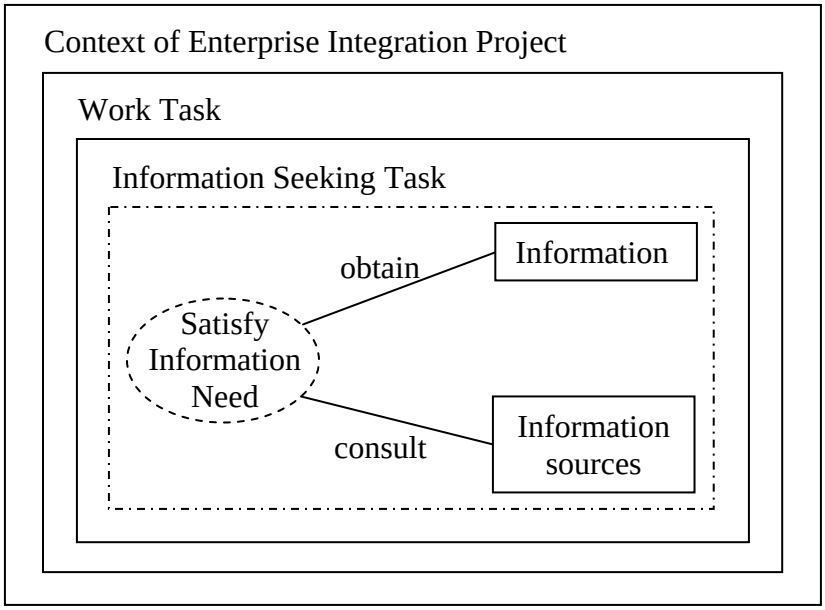


Figure **2-1**: Conceptual framework for the study

The framework, in the above figure, depicts the manner in which the constructs important for the research are linked together. The overall context of interest is that of *enterprise integration projects*, which encompasses *tasks* (or *work tasks*). Subsequently the work task is tied to an *information seeking task* qualified by an urge to *satisfy an information need*, by obtaining certain *information* by consulting one or more *information sources*.

3. Research Methodology and Data Collection

This section describes the methodology adopted for conducting the research process. The study setting and the sampling approach are described prior to letting the reader in on the details related to data collection and data organization strategies.

3.1. Study Methodology

The nature of this research is qualitative, considering the fact that an interpretivist approach has been adopted for the study (Mason, 2002). Further, it is envisioned that interpretation of textual data is required as part of data analysis, which adds to the qualitative angle. The research methodology being followed is based on the case study method.

Many qualitative research forms have been used in organizational and information systems research like ethnography, the case study method, action research and grounded theory. According to Myers (1999), ethnography comes from the social and cultural anthropology discipline and requires the researcher to spend substantial amount of time in the field. It is to be noted that, ethnography is practiced with a very broad research focus in that there are no specific research questions that guide the researcher in the process. The case study method (Eisenhardt, 1989; Pare, 2004) is a focused and rigorous method of inducting theory through empirical inquiry (from data). One or more cases are identified for enquiry within the field setting and then the case data is analyzed in depth to uncover patterns or anomalies within the unit of analysis. Action research (Baskerville and Myers, 2004) aims to solve current practical problems by creating organizational change while expanding scientific knowledge. Its underlying philosophy is that, actions by individuals within a social/organizational context accompany enough truth and rationalism, which can be studied by a researcher by collaboratively bringing about the

actions. The grounded theory method (Eisenhardt, 1989) stands for theory generation from data, involving both deductive and inductive thinking, in terms of hypothesis generation and testing with each informing the other.

My study draws from the case study method proposed by Eisenhardt (1989). The method is well-suited to the study due to its exploratory nature (Pare, 2004) and well-established focus, in that the study context and phenomenon of interest are clearly laid out. Further, the research questions initiate the research process and lead sampling and data collection, which are in line with the sequencing of the case study method. Both cross-case and within-case analysis of the data inform my findings, which help in formulating inferences (for answering research questions). Cases supporting and/or conflicting some of the inferences are identified in order to add strength to the findings. Inferences are interpreted against the current understanding of topics in enterprise integration and information seeking.

3.2. Study setting and Case selection

The potential population, from which data for the study could be obtained, consists of teams of individuals engaged in enterprise integration projects. I consider a generalized characterization of an enterprise integration project to include the *project team*, one or more *stakeholders* and the *project* itself. Traits of the project would then include the following:

- the project involves the conception, design and/or implementation of a mechanism that satisfies a particular integration requirement in the organization of the project stakeholder(s)
- every project exhibits levels of ambiguity and specificity unique to itself
- every project is bound by time which is controlled naturally (project scope, budget, impact, etc.) or artificially (external factors)
- the project team is made up of a group of individuals

- the project team and the stakeholder(s) (or sponsor) may not be co-located
- the stakeholder(s) (or sponsor) may belong to the same organization as the project team or to a different organization

On examining my geographical scope, I identified student teams working for client-sponsored industry projects within a university setting, as a close match for the profile of teams in my study population. It is however important to make a note of any traits exhibited by student teams, that are different from or exclusive of those stated above. In addition to the aforementioned traits of a project team, I highlight that the following trait is unique to student teams:

- members of a student project team, work towards the same learning objective and possess variable skill sets

Within Penn State University, few of the undergraduate-level courses offered at the College of Information Sciences and Technology, adopt a problem-based learning approach. Students taking these courses get directly involved in industry projects as part of the learning mechanism. With this in mind, I embraced the Advanced Enterprise Integration (EAI) course that adopts a similar approach to course projects.

A multiple-case design is chosen to accommodate replicated team behavior (i.e. information seeking, which is being studied). Thus my target sample for data collection consisted of student teams from the EAI class. Pare (2004) suggests that it is not uncommon for researchers to decide the number of cases in advance. The size of my sample was 19 teams, consisting of 4 to 5 students per team; each team being treated as a case.

Detailed description of the projects performed by each of the teams is provided in Appendix A. It can be noted that the kind of work done on the projects reveals the ‘enterprise integration’ nature of the projects.

3.3. Data Collection

With the research objectives dealing with characterization of information needs arising in an enterprise integration project, it is imperative that the project, undertaken by a student team, be studied through out its duration. To this end, the data collection effort was focused on gathering data continuously from start to end, for every enterprise integration project in the sample. Consequently it was decided to collect data from the project teams regularly on a weekly basis. With this scheme of weekly data collection, it could be ensured that periodic data over the entire duration of the projects was available for analytical purposes.

Considering that the student project teams were targeted for data gathering, I leveraged the fact that these teams are expected to submit weekly status reports (over the duration of their project) as part of their EAI course curriculum. I could actually utilize the data contained in these reports for the purpose of my research.

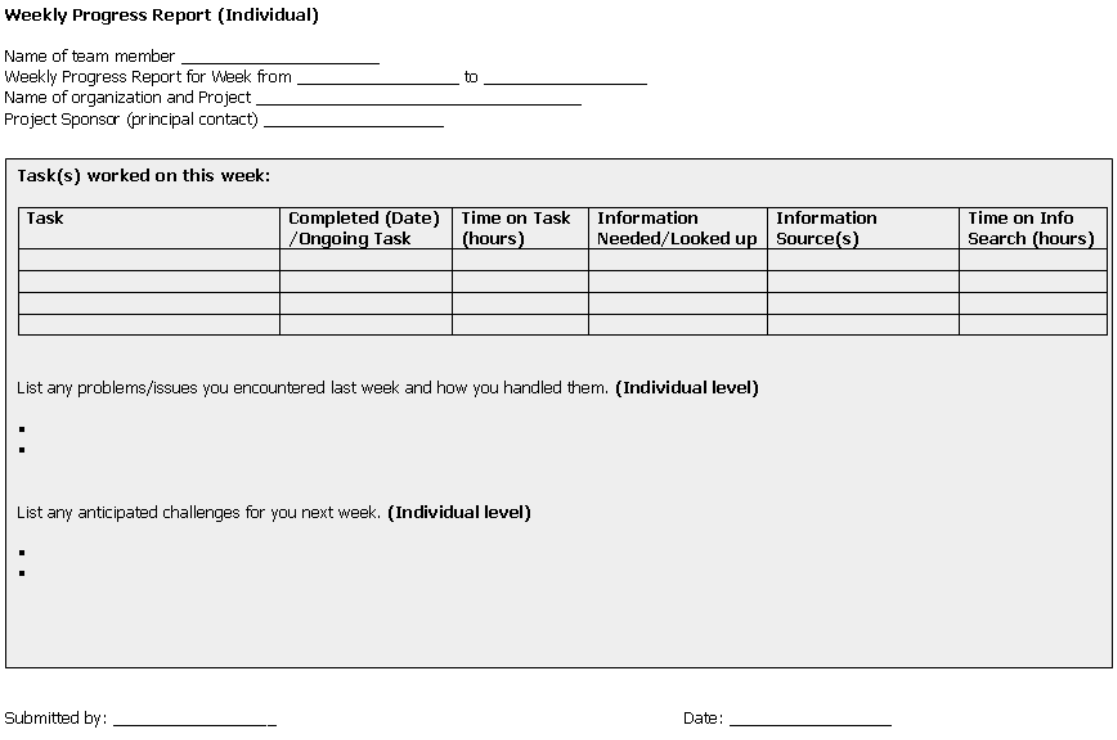
Other methods of data collection like interviews and observation (LeCompte and Schensul, 1999; Mason, 2002) were not used for the following reasons:

- The observational method was not considered useful for data collection in the study context as I was dealing with information needs and information seeking behavior of individuals. With information behavior involving cognitive exercises, observations don't really help to measure accurately what goes on in the mind of an individual seeking information to satisfy an information need.
- Semi-structured interviewing could have been useful as an elicitation technique in uncovering some of the *why* aspects related to the information seeking behavior within enterprise integration projects. But it was difficult to conduct interviews with student teams, considering the fact that coordinating students' and researcher schedules during the semester was a cumbersome task.

3.3.1. Weekly Questionnaire

In order to collect weekly data from the student teams, I used a weekly questionnaire that the each team member would fill out every week. The efforts for constructing this weekly questionnaire boiled down to tweaking an existing weekly status report template that was used by the EAI class. Tweaking was necessary to ensure that the template included certain fields to capture data relevant for the research. The tweaked course template probed team members for details on:

- tasks performed as part of the enterprise integration project (every week)
- information needs tied to these tasks in terms of what information was sought and where the information was obtained from, for each task



Weekly Progress Report (Individual)

Name of team member _____
Weekly Progress Report for Week from _____ to _____
Name of organization and Project _____
Project Sponsor (principal contact) _____

Task(s) worked on this week:

Task	Completed (Date) /Ongoing Task	Time on Task (hours)	Information Needed/Looked up	Information Source(s)	Time on Info Search (hours)

List any problems/issues you encountered last week and how you handled them. **(Individual level)**

-
-

List any anticipated challenges for you next week. **(Individual level)**

-
-

Submitted by: _____ Date: _____

Figure **3-1**: Weekly Questionnaire Instrument

The weekly questionnaire instrument (Figure 3-1) was distributed to the student teams in Microsoft Word format, through our university's course management website. Each member of a team would submit a weekly status report indicating the tasks he/she performed for the week and information needs encountered for these tasks. The data was collected from each of the 19 teams over a period of 10 weeks across which the projects were being performed. On the whole, a total of over 1000 task descriptions were gathered from 19 teams; with each team contributing 55 task descriptions on an average.

3.3.2. Pre-deployment considerations

Prior to the roll-out of the questionnaire as part of the course and the data collection activity, the following measures were taken to ensure that it was appropriate in form and validity:

- As I adapted the EAI course's weekly status report template into the weekly questionnaire, I constantly consulted with the course instructors to ensure that the questionnaire still addresses the instructional purpose behind the template.
- I exercised continuous tweaking of the questionnaire instrument (prior to rollout), as the layout of the questionnaire had to be simple and intuitive to the students (or team members), who would be its users. The emphasis on this was greater as the items in the questionnaire are quite open-ended and I needed to avoid team members misinterpreting the expectations of the questionnaire. The tweaking effort witnessed multiple revisions of the instrument.
- Further all teams were supplied with sample filled-in questionnaires initially, to give them an idea of the expectation from the research. Even though, this is likely to feed some bias in to the data collection, it was done as part of the instructional practice for the EAI course.

3.4. Data Organization

With the data coming in periodically from multiple student teams, it was necessary to plan for organizing the data being received. Awareness of the fact that data was gathered every week for a total of 10 weeks from each of 19 teams was indicative of the need for an efficient method of data organization for subsequent analysis of the data.

As the tasks data obtained from the weekly questionnaire were tabular in structure, it was intuitive to rope in a database for organizing all the data. A simple data model (shown in Figure 3-2) was constructed to accommodate the data gathered in the weekly questionnaires. Following are some of the rules depicted by the data model:

- Each member (or participant) belongs to a team consisting of more than one persons – table: *Participant*
- Every team member completes and submits one weekly questionnaire per week
- Each weekly questionnaire comprises some meta-information (project team name, project sponsor, dates – table: *IndividualWeeklyReportIdentifier*) that identifies and qualifies the tasks and information needs data (table: *IndividualWeeklyReportInfo*)
- Each entry in the list of completed tasks corresponds to an individual *episode of task completion*

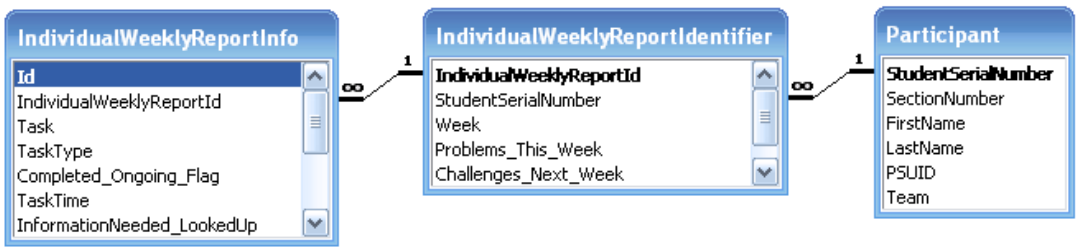


Figure **3-2**: Data model of the database used for organizing data

With the consideration of these rules, a database was implemented using a relational database with appropriate metadata, in an attempt to prepare the data for analysis.

3.5. Orientation of the research process

The research methodology outlined in section 3.1 highlights the different phases of the research process of which the following have been detailed out so far – definition of research focus & research questions (section 1.1); sampling and case selection (section 3.2); and data collection (section 3.3). Figure 3-3 provides a step-by-step illustration of the research methodology, indicating these phases in grey.

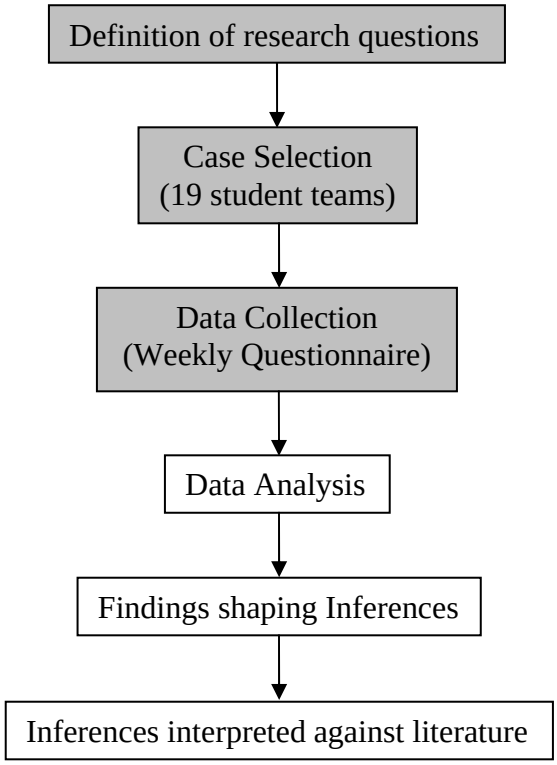


Figure **3-3**: Research methodology for study

The illustration in the above flowchart, gives the reader a sense of orientation regarding the research process and to know what is ahead. The phases that have not been grayed out are covered in the following chapter on data analysis and findings.

4. Analysis and Findings

This chapter contains three sections. The *data analysis* section describes how the data collected was treated for performing the analysis. Specifically I provide details related to the level of analysis and data coding including the classification schemes used. The *findings* section describes results obtained from the analysis in the form of initial observations from several representations of data such as graphs and tables. In the final, *discussion* section, I make deeper inferences connecting the findings to research in other streams, and provide further analysis of the data to support for these inferences. A brief caveat about subjects and other limitations is included at the end of the chapter.

4.1. Data Analysis

Data collected in the form of student responses to the weekly questionnaires was coded using classification schemes decisively chosen for tasks, information and information sources. Once this was done, the qualitative or textual data could be reduced to abstract meaningful categories, preparing it for quantitative analysis.

4.1.1. Level of Analysis

The level of analysis for the study was to be chosen first. Different levels of analyses have been employed for research in the field of information systems – individual, group or team and organizational level. Korpela, Mursu and Soriyan (2001) emphasize that four levels of analysis viz. Individual, Group/Activity, Organizational and Societal are of salience to information systems research. For this research, I specifically choose the intra-group level of analysis that takes in to account only the activities of the individuals composing the group. We are interested in characterizing the information needs and information seeking behavior of teams (and individuals in teams) engaged in enterprise

integration projects. In order to do this, I assess the tasks performed by the individual, which trigger the information needs and information seeking behavior. The inter-group level of analysis is not utilized, as the scope for collaboration across teams is not taken into account.

The information seeking activities undertaken by the individual are aggregated to the team level because the context for the activities is tied to the team's responsibilities and goals. This aggregation opens up the possibility of moving the analysis to the team level from the individual level.

4.1.2. Preparing the data for analysis

With the understanding that the data in the relational tables depict individual episodes of task completion, each such episode needs to be analyzed. With a huge set of task episodes in the database (over 1000), a data reduction strategy was necessary as a precursor to analysis. Because the data collected was textual, i.e. tasks completed, information sought and information sources consulted, I followed a coding strategy (LeCompte and Schensul, 1999) to reduce each task episode description to abstract types.

A *task episode* is taken to denote a single instance of task completion accompanied by the need for certain information and involving the consultation of one or more information sources. To this end, I leveraged classification schemes to categorize each task episode into a combination of a (a) task type, (b) information type and (c) information source type. In all, 928 task episodes had data for tasks and information sources; of which 782 task episodes contained data for the information types involved in task completion.

Prior work leveraged to derive these categorization schemes (for tasks, information types and information sources) is described below.

4.1.2.1.Classification scheme for tasks

In order to come up with task categories, I referred to academic literature in the tasks domain to identify potential classification schemes. A deductive approach (Mayring, 2000) is being adopted to arrive at an appropriate classification for tasks rather than an inductive approach, owing to my focus on mainly understanding information needs within enterprise integration projects; with tasks being used as a lens for examining these needs. In the literature review section on tasks (section 2.2), I described the schemes proposed by (1) Bystrom & Jarvelin (1995) who use a one-dimensional classification of tasks into five categories (Table 2-1) and (2) by Campbell (1988) whose classification scheme (Table 2-2) is based on objective task complexity.

A third source is, McGrath's (1984) Group Task Circumplex, which delineates a typology of tasks grouped into four phases – generate (creativity and planning tasks), choose (intellective and judgment tasks), negotiate (cognitive conflict and mixed-motive tasks) and execute (psychomotor and physical tasks) – that denote the basic processes in any generic activity. The issue with the applicability of this comprehensive task classification scheme for our study is its inclination towards group-level tasks involving collaboration rather than individual performance.

A fourth is developed in her study of dentists by Landry (2006), who identifies tasks (instead of task types) performed by dentists by examining the set of possible roles assumed by them - patient management/treatment provider, student, educator, practice manager/administrator or researcher. This kind of approach could not be easily adopted for our scenario, as enterprise integration projects involve not just one person performing many roles but a team of individuals specialized in one or more roles. With this in mind, it is difficult to come up an exhaustive set of tasks encompassed by enterprise integration.

In judging the applicability of the scheme by Bystrom and Jarvelin (1995) and Campbell (1988), the former was preferred for the study over Campbell's task classification as, "in

information seeking, perceived tasks must be considered because each worker may interpret the same objective task differently (for example, as regards its complexity) and the perceived task always forms the basis for the actual performance of the task and for interpreting information needs" (Järvelin and Wilson, 2003).

4.1.2.2.Classification scheme for information sources

Finding an existing classification scheme for information sources was rather difficult with minimal evidence of such schemes in the information seeking literature. Bystrom and Jarvelin (1995) make a distinction between *internal* and *external* sources of information, which is too broad in essence.

Other studies have come up with schemes that appear to identify different instances of information sources as opposed to classifying them in to abstract types. Nilakanta and Scamell (1990) considered *books, periodicals, people, electronic* and *other* resources as potential information sources in an organizational context. Bystrom (2002) classifies information sources based on the type of the resource into *people* (people concerned, experts and meetings), *documentary sources* (literature, official documents, and registers) and *visits*.

With a view to identify different instances of information sources involved in our study context, I decided to adopt an inductive approach (Mayring, 2000) towards identifying classes of information sources, which would suit the exploratory nature of the study. I started with a broad set of classes – *Internet, intranet* and *people* – which came from initial scanning of the data. On examining the task episodes to assign these categories, significant usage of documents for completion of certain tasks was observed and hence *documents* was added to our initial set. In a similar way, I also recognized people going back to emails often to gather information needed for task performance, which prompted

email archives to be included in the set. In this way, the task of revising the scheme being developed, typically comprised of adding a new exclusive category.

In recognizing that *people* and *documents* were significantly consulted, it was useful to find out what sub-categories, if any, these classes were made up of. Considering *documents,* I identified sub-categories based on where these documents originated from. It could be seen that the documents used:

- came from *clients* (problem description, contact details of key persons involved, requirements/scope document)
- got generated within the *team* (project plan, design documents, meeting notes)
- were related to *past experience* (notes from a class the team member attended previously, text books used in the past)
- came from *external* sources (manuals of software applications utilized, online documentation)

For *people,* the criterion used for exploration of sub-categories was distance. This could be both mental/physical distance of the information seeker from the information source. The sub-categories for *people* were seen to be:

- *self* (personal schedules)
- *team* (team meetings, team schedules, team members)
- *client* (conference calls with clients, people from the project team on the client-side)
- *internal* (class instructor, other people within the university department)

I note that instances of consultation with people external to the project scope, was not observed. In this way, our inductive approach led us to build a classification (i.e. identification of classes) for information sources.

4.1.2.3.Classification scheme for information

The motivation behind this research is to help us understand what information is sought by teams of individuals engaging in enterprise integration projects. Using Buckland's (1991) conceptualizations of information, this translates to adopting the view of information-as-knowledge – "what is the information about?". We are interested in understanding what knowledge is sought (or needed) in an enterprise integration project. Freeman (2001) provides a model of information systems (IS) knowledge identifying three dimensions of knowledge itself – *who* (user of the knowledge), *what* (the nature of the knowledge – tacit vs. explicit, declarative vs. procedural) and *where* (the subject/task domain of the knowledge). Our choice of the conceptualization of information-as-knowledge for this study, coincides with Freeman's *where* dimension of IS Knowledge.

Chen, Nunamaker Jr and Konsynski (1987)	**Lee, Trauth and Farwell (1995)**	**Shi and Bennet (1998)**	**Iivari, Hirschheim and Klein (2004)**
Generic Application Domain Knowledge		Organizational Overview Knowledge	Organizational Knowledge
Specific Application Domain Knowledge	Business Functional Knowledge/Skills	Organizational Unit Knowledge	Application Domain Knowledge
Generic IS Domain Knowledge	Technology Management Knowledge/Skills	Generic IS Knowledge	IS Application Knowledge
Specific IS Domain Knowledge		IS Product Knowledge	IS Development Process Knowledge
	Technical Specialties Knowledge/Skills	Technical Skills	Technical Knowledge
	Interpersonal and Management Knowledge/Skills	Organizational Skills	

Table **4-1**: Existing classifications of IS Knowledge

With this perspective of information-as-knowledge as relating to the subject domain, I acknowledge that studies in IS research (Chen, Nunamaker Jr and Konsynski, 1987; Iivari, Hirschheim and Klein, 2004; D. M. S. Lee, Trauth and Farwell, 1995; Shi and Bennett, 1998) have classified different elements of IS knowledge that is considered important. Table 4-1 summarizes the classification of IS knowledge by these studies. However, an information classification for enterprise integration has yet to be empirically established. I adapt and extend from the existing IS knowledge classification schemes to accommodate the context of enterprise integration projects.

I start the categorization process on my task episodes, with three initial information categories viz. *technology*, *enterprise* and *domain*. While assigning these information categories to the task episodes, significant amount of instances revealed information being sought related to project management and the enterprise integration process aspects. Hence, the categories *EI project* and *EI process* were included in the list of information categories. A final category labeled *Client-Team* was created to account for numerous instances of information seeking involving team schedules and contact information. The following bullets summarize the instances observed for the information categories:

- *Technology* (information related to APIs, existing technological platforms, software/hardware tools, databases and programming)
- *Enterprise* (what the organization does, company policies, organizational structure)
- *Domain* (e.g. ontologies, online social networks, market information for hardware/ software products)
- *EI project* (project documentation, project objectives/goals information, minutes of meeting)
- *EI process* (requirements analysis, design information, information from research, descriptions of testing procedures)
- *Client-Team* (personal schedules, stakeholder/team contact information)

To this end, a classification scheme for information was developed from the data itself. The chosen classification schemes for tasks, information and information sources were then applied onto the task episodes; ultimately preparing the data for analysis in order to arrive at findings.

4.2. Findings from analysis

This section presents my findings that have emerged from quantitative data analysis (using frequency histograms and trend analysis) on classified task episodes. Further this section also highlights answers to my first two research questions that pertain to the relationship between task types and information sources; and the relationship between task types and information types.

The task episodes that are analyzed were subject to classification using the following predetermined schemes (described in the previous section):

- Task categories – automated information processing tasks, normal information processing tasks, normal decision tasks, known genuine decision tasks and genuine decision tasks
- Information sources – people, Internet, intranet, documents and email archives
- Information types – information related to different aspects viz. technology, enterprise, domain, EI project, EI process and client-team

4.2.1. Tasks, Information and Information sources

I use this sub-section to reveal my preliminary findings on the kinds of tasks performed, information sought and information sources consulted in the context of enterprise integration projects.

4.2.1.1.Nature of tasks in enterprise integration projects

Using the task categorization scheme by Bystrom and Jarvelin (1995), tasks from 928 task episodes were analyzed individually and classified into *automated information processing tasks, normal information-processing tasks, normal decision tasks, known genuine decision tasks* and *genuine decision tasks*. A frequency histogram of the task categories aggregated across all teams for all weeks is illustrated in Figure 4-1.

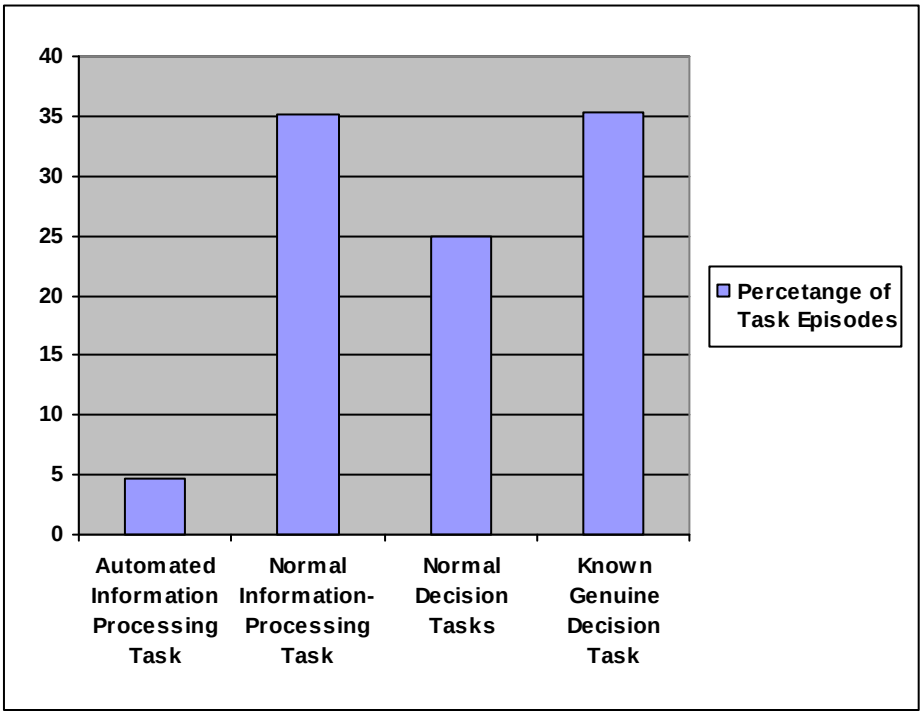


Figure **4-1**: Frequency histogram of tasks in enterprise integration projects

Some of my observations from this frequency histogram are:

- *Automated information processing tasks* (e.g. signing documents, creating accounts) account for less than 5 percent of the overall set of tasks completed as part of enterprise integration projects.

- Over 95 percent of the tasks are accounted for by *normal information processing tasks* (team management and coordination tasks), *normal decision tasks* (project documentation and management tasks) and *known genuine decision tasks* (requirements analysis, design tasks and research).
- None of the tasks were found to be *genuine decision tasks* that represent the extremely unstructured side of tasks.

These observations reflect *prima facie* that enterprise integration projects are neither completely structured nor completely ill-structured.

4.2.1.2.Information sources consulted in enterprise integration projects

As described previously, an inductive coding process was undertaken with regard to identifying classes of information sources. One or more information sources associated with each of 928 task episodes were classified in to the high-level classes - *Internet*, *intranet*, *people*, *documents* and *email archives*. *People* and *Documents* were further classified into sub-categories. Figure 4-2 illustrates the hierarchy of our information source classification scheme.

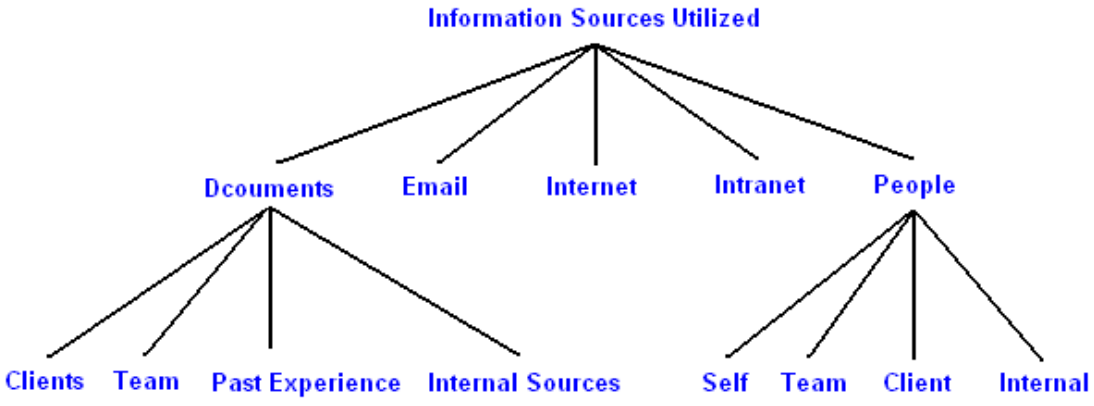


Figure **4-2**: Hierarchy of information source classification scheme

In terms of the extent to which each of information sources was used, here are the findings in addition to those summarized in Figure 4-3.

- Usage of *email archives* as a source of information was notable at 13 percent of the overall. Several task episodes revealed that individuals went back to emails received from clients to gather information they were already exposed to. This can be considered as reuse of own personal experience.
- Web resources comprising the *Internet* and *intranet* top the list by accounting for more than 40 percent of overall usage of information sources. Internet usage included Web search engines (e.g. Google, Yahoo!), corporate websites (of project sponsors) and online forums. Intranet usage was related to internal content management websites.

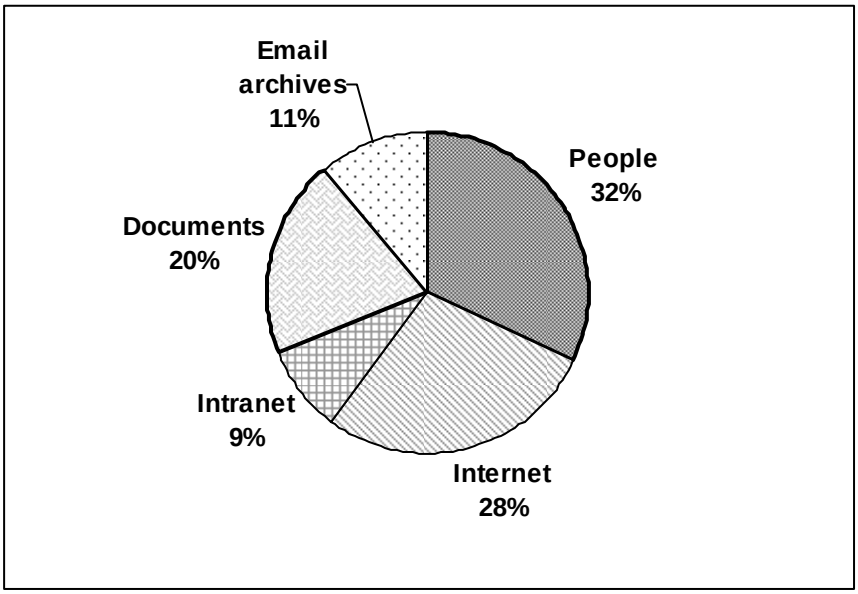


Figure **4-3**: Summary of information sources used

- Of all instances of consultation with *people*, *client* interaction represents over two-thirds of the instances. (Figure 4-4)

- Of all *documents* consulted, over half corresponded to *internal* documents and a third to documents obtained from *clients*. Further, a very small percentage (3 percent) was constituted by usage of documents that came out of *past experience* of the team members, which was unexpected. (Figure 4-4)

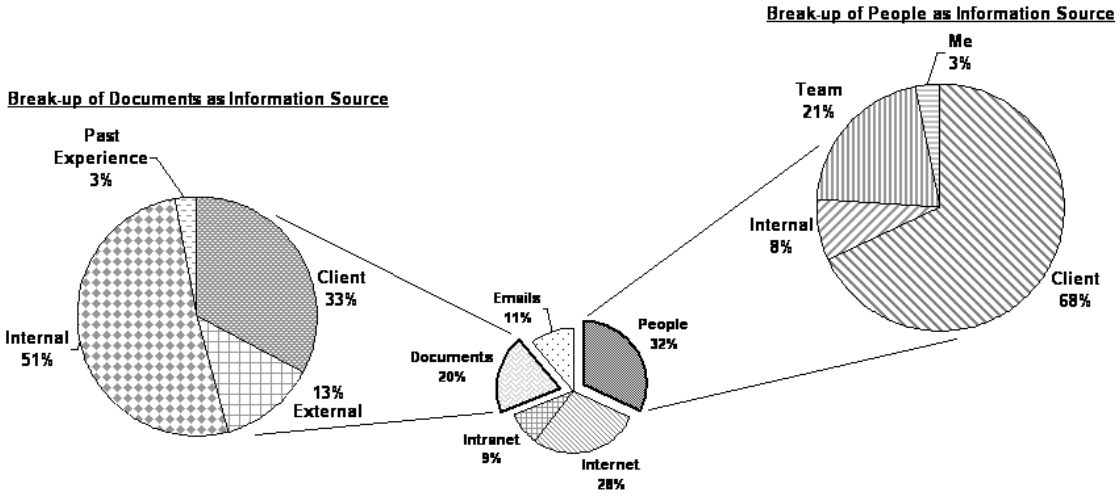


Figure **4-4**: Break-up of people and documents as information sources

- For some of the task episodes, use of multiple classes of information sources was observed. A little over 13 percent of the total task episodes utilized more then one information source. The frequency histogram for number of tasks that used varying number of information sources is shown in Figure 4-5. Considering purely those tasks that utilized more than one information source, the maximum number of information sources consulted per task did not exceed 3 and averaged at 2.10.

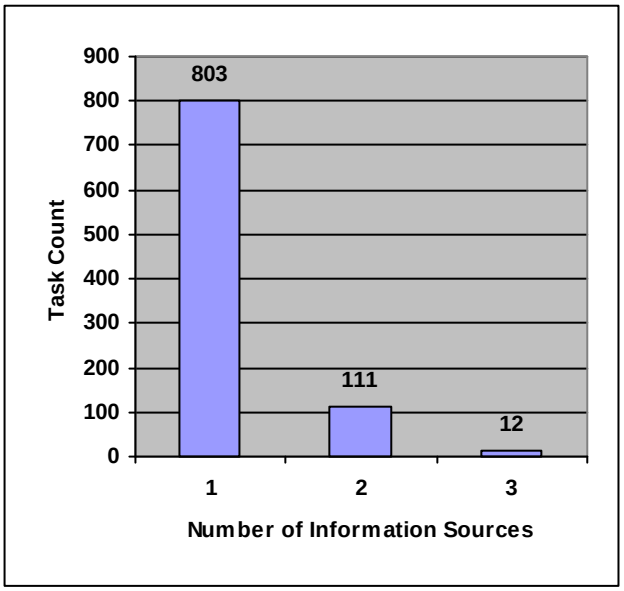


Figure **4-5**: Histogram for number of information sources per task

4.2.1.3.Information sought in enterprise integration projects

A total of 782 task episodes were analyzed and assigned categories from the set of previously determined information types - *technology*, *enterprise*, *domain*, *EI project*, *EI process* and *client-team*. It is important to understand that this finding applies to enterprise integration projects, which are only well-defined parts of the enterprise integration activity that is an ongoing organizational activity. The following observations are made from Figure 4-6 that illustrates the break-up of various categories of information sought by all teams across all weeks:

- *EI Project* and *technology* related information are sought the most and account for over three-fourths of all information sought.
- Information related to client & team members (*client-team*), *enterprise* and *domain* are sparingly sought by the teams. Put together these categories cover lesser than 15 percent of overall information seeking.

- Information sought as part of processes involved in enterprise integration projects (*EI process*) represents only a tenth of the overall.

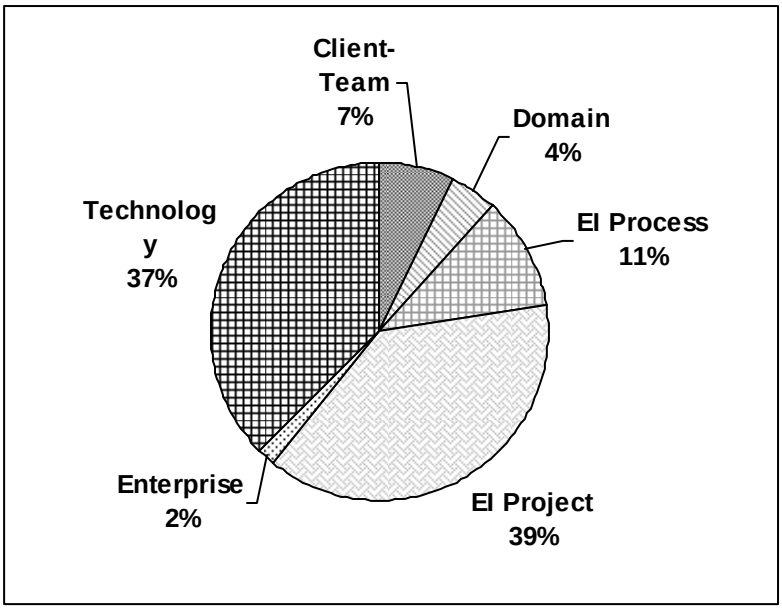


Figure **4-6**: Summary of information types involved in enterprise integration projects

4.2.2. Task impacts on information sources

My first research question pertains to understanding the impact of task characteristics on the choice of information source. At an aggregate level across all project teams, I examine the usage of the different information sources for each task category in our classification of the task episodes. The line chart (Figure 4-7) depicts for each task category, the number of instances involving the consultation of each information source. A total of 928 task episodes are being accounted for by the chart.

It is clear that we are seeing varying patterns of consultation of information sources. Some information sources are preferred over others, when seeking information for task completion.

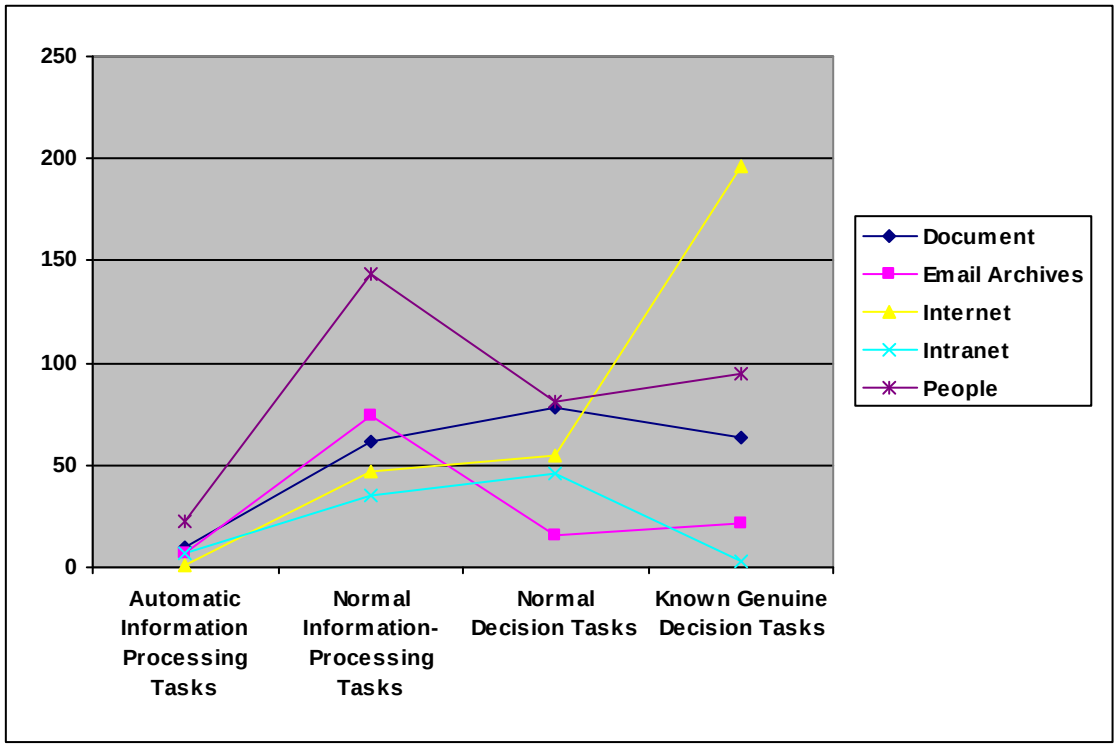


Figure **4-7**: Information source consultation across task categories

Some of the observations from this analysis are summarized according to information source types and task categories in Table 4-2 and Table 4-3 respectively.

Information Source Type	**Impact due to increasing task complexity**
Internet	Its usage pattern rises sharply (indicated by the drastic increase in the number of task episodes involving Internet usage for known genuine decision tasks)
People and Email archives	As complexity increases, its usage drops relatively; Significantly consulted for normal information processing tasks which are quite structured
Intranet and Documents	Its usage increases for normal decision tasks and then drops for known genuine decision tasks

Table **4-2**: Task impacts on information source - findings by information source

Task Category	Impact on choice of information source
Automated information processing tasks and normal information processing tasks (representing the more structured side)	People are the most preferred information source; Intranet was less preferred; Email archives appear significantly important for these tasks
Normal decision tasks	People and Documents consulted the most; Email archives the least.
Known genuine decision tasks (unstructured for the most part)	Internet stands out as the most sought after source of information

Table **4-3**: Task impacts on information source - findings by task category

4.2.3. Task impacts on information types

A similar line chart approach (like in Figure 4-7), is being followed here too, to uncover patterns in information types sought across different task categories within enterprise integration projects. Figure 4-8 depicts for each task category, the number of instances involving the usage of each information type. The chart accounts for a total of 782 task episodes that represent valid combinations of task categories and information types. I note that this examination is related to my second research question that seeks to understand the relationship between task types and information types.

Again, we observe varying patterns of information types being sought for different task categories. In a similar manner as information sources, we note a spike in the information seeking activity for known genuine decision tasks, which is interesting. I summarize observations from this analysis according to information types and task categories in Table 4-4 and Table 4-5 respectively.

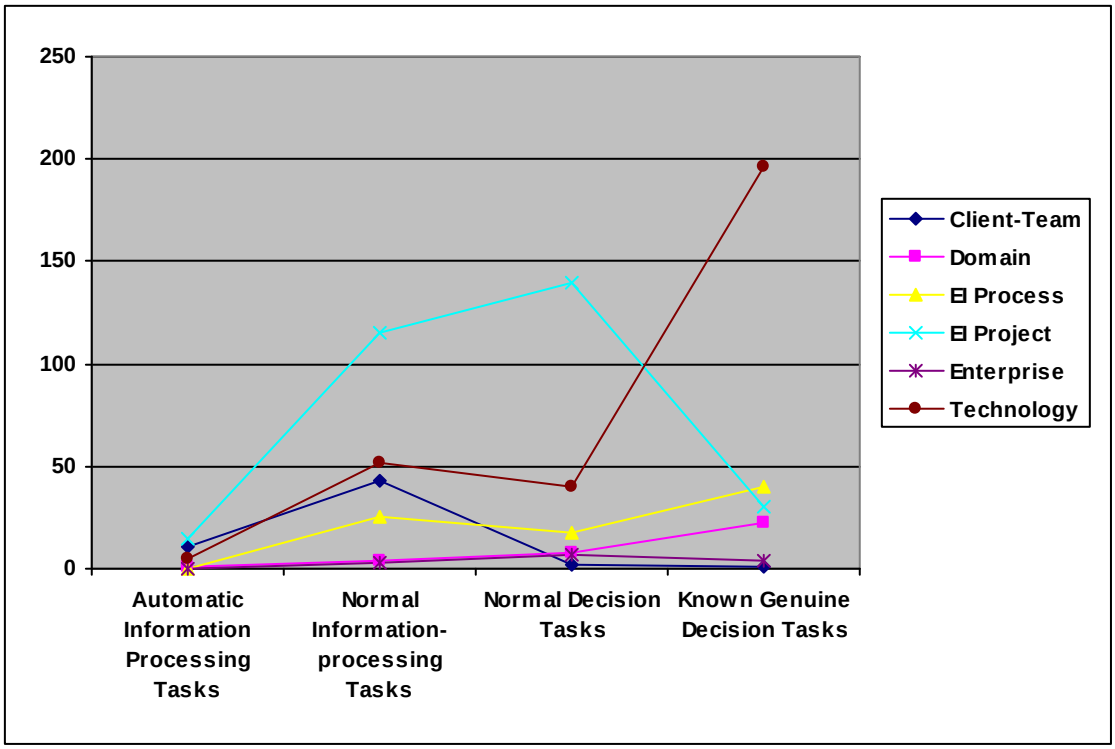


Figure **4-8**: Information types sought across task categories

Information Type	**Impact due to increasing task complexity**
Technology and EI project-related information	Both these types of information are significantly sought after across the duration of enterprise integration projects
EI process information	Sought more for normal information-processing tasks (structured) and known genuine decision tasks (ill-structured) than normal decision tasks
Domain information	Sought mainly for known genuine decision tasks that involve more thinking and analytical ability
Client-team information	Mainly used only for normal information-processing tasks like team/client meetings
Enterprise information	Overall importance of this information type seems low; it is the least sought after for any task type.

Table **4-4**: Task impacts on information types - findings by information type

Task Category	Impact on choice of information type
Automated information processing tasks	EI project and client-team related information are sought more for this category of tasks
Normal information-processing tasks	EI project-related information is sought most; notably technology information is sought more than client-team information, even though this category mostly represents team management and coordination tasks
Normal decision tasks	Being project documentation tasks, it makes sense that EI project information is involved the most.
Known genuine decision tasks	Technology-related information greatly dominates this task category

Table **4-5**: Task impacts on information types - findings by task category

4.3. Discussion

As part of the findings section I have explored my first two research questions based on preliminary quantitative analysis of the data:

- For an enterprise integration project, what is the relationship between task types involved and information sources consulted?
- What information is sought for completing different types of tasks, in an enterprise integration project?

In this section, I develop interpretations related to information seeking in enterprise integration projects, that stem from observations made initially and perform further analysis on the data to corroborate these interpretations.

4.3.1. Interpretations of tasks in enterprise integration projects

We initially observed that more than 95 percent of the tasks composing enterprise integration projects were represented by normal information-processing tasks, normal decision tasks and known genuine decision tasks. This establishes the fact that enterprise integration projects do involve a certain degree of uncertainty in its process. To verify

this claim, I observe the trend of task categories across time (Figure 4-9) and project phase (Figure 4-10).

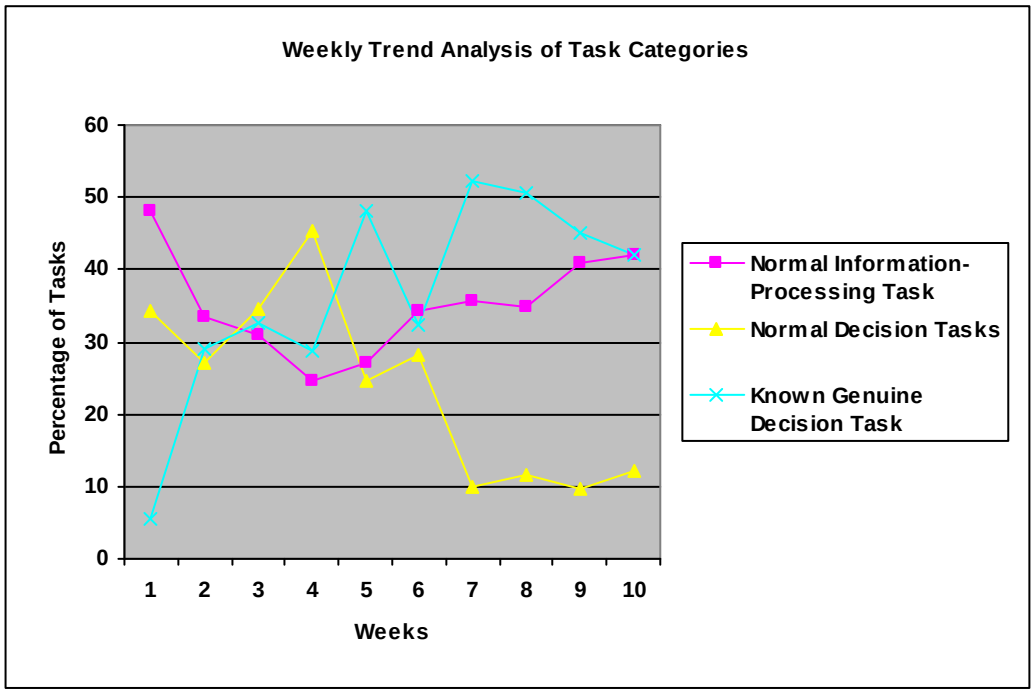


Figure **4-9**: Weekly trend of tasks categories in enterprise integration projects

From the weekly trend analysis, it is clear that

- The initial couple of weeks are dominated by normal information-processing tasks
- The next couple of weeks (week 3 and 4) display a higher concentration of normal decision tasks
- Subsequently there is notably higher levels of known genuine decision tasks being performed in the later stages

This hints that the overall complexity involved in the projects rises across the duration of the enterprise integration project.

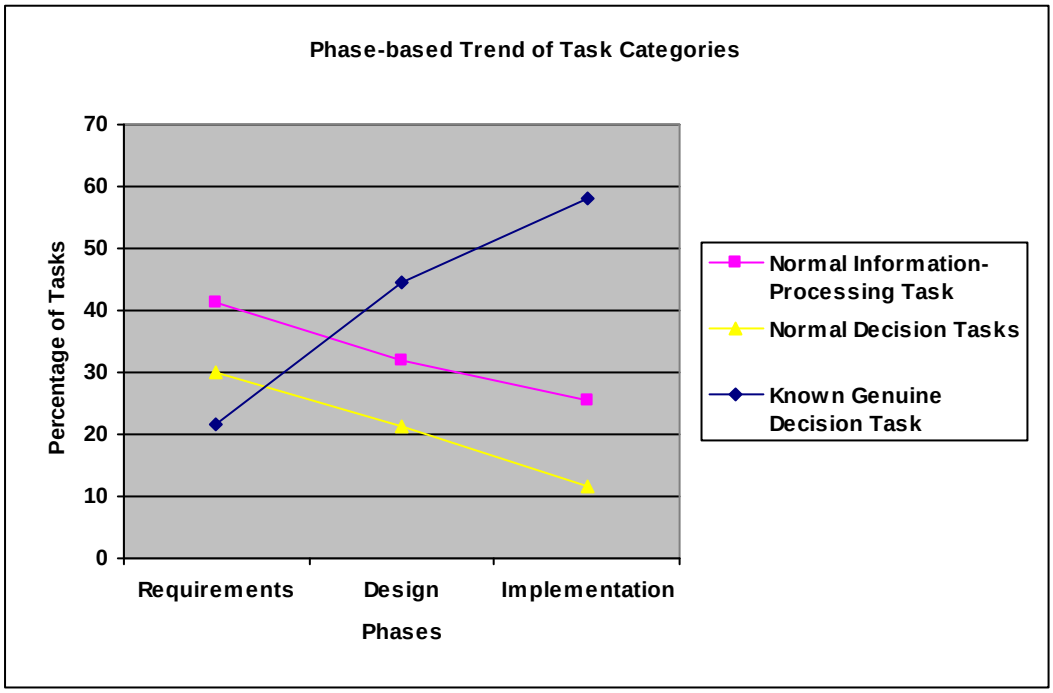
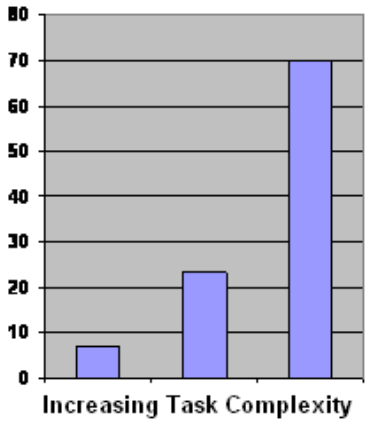
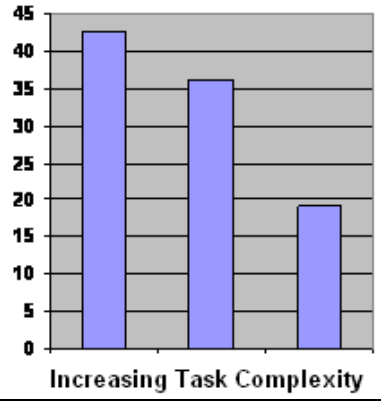


Figure **4-10**: Phase-based trend of task categories in enterprise integration projects

From the phase-based trend I gather that uncertainty increases steadily across project phases. It is clear from this trend that *design* and *implementation* phases in enterprise integration projects involve more *known genuine decision tasks* than the *requirements* phase. This distinction fits in with the context of enterprise integration as these projects do not start with a clean slate (Purao and Cameron, Forthcoming), unlike IS Development. I assert that design and implementation phases in enterprise integration projects are time-consuming and involve significant amount of effort in task completion, contrary to the belief in IS Development wherein the requirements phase is the most important and time-consuming (Castro, Kolp and Mylopoulos, 2002).

A second finding about the nature of tasks in enterprise integration (from referring Figure 4-1) is related to the way in which different task categories are distributed for a project, taken as a single unit. My claim is that the task category distribution bears a relation to the project itself. To substantiate the claim, similar graphs (as in Figure 4-1) are

constructed for each of the project teams in our sample. In these graphs, I observe four kinds of models – Uphill model (displaying a rise in task count for increasing task complexity), Downhill model (displaying a drop in task count for increasing task complexity), Hockey-stick model (displaying a U-shape in the curve across increasing task complexity) and Bumpy model (displaying a bump in the curve across increasing task complexity). Table 4-6 illustrates the models clearly and identifies support for each model from amongst the cases (or teams) examined. I to note that these models just look at increasing task complexity for projects and do not incorporate the time factor (i.e. they do not depict any kind of trend across time).

Model of Task Category Distribution	**Number of Teams**	**Sample case**
Uphill model (sample case displays a rise in task count for increasing task complexity)	4	
Downhill model (sample case displays a drop in task count for increasing task complexity)	4	

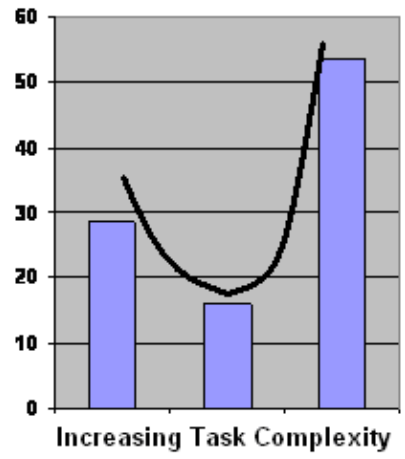
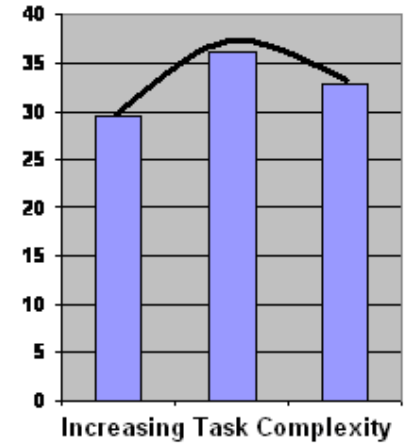
Hockey-stick model (sample case displays a U-shape in the curve across increasing task complexity)	5	
Bumpy model (sample case displays a bump in the curve across increasing task complexity)	2	

Table **4-6**: Models of task category distribution

In studying the relationship of the task category distribution models with the projects, projects are classified as *routine* and *innovative*, drawing upon the characteristic of structuredness of the project (Remenyi and Heafield, 1996); with routine projects being on the structured side (with the team knowing what to do and how to do) and innovative projects on the unstructured side (when the team attempts something not done before). Thus based on the following rubric the projects were classified as either:

- *innovative*; if similar work has not been done before in the technology or in the domain; requires significant novel thinking (or)

- *routine*; if similar work has been done before in the technology and in the domain; does not require new thinking

Of the 15 projects classified under this scheme, 12 neatly fit one of the innovative or routine classes. The remaining 3 projects were jointly assessed and classified based on joint determination by the author and his supervisor. With each of projects classified on structuredness and associated with one of the four task category distribution models, the relationship between the two factors is explored in Table 4-7. A detailed listing of the projects is provided in Appendix A.

Project	**Project Type**	**Task Category Distribution Model**
Team 1	Routine	Downhill
Team 2	Innovative	Uphill
Team 3	Innovative	Uphill
Team 4	Innovative	Hockey-stick
Team 5	Innovative	Hockey-stick
Team 6	Innovative	Hockey-stick
Team 7	Routine	Downhill
Team 8	Routine	Downhill
Team 9	Innovative	Bumpy
Team 10	Innovative	Hockey-stick
Team 11	Innovative	Uphill
Team 12	Innovative	Hockey-stick
Team 13	Innovative	Uphill
Team 14	Routine	Downhill
Team 15	Innovative	Bumpy

Table **4-7**: Project structuredness and task category distribution

I make the following observations from the table and provide possible explanations:

1. All 4 routine projects follow a downhill model – this makes sense because routine projects deal with similar work already being done in the past and hence there are not many known genuine decision tasks that involve research and/or novel problem-solving.

2. Innovative projects accommodate different models:

    a. Uphill model – Unlike a routine project, an innovative project involves new/novel thinking to solve unseen/difficult problems and most of the tasks performed by the team are known genuine decision tasks and very less of normal information processing tasks.

    b. Hockey-stick model – In order to explain, why such a model might be followed (with more number of both normal information processing tasks and known genuine decision tasks) I analyzed the weekly trend of task categories for the 5 teams exhibiting this model. The analysis revealed that these teams exhibited one of two trends:

        - Team initially performed more of normal information processing tasks and then significant amount of known genuine decision tasks at later stages (refer Figure 4-11 for the graph from one of the 5 teams), implying that the team initially started the project as routine and went on to discover that it was innovative. 4 of the teams out of 5 fit this model.
        - Team initially performed more of known genuine decision tasks and subsequently normal information processing tasks at later stages (refer Figure 4-12 for the graph from one of the teams), implying that the team initially started the project as innovative and went on to understand that it was routine. One team accommodated this model.

    Thus it is inferred that innovative projects are characterized by higher task complexity accompanying more known genuine decision tasks, while routine projects portray a concentration of more normal information processing tasks.

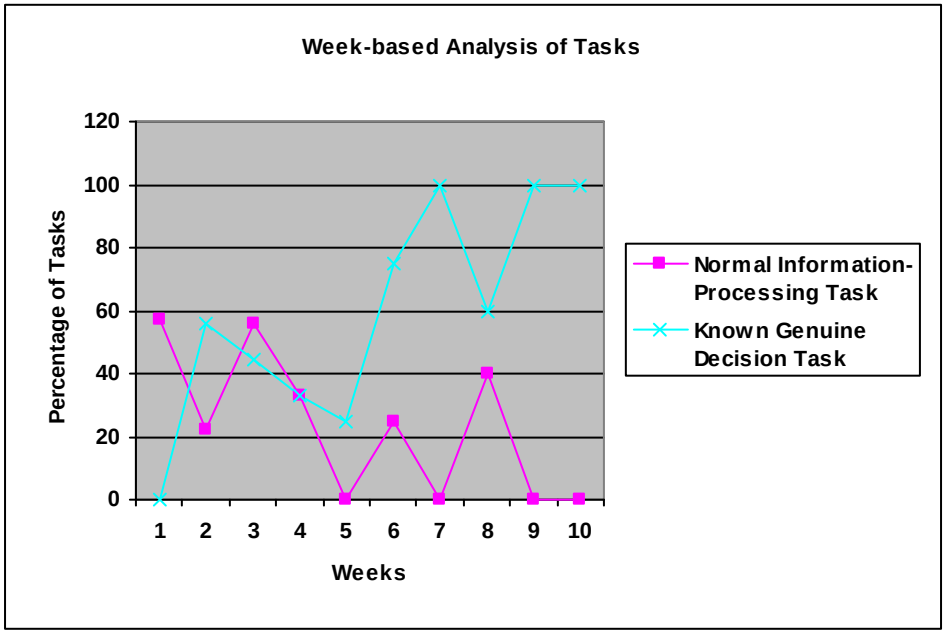


Figure **4-11**: Trend of task categories for a routine-to-innovative project transition

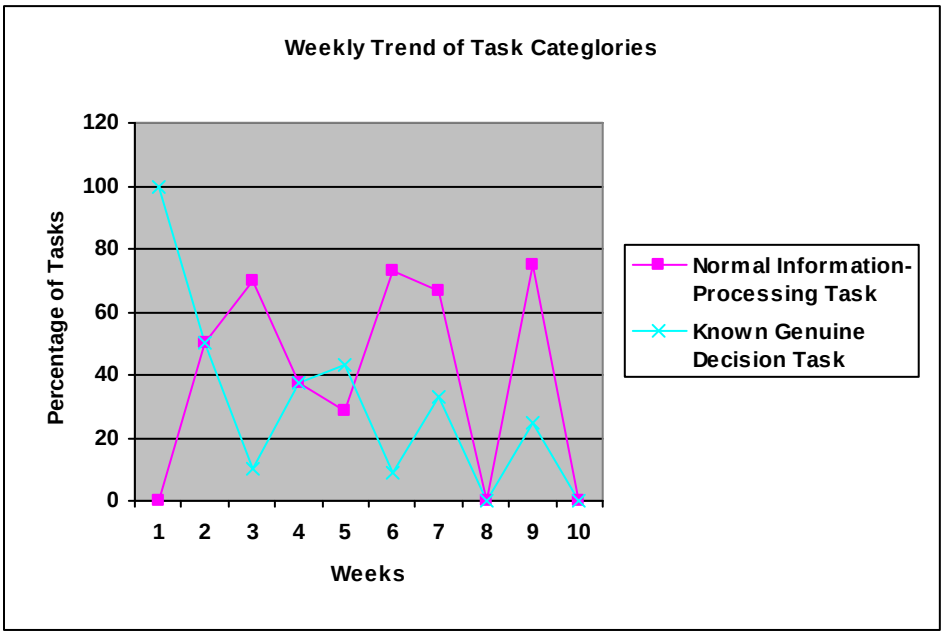


Figure **4-12**: Trend of task categories for a innovative-to- routine project transition

c. Bumpy Model – this model incorporates a higher concentration of normal decision tasks in the task category distribution. This category of tasks actually deals more with reporting and documenting project outcomes than “doing the project”. It was speculated that the 2 teams associated with this model, got bogged down in reports and reviews; the claim was further validated on speaking with the instructors who evaluated and overlooked these projects.

Using the above analysis, I deduce that the type of project (routine vs. innovative) tells us something about the nature of tasks (likely to be) performed by the project team. The different models that we have identified above can serve as a frame to better understand project tasks in enterprise integration.

4.3.2. Interpretations on information sources

Our findings related to information sources revealed that people, Internet, intranet, documents and email archives are preferred sources of information in the enterprise integration project context. With this basic understanding, it is useful to look into the data to understand better the manner in which information sources compare with one another and get used.

A trend analysis of the top 4 information sources viz. people, Internet, documents and email archives (identified from Figure 4-3) is shown in Figure 4-13.

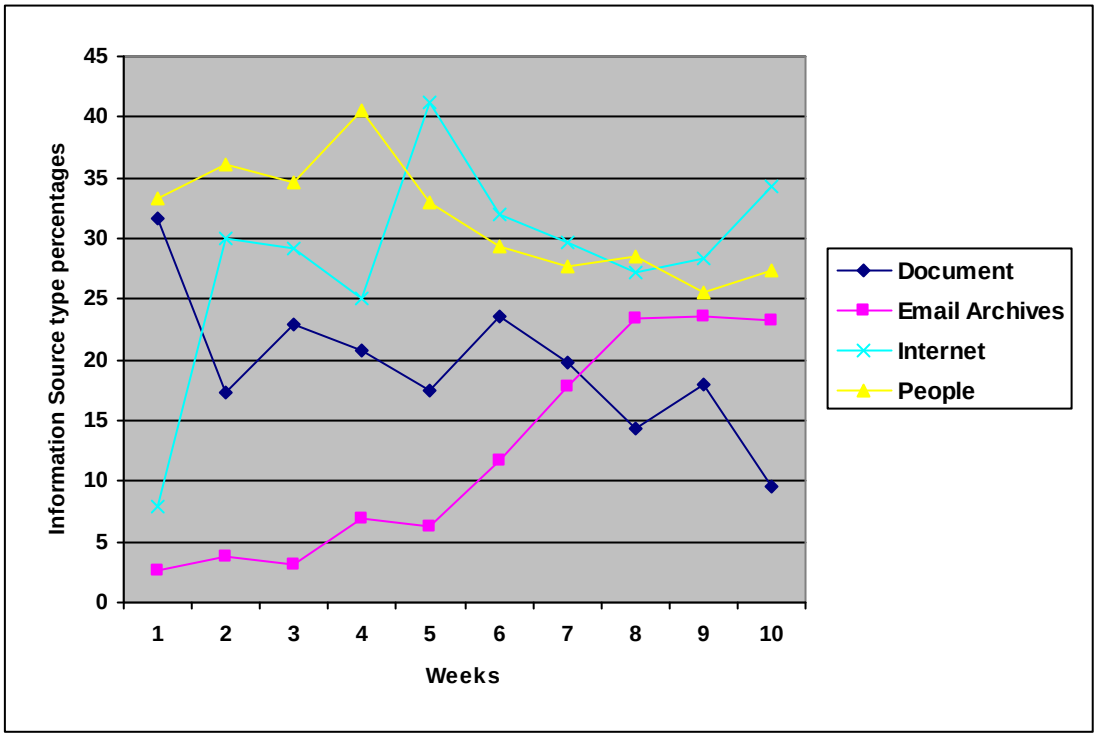


Figure **4-13**: Usage trend of the 4 widely used information sources

Following are some of the inferences that become evident from the trend analysis and with related interpretations:

1. Consultation of email archives displays a notable rise towards the final stages of the projects. In an attempt to understand why this occurred, I looked at the composition of task categories associated with this increased usage and found that more than 60 percent of the tasks were normal information-processing tasks representing team coordination activities. Further, it was discovered that close to 85 percent of the increased usage of email archives was the result of a single team's activity - trying to resolve an internal team conflict by scheduling multiple meetings with the instructor and the project sponsor. Considering this team's activity as an outlier, it can be derived that overall usage of email archives as information source, is likely to be low across the project duration. However, I note that this usage references email archives

as an information source, which is different than using email for communication, which we are not concerned about. Also this tendency of using email archives as information source facilitates re-use of previously seen information among users, which has been established (Dumais, Cutrell, Cadiz, Jancke, Sarin and Robbins, 2003). In fact desktop search tools aiding such behavior are being widely used today.

2. *People* and *internet* are consulted significantly across the duration of the project and at comparable levels. Earlier, we inferred that innovative projects account for more known genuine decision tasks; and routine projects, more normal information–processing tasks. And our findings related to task impacts on information sources (referring Table 4-3) reveal that known genuine decision tasks witnessed more Internet usage and normal information-processing tasks involved more of people as information sources. Connecting the two inferences, I make the assertion that *routine projects involve more people and innovative projects involve more Internet usage for information seeking*.

   To verify this assertion, I analyze each case (or team) to draw support for the assertion. For each team, I calculate the percentage of consultation (based on the number of task episodes) of people and Internet and assess the difference (whether greater than zero or less than zero) to see if the case supports or contests the assertion. The assessments are tabulated in Table 4-8. We observe that there are several instances that support our assertion on information source preference (Internet vs. People) given the nature of the project (innovative vs. routine). The cases that do not support the assertion are described below:

   a. Team 4, 5 and 10 follow a hockey-stick model of task category distribution (refer Table 4-7). This tells us that the teams' view of the project being innovative or routine had a pronounced effect on their information seeking. It is likely that consultation with people is useful for the teams in realizing the structuredness of the project.

Project	Project Type	People (%)	Internet (%)	P – I (%)	Assertion
Team 1	Routine	71.43	10.71	> 0	S
Team 2	Innovative	15.00	57.50	< 0	S
Team 3	Innovative	18.60	19.77	< 0	S
Team 4	Innovative	43.80	28.93	> 0	NS
Team 5	Innovative	58.67	29.33	> 0	NS
Team 6	Innovative	27.78	41.11	< 0	S
Team 7	Routine	29.79	25.53	> 0	S
Team 8	Routine	2.13	0.00	> 0	S
Team 9	Innovative	45.83	33.33	> 0	NS
Team 10	Innovative	62.30	4.92	> 0	NS
Team 11	Innovative	53.85	34.62	> 0	NS
Team 12	Innovative	39.13	39.13	= 0	Ex
Team 13	Innovative	4.65	90.70	< 0	S
Team 14	Routine	16.98	18.87	< 0	NS
Team 15	Innovative	21.33	32.00	< 0	S

Table **4-8**: Project structuredness and information source preference

[S – Supported; NS – Not Supported; Ex - Exception]

b. Team 9 follows a bumpy model of task category distribution (refer Table 4-7) being an innovative project, which implies that their concentration on normal decision tasks (i.e. project documentation and management activities) led them to seek information more from people and other sources.

c. Team 12, which involved both people and Internet usage to a considerable extent deviates from our assertion in that, being an innovative project, it displays equal consultation of both sources. Considering that the project involved a feasibility study of inducting a new technology into the project sponsor's organization, I argue that their increased consultation with people was justified in that constant interaction with people (project sponsors) was important for the project. From the data it is evident that most of their tasks involving consultation with people are related to conducting reviews and obtaining feedback.

d. Team 11 and 14 are potentially outliers, in that they project the opposite tendency of people being more sought after for innovative projects and Internet for routine projects.

3. From the trend analysis of tasks (referring from Figure 4-9), we saw that the initial couple of weeks are dominated by normal information-processing tasks; the next couple of weeks (week 3 and 4) display a higher concentration of normal decision tasks; and subsequently there is notably higher levels of known genuine decision tasks being performed in the later stages. By superimposing this understanding on Figure 4-13, which is a trend analysis of information source usage, I hypothesize that less complex tasks (normal information-processing tasks) are connected with people and more complex tasks (known genuine decision tasks) are connected with Internet usage. To verify this claim, I analyze the trends in the usage of people and Internet for these two task categories – normal information-processing tasks and known genuine decision tasks (Figure 4-14 and Figure 4-15). The trends aptly reveal that, people are more consulted for normal information processing tasks and Internet is more preferred for known genuine decision tasks.

   With regard to research and development projects, Hertzum and Pejtersen (2000) found that individuals consider people as important information sources for project task completion. Our claim goes a step further in underlining the preference for people in less complex tasks. It is however contradictory to Bystrom's (2002) finding that people become popular information sources as task complexity increases. A possible explanation for this is the difference in the context of the study. Bystrom (2002) conducted her research among municipal administrators performing tasks as part of their work routines involving minimal variation between administrators' tasks, while our study deals with enterprise integration projects with each project unique to itself.

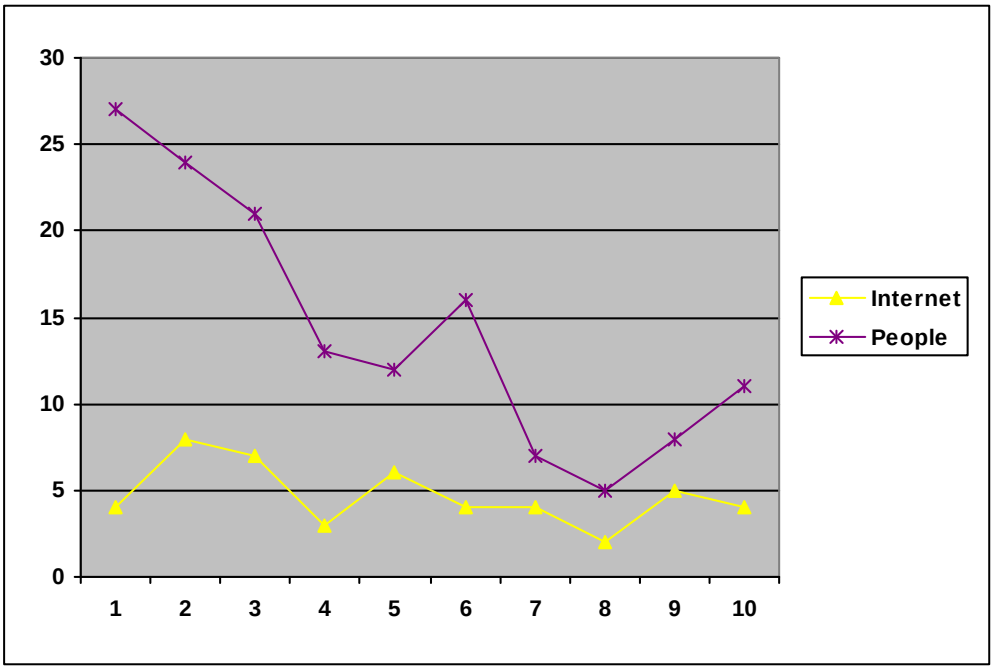


Figure **4-14**: Internet and People usage trend for normal-information processing tasks

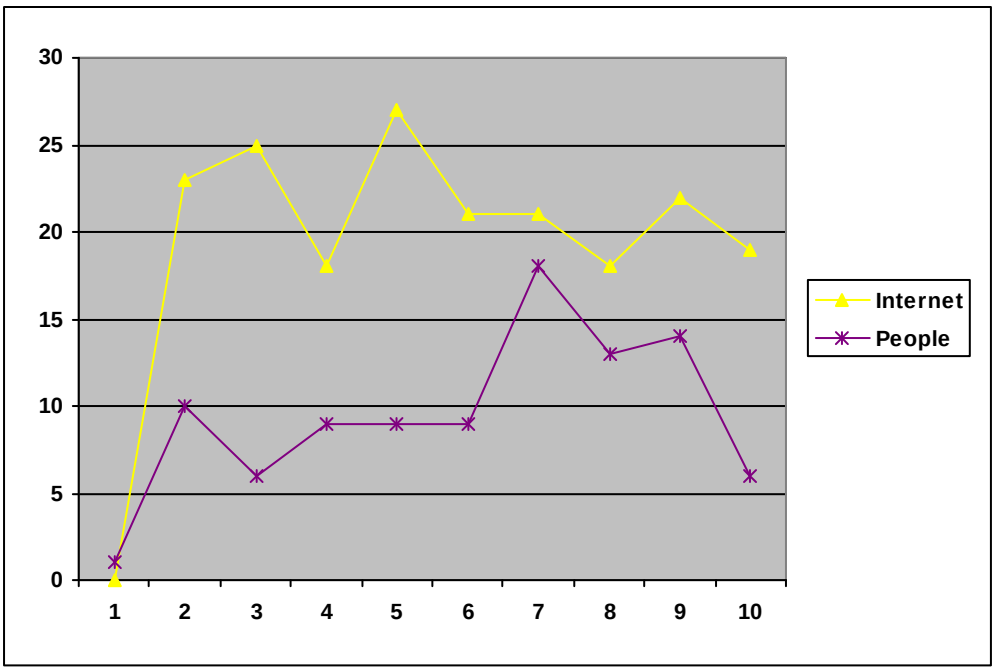


Figure **4-15**: Internet and People usage trend for known genuine decision tasks

4. Instances of consultation of multiple information sources for completing a task were observed. Referring from Figure 4-5, I recall that a total of 111 task episodes involved 2 information sources per task completion and 12 task episodes witnessed the usage of 3 information sources per task completion. I examine in detail, the former category involving 2 information sources per task completion, as the number of tasks involved in this category is considerable. Table 4-9 provides a summary of the frequency counts of information source combinations involved in this category.

Information source pair		**Count**
Document	Email Archives	4
Document	Internet	24
Document	Intranet	6
Document	People	20
Email Archives	Internet	8
Email Archives	Intranet	5
Email Archives	People	4
Internet	Intranet	2
Internet	People	33
Intranet	People	5

Table **4-9**: Summary of two information sources usage in task completion

It can be seen that the combination of *Internet* and *people* is highly used and accounts for over 30 percent of the overall. Further, tasks that used 2 or more information sources were mostly composed of normal decision tasks or known genuine decision tasks. This is somewhat in line with existing knowledge (Bystrom, 2002; Bystrom and Jarvelin, 1995) that increasing complexity in tasks results in consultation of multiple information sources.

5. Documents and intranet are mostly used for normal decision tasks. This makes sense as these resources are likely to be useful in project documentation and tracking. The intranet, in our case was the source of templates used in project documentation. Also these sources are consulted less for known genuine decision tasks that are complex in nature, which can be attributed to the fact that these sources may not provide

problem-solving information (O'Brien and Buckley, 2005), that is often needed for complex tasks.

4.3.3. Interpretations on information types involved

Our initial findings on types of information sought in enterprise integration projects revealed that information related to different aspects viz. enterprise, domain, EI project, EI process, technology and client-team, is sought across the duration of the project activity. From a project perspective, this finding complements Linthicum's (2000) view of the need for information related to technology, enterprise, business process and data for enterprise integration.

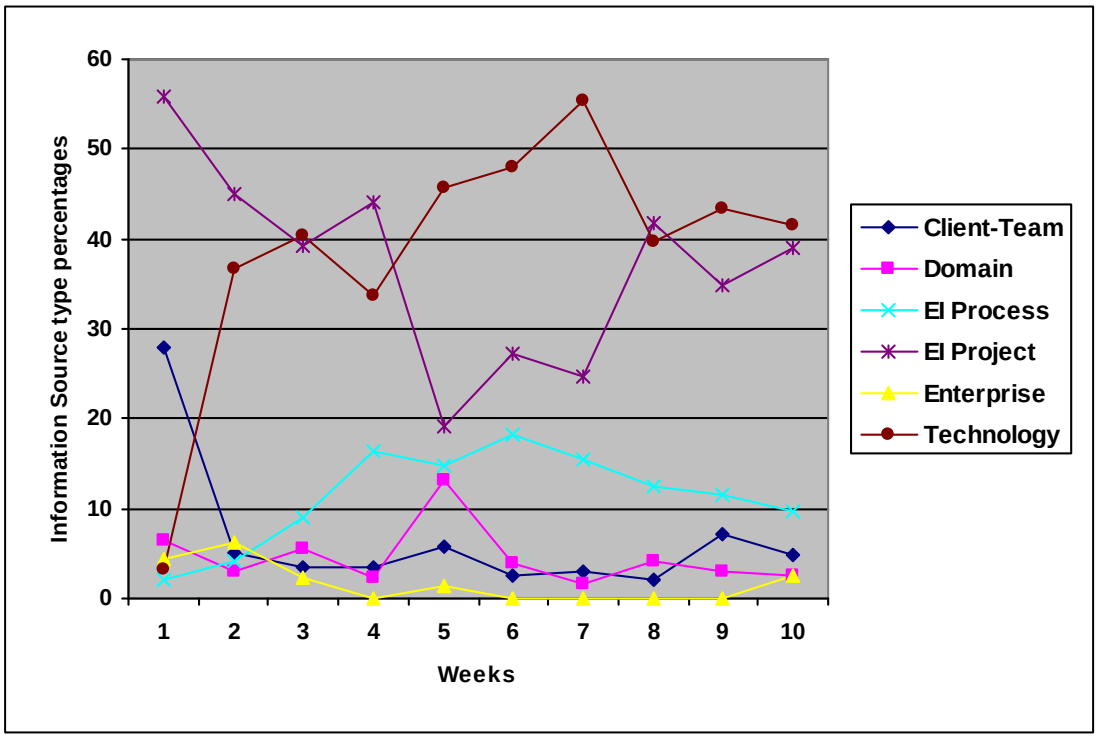


Figure **4-16**: Trend of information types sought across the duration of the projects

Below, I highlight inferences related to each information type (referring back from Figure 4-6). The trend analysis plot (Figure 4-16) for the different information types is used to derive support for some of the discussion that ensues.

1. Consultation of enterprise-related information is notably low throughout the duration of the projects. This is probably due to the fact that, enterprise information appears not-so-vital for project completion. The task category breakup for this information type shows that, mostly enterprise-related information was being sought for normal decision tasks, for inclusion of organizational details as part of project documentation. One team (team 13 – refer Appendix A for project-specific details) however sought enterprise-related information for some of their known genuine decision tasks, which can be directly related to the nature of their project (innovative). Their project objective was to research various server-monitoring software tools and recommend a suitable tool for their project sponsor's organization and this indeed warrants gathering and analysis of information related to the organization.
2. Also, I point out that domain information did not matter much at an aggregate level, looking across all projects. In examining the teams that sought domain information for their project, it becomes evident that teams 4, 6, 12 and 15 that sought this type of information are all innovative projects. Further Table 4-7, informs us that teams 4, 6 and 12 followed a hockey-stick model of task category distribution, which means that these teams realized the structuredness of their project (in terms of innovative vs. routine) only midway.

   This provides a strong reasoning for us to think of domain information as being useful for a team to realize project structuredness. In other words, the use of domain information can be considered as a structuring mechanism helping the team in making informed judgments in structuring the problem at hand; akin to the model of design decision making in IS Development proposed by Zannier, Chiasson and Maurer (2007). Further, from a task-oriented information seeking perspective, it is known that complex tasks accompany information needs that are not clear (Bystrom and Jarvelin,

1995) and hence domain information, that is fact-oriented, serves as a tool to orient the task performer.

3. Information related to the team and project sponsors (i.e. client-team information) is sought initially and later on, this seeking trend fades. This can be directly attributed to the nature of the information involved, predominantly contact information and personal schedules (recurring meeting dates and times set up at project start). To a considerable extent this kind of information possesses a static or non-changing nature, which influences the diminishing information seeking behavior for this type. For instance, details about client contact information need only be obtained once, for it is not likely to change often.
4. The need for EI process information seems to gradually increase across the duration of the projects. I assess the distribution of tasks categories (Figure 4-17) that involved the usage of EI process information.

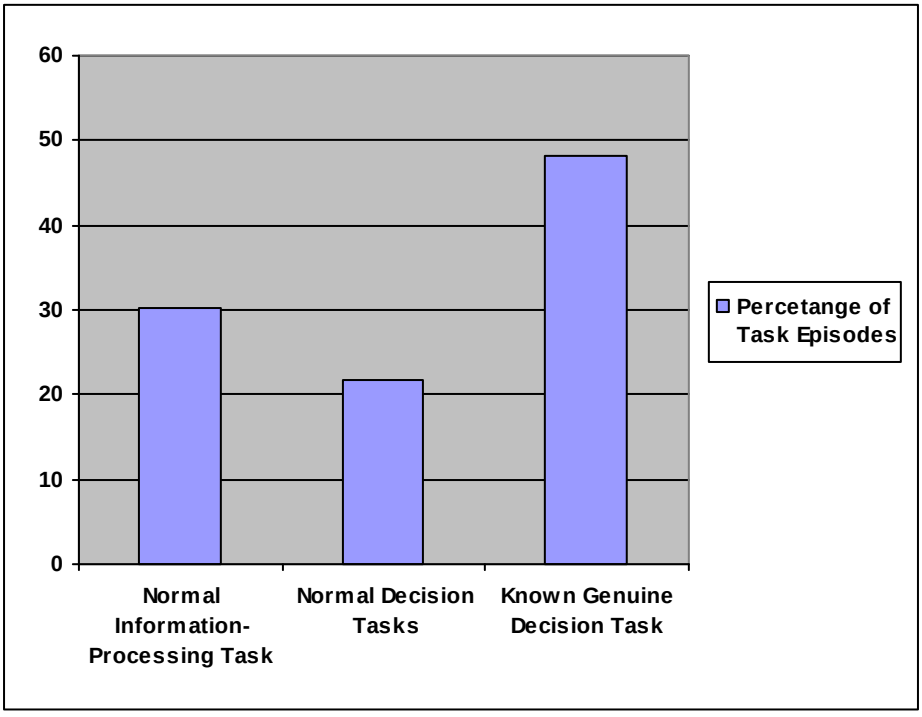


Figure **4-17**: Task category distribution for EI process-related information seeking

It becomes clear that EI process information is mostly utilized for performing known genuine decision tasks (that dealt with requirements analysis, systems design and implementation) towards the later half of the project; also normal information-processing tasks used this information for meeting/brainstorming sessions within the team and between the team and project sponsor(s); EI process information was least sought for normal decision tasks (for documentation purposes).

With the lack of standardized knowledge about the lifecycle and process of enterprise integration (Irani, Themistocleous and Love, 2003), it is interesting to discover where teams gathered EI process information from. Figure 4-18 provides a summary of information source usage for EI process-related information seeking.

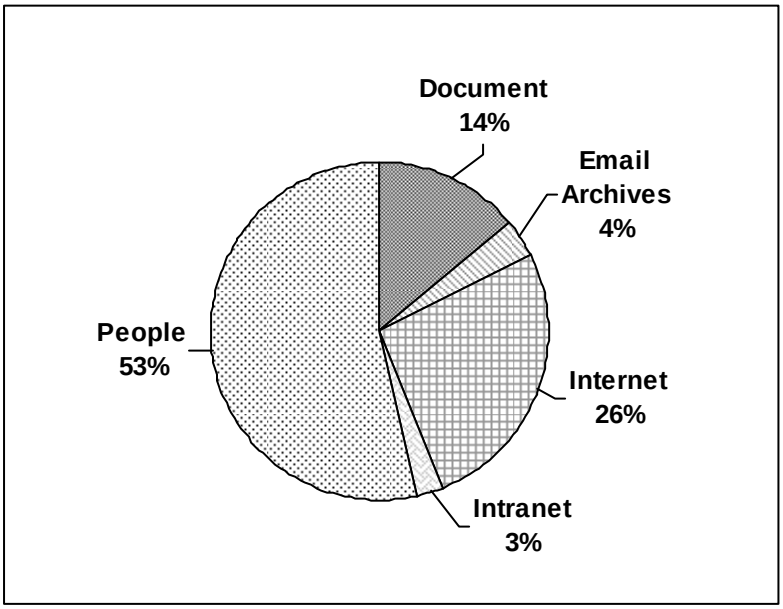


Figure **4-18**: Summary of information sources consulted for EI process information

We note from the pie-chart that people are consulted most for gathering EI process information. This finding makes sense, given the dearth of documented process knowledge about enterprise integration.

5. Technology and EI project information appear to be the most sought after information types across all projects. Findings from Figure 4-8, reveal that EI project information is sought more for normal information-processing tasks and normal decision tasks; while known genuine decision tasks involve significant technology-related information. To confirm this inference, I use the trend analysis of tasks (referring from Figure 4-9), describing the task type variation with time (in weeks) - normal information processing tasks dominating the initial couple of weeks; higher concentration of normal decision tasks across weeks 3 and 4; and subsequently higher levels of known genuine decision tasks in the later stages. Applying this task category trend as backdrop to Figure 4-16, we observe that EI project information is being sought more initially and later on as the projects progress after week 4, technology information is sought more.

   To further substantiate our understanding of this relationship between task type and these 2 information types, I particularly analyze trends in the usage of EI project information and technology information for these 3 task categories individually – normal information-processing tasks (Figure 4-19), normal decision tasks (Figure 4-20) and known genuine decision tasks (Figure 4-21). From the trends, it is evident that known genuine decision tasks clearly involved more technology information and the former two task categories involve more EI project-related information seeking, for the most part. Treating technology information as problem-solving information (O'Brien and Buckley, 2005), our finding is consistent with Vakkari's (1999) acknowledgement that complex tasks demand more problem-solving information. Further, this is well in agreement with Serola's (2006) findings on information seeking behavior among city planners that problem-solving information is sought more for complex tasks.

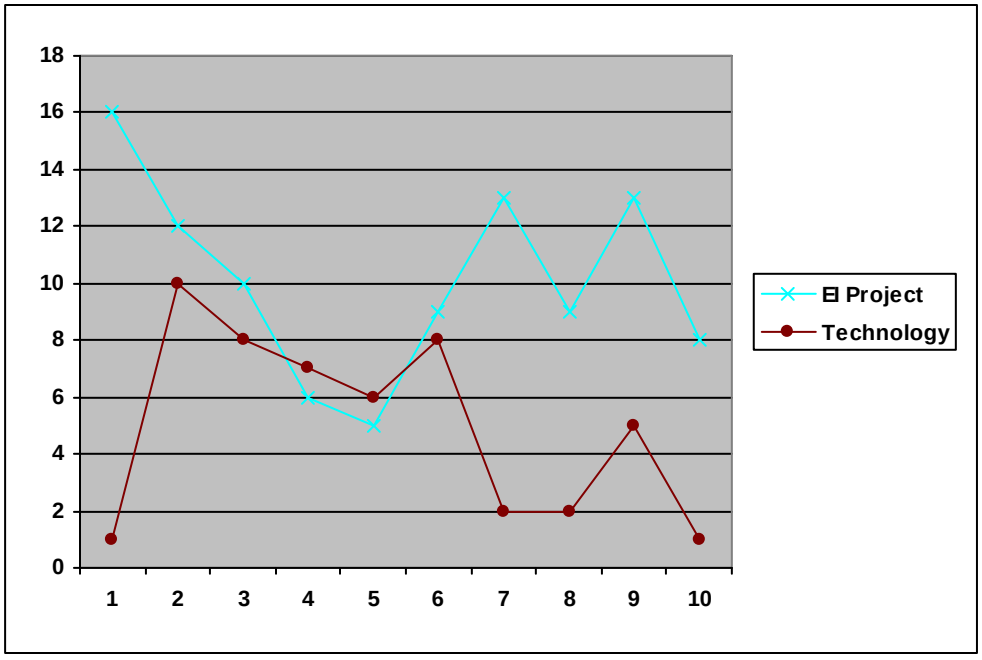


Figure **4-19**: Technology and EI project information usage trend for normal information-processing tasks

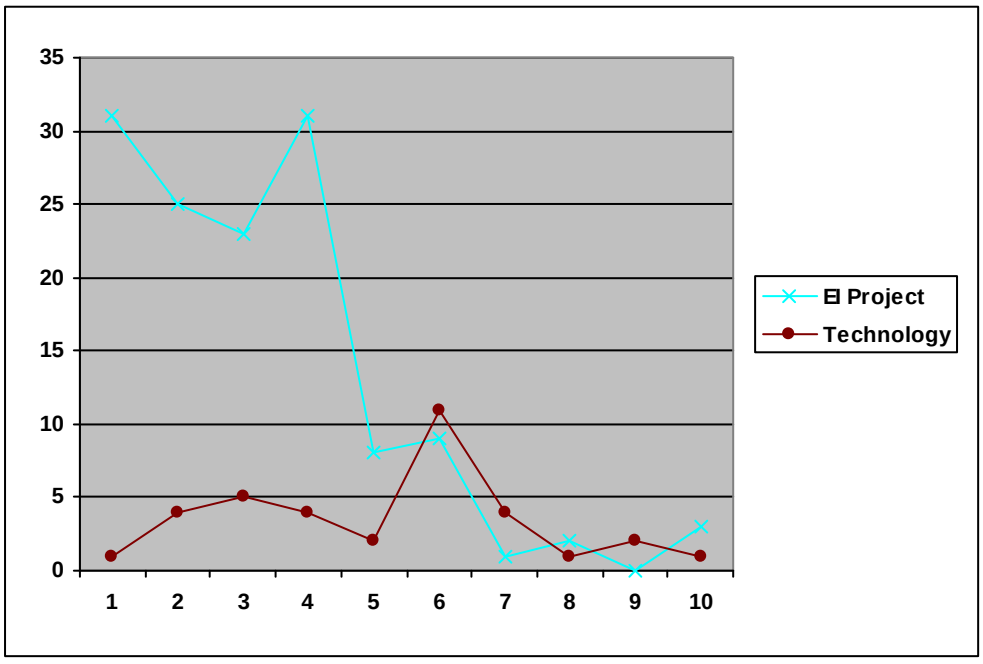


Figure **4-20**: Technology and EI project information usage trend for normal decision tasks

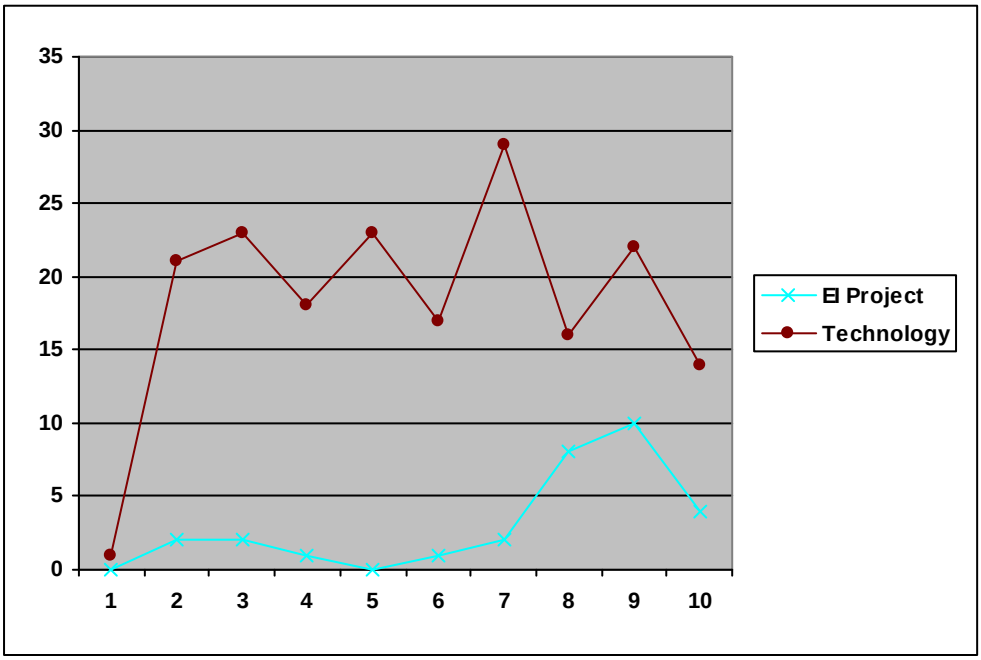


Figure **4-21**: Technology and EI project information usage trend for known genuine decision tasks

Referring back to Figure 4-16, the increased consultation of EI project information for weeks 4 and 8 (when it exceeds technology-related information seeking), can probably be explained by the fact that student teams worked towards submission of project deliverables (project plan document and final project report document) as a result of deadlines following these weeks. And project documentation tasks naturally involve EI project information. This instance perfectly aligns with Vakkari's (2003) notion of task-oriented information seeking that, "tasks warrant information seeking/ searching for task performance or task completion".

4.3.4. Linking task category, information type and information sources

My third research question is targeted at uncovering patterns of task-oriented information seeking within enterprise integration projects. I operationalize such a pattern as a combination of a task category, information type and information source, that occurs

repeatedly. I analyze the occurrence of different such combinations across 782 task episodes (for which data is available) and look at the number of occurrences in order to interpret the prevalence of the combinations.

The top five most frequently occurring combinations were:

1. Known genuine decision tasks - technology information - Internet
2. Normal decision tasks - EI Project - Document
3. Normal decision tasks - EI Project - Intranet
4. Normal decision tasks - EI Project - People
5. Normal information-processing tasks - EI Project - Document

As part of previous discussion, I have verified claims on task impacts on information and information sources separately. I use those to make sense of some of the patterns being observed here. Given that known genuine decision tasks involved more Internet usage (section 5.3.2) and also dealt with technology-related information seeking (section 5.3.3), it is not surprising to see that both these assertions actually tie in, accounting for the most common pattern of task-oriented information seeking.

Previously, we detected that normal decision tasks mainly involved EI project information (section 5.3.3) and noted documents and intranet usage being highest for these tasks (Figure 4-7); these observations help us infer that EI project-related information is the bridge that is likely to connect normal decision tasks with documents and intranet usage. It is however surprising to note that people were also linked to normal decision tasks by this bridge. Further, it is interesting to note that most of the EI project information needed for normal information processing tasks came from people.

Conversely thinking of patterns that never occurred, it could be seen that enterprise information and EI process information were never sought for automated information processing tasks through any of the information sources. Also domain information for automated information processing tasks was very rarely sought. In a similar fashion,

client-team information was sparingly sought for complex tasks like normal decision tasks and known genuine decision tasks, through any information source.

4.4. Caveats

Some of the shortcomings of data collection and analysis of the study are covered in this section. The first and foremost issue is related to the study setting, in using student teams to study a phenomenon taking place in the organizational context. There are certainly factors that differentiate a university setting from an enterprise. The latter is likely to exhibit more financial, management, technological and political constraints, among others, which could potentially influence the phenomenon of interest. The impact resulting from these differences could create room for sampling bias.

Further, there were issues involved in using the student teams for data collection. Some of the students (or team members) would fail to turn in their weekly questionnaires for some of the weeks as a result of busy project schedules. This naturally becomes a problem for the research. Also, towards the initial stages of data collection, varying perceptions of the study objectives among the teams influenced the way they used the weekly questionnaires to submit research data.

The employment of student teams made it difficult for the researcher to use other methods of data collection that could have been useful for data triangulation. Especially, with the use of interviews with the teams, richer answers could have obtained for my research questions, with reference to the *why* aspects of the kind of behavior observed from analysis of the data. This was difficult as scheduling interviews was not easy considering busy schedules of the students and large number of teams.

The data coming in from the weekly survey questionnaires, which is collected at an individual-level is interpreted at the level of the team. In other words, individual differences are ignored, as part of data analysis. In gathering details about task

completion and information seeking, the time aspect is not considered. The time taken to complete a task or information seeking activity is not taken into account while analyzing the task episodes. Further, collaborative information seeking has not been explored, even though it is likely to have been a part of information seeking for task performance.

5. Conclusion

5.1. Summary of thesis

The overall objective of the research was to understand and characterize the information needs of teams engaged in enterprise integration projects. Using a task-oriented information seeking perspective, an information need was operationalized in terms of a task creating a need for certain information that is obtained from one or more information sources. A study was conducted among several student teams engaged in enterprise integration projects, from whom data was collected on a periodical basis across the duration of the projects. Quantitative data analysis was then employed on manually coded data, in order to find answers to research questions previously defined.

An understanding of the task-oriented information needs accompanying enterprise integration projects has been developed. Through this research, we have established the nature of tasks encompassed by enterprise integration projects and found that it is mostly composed of tasks possessing some amount of complexity - less complex tasks (related to team coordination); moderately complex tasks (related to project management and documentation) and highly complex tasks (related to requirements analysis, project design and implementation). It was learnt that various information sources matter in the process of information seeking – people, documents, Internet, intranet and email archives. Further, different types of information pertaining to the technology, enterprise, domain, client & team members, enterprise integration project aspects and process steps, was found to be sought by the project teams.

The following characterizations are being derived from some of the assertions that were verified through discussion of my findings:

1. As regards, task impacts on choice of information sources in enterprise integration projects, it could be seen that less complex tasks involve consultation with people and more complex tasks involve Internet usage for information-seeking. Moderately complex tasks, dealt with consultation of documents as much as with people. From this, I deduce that increasing task complexity directs individuals towards sources capable of providing vast information and accompanying higher accessibility. Further, based on the project type, it was seen that routine projects mostly attract people and innovative projects attract more Internet usage.
2. With regard to task impacts on information types, I note that more complex tasks predominantly dealt with technology-related information for task completion and less complex tasks, EI project information. Hence, for increasing task complexity in enterprise integration projects, it can be said that information related to actually "doing the project" is of interest as opposed to information needed to "project the doing". Further it was discovered that domain information is sought by a team dealing with an innovative project, in order to realize the complexity involved in "doing the project".
3. Patterns linking task categories, information types and information sources – technology information being sought from Internet for completing more complex tasks; EI project information sought from documents for completing moderately complex tasks – highlight specific instances of task-oriented information seeking behavior observable in enterprise integration projects.

In this way, the characterizations that we arrive at, serve as fitting answers to my research questions targeted at understanding relationships between tasks, information and information sources, for enterprise integration projects.

5.2. Implications and Limitations

The research accompanies many findings with reference to tasks, information and information sources important in the context of enterprise integration projects. It is useful to learn about the implications of these findings for practice as well as academic research.

With the knowledge that 95 percent of tasks in enterprise integration projects involve some amount of complexity (ranging from low to high), we learn that enterprise integration projects are non-deterministic in nature. This re-iterates the need for effective project management. Further, our analysis of routine and innovative projects informs us that this trait bears a relation with the kind of tasks likely to be involved in the process, which further feeds into the project management efforts needed in enterprise integration projects. By definition, automated information processing tasks (Bystrom and Jarvelin, 1995) are those that can potentially be automated. In our study, instances of this task category were seen to include sending introductory emails to project sponsors and signing documents. This highlights the scope for automation of some of the tasks within enterprise integration projects – sending automated emails using team and client contact information; employing electronic document sign-off mechanisms and so on.

People and Internet were among the most used information sources. Thus, availability and accessibility of these resources needs to be ensured, as it becomes crucial for completion of project tasks. With client interaction reaching considerable levels (over two-thirds of all consultation with people), reliable channels for communication happen to be vital for information gathering from the team's perspective. With documents also contributing as information sources, it could be worthwhile to pursue efforts in document digitization and document management to aid in quicker retrieval of the information being sought from documents, considering the finding that web resources acts as a chief information source. With teams exhibiting a tendency to re-use previously seen information, in the form of email archives for less complex tasks, the use of desktop search tools that index and make desktop content searchable, can be promising.

For a few of the innovative projects, we observed that domain information was sought by the teams. Further the fact-oriented nature of domain information serves to orient the task performer in complex tasks accompanied by these projects. Thus, the management or project sponsor should take efforts to make useful domain information available to the team to assist their progress, for innovative projects. Since EI process information was seen to be obtained mainly from people, it would be constructive for the organization to devote time to document useful EI process-related information, in order to enhance its accessibility and availability.

From the perspective of research in enterprise integration, lack of standardization in enterprise integration process methodologies has been previously acknowledged. My research has identified that information related to this aspect is important in enterprise integration projects and is mainly sought from people – emphasizing the absence of documented enterprise integration process knowledge. This finding highlights the need for research efforts in devising standardized methodologies for enterprise integration.

There are a few limitations to my study that need acknowledgement. Insufficiency in the data that was submitted by the student teams as part of the weekly questionnaires was observed. Few teams (4 out of 19) did not submit their weekly questionnaires for three out of the ten weeks for which data collection lasted. Eventually, data from these teams had to be discounted for analysis. Another shortcoming is related to the study setting, which was based in a university environment as opposed to an organization. My counter-argument to this would be that, all projects originated from organizations in the industry and they were addressing genuine organizational needs. Further, most of the students composing the teams possessed at least one internship experience, thereby gaining the necessary exposure to organizational practices. So, in a way, the overall project experience could not be very different from what would have transpired in an organizational setting. Lastly, the issue of accessibility to information and/or information

sources was not considered, even though this factor that is likely to affect information seeking behavior.

5.3. Directions for future research

There have not been many studies of human information behavior in the domain of information systems research. Detlor's (2003) study of information needs among information technology (IT) professionals in organizations focused on Internet-based information systems use for information seeking and proposed recommendations on information formats for Web-based information systems. More recently Freund, Toms and Waterhouse (2005) based their study on the development of a model of contextual work-task factors shaping information searching among software engineers and go on to provide recommendations for design of search systems in the work place. This highlights the focus on aspects related to information retrieval.

With my research adopting an information seeking perspective, there is need for similar empirical studies contributing to understanding human information behavior at a theoretical level. Besides information needs, it would be useful to understand the processes involved in information searching and information use. In other words, I am stressing the scope for future research that wears the lenses of human information searching behavior and information use.

Most of the data analysis in my study has been quantitative, with initial employment of qualitative methods like textual coding. Even though, this is useful for making insightful inferences based on reliability assessments (i.e. drawing support for inferences from multiple cases), it does not facilitate the generation of rich answers to research questions. The use of qualitative methods like semi-structured interviews (LeCompte and Schensul, 1999; Mason, 2002) and task diaries (Bystrom and Jarvelin, 1995) for similar studies, is really worth pursuing as these can provide rich data to the researcher using which, "why"

aspects related to the information seeking behavior, information source preferences and information type choices for task completion can be interpreted.

By adopting a task-oriented information seeking perspective, we were able to understand more about the nature of tasks encompassed by enterprise integration projects. Given the nature of enterprise integration, it is to be noted that the scope of an enterprise integration project can vary greatly compared to another. The possibilities range from market analysis to systems implementation. Projects related to implementing enterprise systems (e.g. ERP software) within organizations are a different pool altogether. Accounting for this diversity in enterprise integration projects by treating different kinds of projects under separate umbrellas is likely to yield more accurate insights from task-level analysis. This contributes towards the development of a better understanding of the domain of enterprise integration.

5.4. Conclusive remarks

The aim of this research was to answer the over-arching question of where enterprise integration teams go for information for performing their tasks and what information they seek. Through this study I have attempted to provide an answer to this question in terms of constructs chosen from task-oriented information seeking theory – tasks, information and information sources. The findings have equipped us with insights into the kinds of tasks representing enterprise integration projects, information involved in project task completion and information sources that matter. Further, the impacts of task complexity on information and information source preference were also discussed.

The contributions of this research are two-fold. I emphasize the fact that the study is situated at the intersection of two prominent research areas – information systems and human information behavior. With our research focused at understanding information needs of teams engaged in enterprise integration projects, our results inform both the fields. Further, the data and findings have been instrumental in helping me develop

several inferences that could be verified using deeper analysis of the data. These findings hold implications for practice in the industry (refer section 6.2) and hence can be directly applied.

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Appendix A

Details of projects dealt with in the study

Project	Project Type	Description of the project
Team 1	Routine	* Testing a project management software and giving recommendations on its fit to manage enterprise-level projects * Identify integration points for MS Office file formats
Team 2	Innovative	* Research on online Web services and their integration with existing website * Assessment based on business value
Team 3	Innovative	* Gather requirements for developing a text book exchange application for students nation wide * Design website for the application * Demonstrate usefulness of the website environment in assisting the sponsor organization to test the market for assessment of the utility
Team 4	Innovative	* Develop a solution leveraging existing infrastructure components within organization for business growth in the telecommunications industry
Team 5	Innovative	* Design and implement a user interface in Sharepoint to integrate information across different websites within sponsor's organization
Team 6	Innovative	* Evaluation of Adobe product features for business need * Development of a small module to achieve specific functionality related to 3D models
Team 7	Routine	* Investigation of different aspects of ERWIN API * Develop recommendations based on the analysis of capabilities of ERWIN * Write technical documentation for web service
Team 8	Routine	* Evaluate how a project management software will suit a university setting by identifying key performance indicators in this context * Develop recommendations for changes to be made to the software to suit the context

Team 9	Innovative	* Analyze requirements to identify features of an information system that will pull data from existing sources * Design system architecture and develop system prototype
Team 10	Innovative	* Understand current video surveillance technology * Collect data from University police for understanding the technology integration requirements * Propose new infrastructure to satisfy requirements of University police surveillance function
Team 11	Innovative	* Understand Microsoft BizTalk and set up environment for development * Developing .NET application for integration with existing BizTalk environment
Team 12	Innovative	* Research Service-oriented Architecture (SOA) and its compatibility for organization's vendor products * Understand standards in Engineering Systems * Forecast feasibility of SOA implementation in sponsor’s organization
Team 13	Innovative	* Research various tools for reporting server usage statistics * Recommend the best tool based on comparative analysis
Team 14	Routine	* Develop a drag-and-drop user interface for graphically depicting car accidents, by pulling car accident data from existing data sources
Team 15	Innovative	* Research existing social networking web sites * Develop report for sponsor with recommendations for online social networking website * Creating user interface prototypes