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Empirical study of attributes and perceived benefits of applications integration for enterprise systems

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EMPIRICAL STUDY OF ATTRIBUTES AND PERCEIVED BENEFITS OF APPLICATIONS INTEGRATION FOR ENTERPRISE SYSTEMS

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DEDICATION

To Diane who is the true love of my life, my best friend, my biggest fan, and my wife. Completion of a Ph.D. program at my age was only possible because of her unwavering faith, sacrifice, support, and help.

To Mother, who gave me life, constantly inspired me, had unending faith in me, and nourished a passion for learning.

For my children and grandchildren: Let this accomplishment inspire you always to pursue your own dreams and ambitions with the assurance that fulfillment is possible.

To Aunt Louise who is like a second mother and taught me to be happy above all else.

*In memory of: G*randmother Joyner, the kindest person I ever knew who taught me many things that no one else even considered. To Uncle Gaston and Aunt Pearl who indulged me for endless hours on numerous occasions with memorable conversations and lessons that have lasted a lifetime.

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PREFACE

The purpose of this preface is to explain the origin of the idea for this research and to explain why such an ambitious three-phase research plan was undertaken. Additionally, the notion of IT integration is introduced and the context established for the research. This was deemed vital because of the paradox of the concurrent ubiquity and vagueness of integration.

Origin of Research Idea

The idea for this research topic emerged during my studies for a master's degree while I was learning about SAP, ERP, and enterprise systems. A recurring theme was integration. The concept of integration resonated true and profoundly important because of my extensive background with applications and systems development. So, I began asking questions about, and digging deeper into, the notion of information technology integration often known as ERP.

I wanted to know how integration among applications was represented and how one knows what was integrated along with all the various specifics. While integration was like the Holy Grail of IT, the concept was actually fuzzy and fluid. For my master's thesis, this led me to develop a way to model integration among applications. All along, I was constantly haunted by the questions: What is integration? Does IT integration have value? How do you know when applications are integrated?

The Integration Concept

Upon entering the Ph.D. program, it was clear that IT integration would be my research topic although I was not clear what form it would take. Research leads me to believe that integration is a concept that extends beyond information technology to most areas of academia.

My research has revealed that the essence of integration, in a very simplified sense, is components or artifacts working together. Given this perspective, integration resembles an infrastructure. There are many infrastructures in IT, in business, in society, and so forth. Upon closer inspection we find that integration is the glue or abstract force that holds the components together and facilitates the coordination of the components. Finally, even a cursory review reveals that infrastructures are hierarchical in nature. For example, IT has many infrastructures for which ERP systems are only one component. We can decompose ERPs into applications, applications into computer programs and programs into modules, functions, and subroutines all of which are a type of infrastructure. Going in the other direction, we find that IT is part of an organization's infrastructure, which is part of an industry infrastructure, and so on.

The Research Challenge

The de facto process for Ph.D. students in MIS conducting social science type research is to do a case study or adapt existing scales to perform quantitative research. However, this dissertation has required three major undertakings: An in-depth qualitative study, the development of a new scale, and the collection and analysis of quantitative data to validate the scale. There are numerous examples where each of these parts alone are sufficient for a dissertation or publication in "A" journals. This triple dissertation research load was never sought although often admonished by me using choice superlatives. The research question drove the decision. Lack of prior research on the integration topic led to the three-part design that was required to answer the research questions.

The questions about IT integration are extensively addressed in this dissertation along with several related issues. In researching this topic, as is often the case, many new unanswered questions emerged. Further research is required to explore this important issue.

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ABSTRACT

This research investigates the very essence of integration by focusing on the integration of applications for enterprise systems. Integration is a large and complex topic recognized as a key concept in a wide variety of IT domains that dates back to the dawn of the computer era. The evolution of IT integration has included integration of sub-routines of computer programs, integration of separate islands of data to create common databases, and integration of disparate applications to form enterprise systems. Perhaps the most touted characteristic and principal goal of enterprise systems is integration although virtually no research is available regarding this phenomenon. The value of integration is rarely defined either in abstract or practical terms. We generally assume that the value of integration is obvious although there is no evidence that supports this implicit view. To address the lack of evidence, this investigation began by examining the perceptions of three practitioner stakeholder groups about the characteristics and benefits of integration. These groups were senior managers, IT professionals, and end-users. In part I of the two-part study, interviews of 51 practitioners revealed 15 major themes related to practitioner perspectives of the characteristics, benefits, and downsides of applications integration. For part II, a new measure was created based on the literature and the analysis of the phase I interviews. 926 people in three organizations were surveyed. Contributions of the research included a new partially validated instrument to assess attributes and benefits of applications integration, taxonomies were created for integration attributes and perceived benefits, and a model was proposed to frame and study IT integration infrastructures. A foundation was established to evaluate the degree of applications integration for enterprise systems. Several downsides to applications integration were documented. Two new high order constructs (attributes and benefits) were established, along with four attribute dimensions and six benefit dimensions.

CHAPTER 1 – INTRODUCTION

While organizations, collectively, spend billions of dollars to achieve "applications integration," little is known about practitioners' perceptions of integration that influence these decisions and actions. This dissertation describes the empirical research aimed at surfacing and validating practitioner interpretations (assumptions, knowledge, and expectations) of applications integration. The research was conducted in two parts: A qualitative part consisting of interviews and a quantitative part for which a questionnaire was employed to collect data. The study investigated the perceived characteristics and benefits of integration by three stakeholder groups: senior managers, IT professionals, and end-users.

Integration has been the dominant IT theme for organizations over the past ten years. The integration of separate and isolated "islands" of systems and data began with projects involving a few applications (Tapscott and Caston 1993). Today, the scope of the integration efforts has broadened to encompass enterprise-wide initiatives such as enterprise resource planning (ERP) systems, enterprise data warehouses (Davenport 2000), and interorganizational systems (IOSs) that transcend legal enterprise boundaries (Konsynski 1993; Kumar and van Dissel 1996).

Integration is a large and complex topic. Only a few of the open issues are addressed in this research. Integration is recognized as a key concept in a wide variety of IT domains that date back to the dawn of the computer era. The evolution of IT integration has included integration of functions and sub-routines of computer programs, integration of separate islands of data to create common databases, and integration of disparate applications to form enterprise systems.

This research focuses on the integration of applications for enterprise systems which is one of several IT infrastructures. Perhaps the most touted characteristic and principal goal

of enterprise systems is integration although virtually no research is available regarding this phenomenon. Is integration a good thing or a bad thing, and why? The value of integration is rarely defined either in abstract or practical terms. We generally assume that the value of integration is obvious although we lack supporting evidence.

A comprehensive model is proposed to represent the antecedents, components, and relationships of an integration infrastructure for information technology, especially for enterprise systems. The proposed model serves as a reference and context for the reduced, more focused model used for this research. Enterprise systems are a type of IT infrastructure. Broadbent et al. (1996) and others have described IT infrastructures for Application Development, Communications Technology, Database and Security, etc. An emerging concept is integration infrastructures. A search of the web using Google produced 6,800 references for "integration infrastructure" of which 5,140 also referred to applications. Thus, it appears reasonable to think of applications integration for enterprise systems in terms of an integration infrastructure.

Importance of Research

According to leading researchers, integration is the most distinguishing characteristic of Enterprise Systems (ES) and is often a core objective for the organizations that acquire and implement these large-scale systems (Markus 2001; Parr & Shanks 2000; Markus & Tanis, 1999; Alsene 1994). Cadarette and Durward suggest that the goal of integration for information technology (IT) is not new and that full integration has not been easy to achieve (2000, p. vp[1]):

[1] vp (virtual page) denotes that the article exists only on the web or the article was found on the web but the printed version was not available at press time.

> "…from the dawn of the computing age, integrated automation has been the Holy Grail of computing. And like the Holy Grail, achieving full integrated automation remains elusive, despite huge investments in a wide array of technologies that promise integration…"

Markus and Tanis write that, "Integrated enterprise systems deserve serious research because of their great potential for financial, technical, managerial, human, and strategic benefits, costs, and risks" (1999, p. 173). All indications are that integration is central to ES and its success (a critical success factor). A better understanding of integration attributes and benefits along with understanding why people value integration should allow us to improve our planning, selection, management, and evaluation of enterprise systems.

Research Overview

The research was conduced in two phases. In part I, interviews of 51 practitioners representing three stakeholder groups revealed 15 major themes related to practitioner perspectives of the characteristics, benefits and downsides of applications integration. The four organizations that participated included two universities and two large petro-chemical companies. Participants were asked a series of 12 semi-structured questions aimed at surfacing information about applications integration, which include: characteristics (attributes), benefits, downsides, and suggestions to assess and measure integration.

For phase II, a new measure was created based on the literature and the analysis of the phase I interviews. 926 people in three organizations were surveyed. 414 surveys were returned representing a 44.7% return rate. Of these, the 399 usable surveys were analyzed using structured equation modeling. Confirmatory factor analysis (CFA) partially supports that attributes consist of 4 dimensions representing 16 separate items and that benefits consist of six dimensions made up of 25 items. Path analysis confirms a positive relationship between the higher order construct integration attributes and integration benefits.

Research Questions

The chief purpose of the research was to investigate the concept of IT integration to improve our understanding of this fundamental MIS phenomenon. The primary question is, "what is integration and does it have value?" To address this question, integration was operationalized as attributes and benefits of integration, along with how the perceptions vary among three primary stakeholder groups. Specific questions were:

- What are the attributes (characteristics) of applications integration people associate with enterprise systems?
- What are the perceived benefits of applications integration people associate with enterprise systems?
- What is the relationship of attributes to perceived benefit?
- Do perceptions of applications integration attributes and benefits vary significantly among the three stakeholder groups?

Contributions

This dissertation provides a research model which begins to address the value of integration in information systems by looking at linkages between stakeholders, integration, and benefits. Because integration has been identified so strongly with enterprise systems, this technology was selected as the lens to research applications integration. Since stakeholders participate in decisions which ultimately enact ES, their perceptions of applications integration are clearly important. In general, the contributions of the research include a better understanding of application integration and the related issues of measurement, definitions, taxonomies, and downsides.

CHAPTER 2 – LITERATURE REVIEW

Integration is a widely applied concept in science, engineering, and economics as well as IT (Pelkmans 1980; Anderson 1991; Hill et al. 1993; Davenport 1998). To avoid continually expanding the scope of this research, the review of integration was limited to what could be discovered in the IS/IT literature. Integration for a variety of contexts has long been a topic of research in MIS (Senn 1978; McLeod and Bender 1982; Ein-Dor and Segev 1982; Goodhue, et al. 1992; Kalakota and Whinston 1993; Alsene 1994; Davenport 2000; Markus 2001). However, the value, characteristics, and measurement of integration have largely been ignored.

References to integration can be found in discussions of applications (as a whole), computer programs and modules, business processes, data, and technology. Because of the concern with the perceptions of stakeholders such as managers and end-users as well as with IT professionals, material is included from key practitioner works. IT infrastructures and enterprise systems provide the lens to discuss and research integration. Although IT integration covers data, processes, hardware, software, people, facilities, networks and communications, web, etc., this research looks only at applications integration for enterprise systems.

History of IT Integration

The pursuit of integration is almost as old as the computer itself. At ICIS 1998, the introduction to Panel 3 states:

> "Since the early days of computing, organizations have aspired to integrated, enterprise-wide information system architectures. Throughout the years, these aspirations have been reflected in the quest for integrated MIS, enterprise-wide data models, and integrated databases" (Veth 1998, p. 410).

The idea for enterprise-wide integration was considered as far back as the 1950s and 1960s (Alsene 1994). Table 1 provides a historical summary of the major developments regarding IT integration technologies. These have evolved from interfacing modules of a computer program to coupling of entire organizations with one another (known as B2B)—See Figure 1. As might be expected, successive generations of integration technologies have become increasingly complex as the scope is continuously expanding.

Table 1: Evolution of IT Integration

Time Frame	Dominant Integration Technology Strategy
Before mid 1960s	Programmed interface between autonomous applications and data silos
Mid 1960s	Shared databases especially relational database
1970s	EDI—interfaces among separate businesses
Late 1980s	ERP—A set of integrated applications that use a single database
1990s	Middleware—allows information sharing among heterogeneous databases & applications
1990s	XML—Standard language for use in sharing information over the web among heterogeneous databases and applications especially between different firms
Mid 1990s	EAI—Integration among ERP, Legacy Systems, and web applications

"Computers were already integrating work in enterprises long before any social scientists became aware of it. For 40 years, experts and industrialists have been striving to integrate the various functions of the enterprise…by using computers and other electronic means" (Alsene 1994, p. 657 citing Diebold 1952). The initial idea was to create a single,

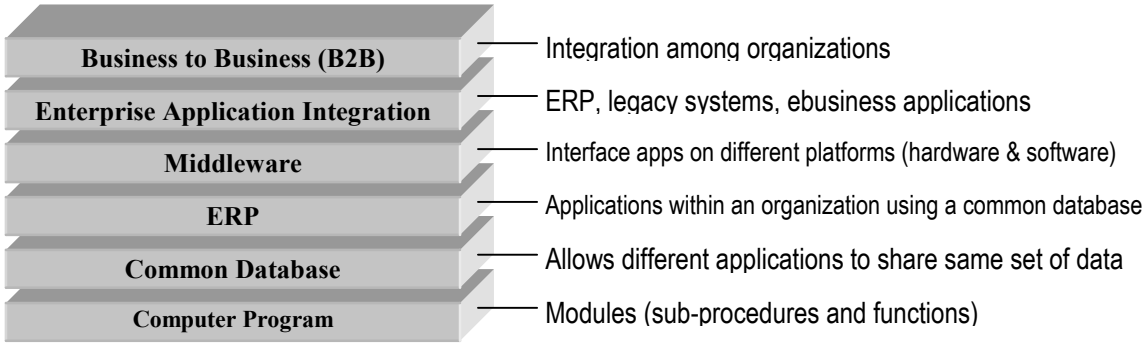

Figure 1: Integration Developments and Hierarchy

total integrated system for an enterprise (Gordon 1960; Blumenthal 1969). The next major school of thought was to achieve enterprise integration by having all programs "feed" off a single, centralized database for the entire organization (Diebold 1965).

Benjamin and Blount predicted, "The 1980s will be a decade of integrating applications across functions" (1980, p. 8). In the 1990s, SAP, Oracle, Baan, PeopleSoft, and others created Enterprise Resource Planning (ERP) software in an attempt to integrate all departments and functions within a company into a single computer system (Somers & Nelson 2001). Enterprise applications integration (EAI) appears to be the next logical progression (Biggs 1999). Practitioners have continuously strived to achieve integration. According to Kalakota and Whinston (1993 p. vp), the challenge of the 90s was:

1. To integrate information systems…to form a cohesive unit capable of delivering quality, and innovative customer satisfaction
2. To tie computing and communication resources into an integrated enterprise
3. To design computing processes…to ensure flexible organizations which can adapt to changes in the business environment

Repeatedly, one sees that integration is an important topic—the merits are discussed, predictions are made, and challenges offered. Conspicuously absent is an explicit discussion of what it means to be integrated, how to measure integration, and what benefits can be tied directly to integration. What is apparent from the literature (academic and practitioner) is that, during the past four decades, we have not been able to fully achieve the promise and dream of applications integration.

Defining Integration

A closer look at the concept of integration reveals not clarity but a tangled mess. Generally, the concept of integration is offered without definition; its value and the source of

its value are generally unexamined. This situation becomes even more complex when placed in the context of enterprise systems due to their large scale and scope. Bhatt (1995) proposed that integration for ES is "the extent various information systems are formally linked for sharing of consistent information within an enterprise."

Bhatt's definition provides a starting place to measure ES integration in a post-implementation snapshot for a single system. It isn't clear how this construct would help firms determine the extent to which integration would be valuable for their firm, or to compare alternative systems, or to evaluate the benefit of various design scenarios. While the merits and nature of integration are implicit in most ES articles, the attributes and specific benefits are not tied directly to integration. Integration is a huge subject and includes applications, computer programs, processes, and data to name but a few examples. This research focuses on the role of integration in the context of enterprise applications.

Fundamentally, most would agree that integration means working together. This simple idea, while accurate, fails to capture the complexity of integration which includes, among other things, the environment or domain. For this research, "Applications Integration" is defined as:

> "the infrastructure that results from the combination of all necessary components within a specified domain where all components work together by sharing data without any perceptible delay and coordinate functionality such that the combination of components appear as a single system to users."

Information Technology Infrastructures

Integration and infrastructure have much in common. An infrastructure is a set of related components that are implied to "work together" such as a highway system infrastructure. Thus, it is not surprising to see the relatively new term, Integration Infrastructure, emerging. However, the term infrastructure is ubiquitous, much like

integration, in the sense that both are generic terms employed to refer to a wide array of endeavors and concepts. A search of Google on April 6, 2003, returned 6,800 references to "integration infrastructure". Most of the 6,800 references referred to middleware for applications integration, software vendors and software products, and methodologies to accomplish tasks e.g. engineering, software development, CIM, and etc.

IT infrastructures have gained much research attention during the past two decades (Brown and Magill 1994; Lee et al. 1995; Richardson et al. 1990; Brown 1999; Allen and Boynton 1991; Niederman et al. 1991; El Sawy et al. 1999; Broadbent and Weill 1997; Cross et al. 1997; Bharadwaj 2000; Taudes 2000; Orlikowski and Barley 2001; Shaw 2000; Dejnaronk and Tadisina 2000). An IT infrastructure is "A base of shared technological, human, and organizational capabilities that provide the foundation for computer-based business application systems in the form of services to users" (Dejnaronk and Tadisina 2000). Niederman et al. (1991) found that IT Infrastructure first became a key issue for practitioners in 1987.

As mentioned above, the term "infrastructure" is a common term used frequently to describe a variety of structures, and systems, although unfortunately, not very precisely. In general, an infrastructure is defined as:

1. An underlying base or foundation especially for an organization or system.[2]
2. The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water

[2] Usage Note: The term infrastructure has been used since 1927 to refer collectively to the roads, bridges, rail lines, and similar public works that are required for an industrial economy, or a portion of it, to function. The term also has had specific application to the permanent military installations necessary for the defense of a country. Perhaps because of the word's technical sound, people now use infrastructure to refer to any substructure or underlying system. Big corporations are said to have their own financial infrastructure of smaller businesses, for example, and political organizations to have their infrastructure of groups, committees, and admirers.

and power lines, and public institutions including schools, post offices, and prisons.

Source: The American Heritage® Dictionary (2000)

Common infrastructures include utilities (electrical, communications, water, etc), educational, governments, military, and agriculture. We can classify these as societal infrastructures, which differ from organizational and industry infrastructures. Organizations depend on a number of external infrastructures like supply chains and distribution networks plus many of the previously mentioned societal ones. While IT infrastructures are the focus of this paper, it is important to remember that they do not exist in a vacuum and therefore typically depend upon and interact with many other infrastructures found in the organization, industry, and society.

Not long ago, the IT profession was concerned with integrating islands of information. Then the focus shifted to integration of applications to form enterprise systems. A major challenge of the new millennium is the integration of several infrastructures that have emerged as technology has rapidly advanced during the past several decades. Beginning in the 1990s, the emphasis of senior IS professionals shifted to architecting and infrastructure (Cross et al. 1997). Information technology infrastructures have been the focus of much research during the past two decades. The focus of this dissertation is applications integration for enterprise systems which is viewed in this research as the applications infrastructure of enterprise systems.

The literature contains references to a variety of infrastructures for IT including information, network, database, organizational, hardware, software, and enterprise systems. In some cases, most, if not all of the infrastructures, fall under the IT infrastructure umbrella. Broadbent et al. (1996) and others have described infrastructures for: (1) Application

Development, (2) Communications Technology, (3) Database and Security, (4) Technical Support, and (5) Web Technologies. Included in these categories are hardware, software, and human-centered activities. Each represent an integrated set of components that work together to form the infrastructure. Antecedents to integration infrastructures are the separate IT infrastructures. Integration is responsible for the cohesion and interaction among components of an infrastructure allowing the various components to work together.

Regardless of the infrastructure categories or the number of categories, it appears reasonable that integration of the infrastructures is required to maximize the full potential of the individual infrastructures. In other words, a synergy of infrastructures will yield benefits greater than the sum of the individual infrastructures. This research suggests that an integration infrastructure is the "glue" that holds all of the various IT infrastructures together to create the desired synergy thereby facilitating the coordination among the infrastructures which allows them to work together. This idea is similar to the alignment of IT infrastructures with the organization as suggested and researched by Brown and Magill (1994), Lee et al. (1995), and others.

One indicator of IT infrastructure importance is the magnitude of the investments that firms have been willing to make. For instance, the costs of an IT infrastructure can exceed 50% of the total IT budget in large companies (Broadbent and Weil 1997). This seems perfectly reasonable since "Increasingly, infrastructure is viewed as the enduring IT resource…" (Cross et al. 1997).

"IT infrastructure is defined as the shared IT capabilities that support information flow in an organization" (Shaw 2000). IT infrastructure consists of IT services, human IT infrastructure, and other IT infrastructure components (Broadbent, et al. 1996). IT infrastructures must be well integrated into the overall infrastructure of the organization for

the true benefits to be realized. "Aligning IS solutions with business goals and needs as well as building the infrastructure for technological integration are becoming the top priorities for IS activities" (Lee 1995 p. 332). Thus, we see the need to integrate the various infrastructures necessary for an effective IT operation to support the needs of an organization.

Different approaches to IT infrastructure implementation have been found. Investments in IS infrastructure often take the form of "corporate-wide networks, central data collections, common business practices, common application systems, and standardized hardware, operating systems, and databases" (Allen and Boynton 1991, p. 440).

In a 1994-1995 study, IT infrastructure was ranked as the most important key issue in MIS (Brancheau et al. 1996). Dejnaronk and Tadisina (2000) suggest that inadequate infrastructures are a major cause of IS failures for organizations that depend on computer systems. "An IT infrastructure is integral to the transformation of enterprise architecture to suit the needs of the electronic economy" (El Sawy et al. 1999). However, IT infrastructures are only one of several infrastructures that must be effectively integrated for companies to prosper or even survive in an increasingly global economy. This dissertation suggests one way to view and evaluate the integration of the requisite IT infrastructures needed by organizations.

Integration Limits and the Downside

The a priori belief was that integration is always beneficial. In an effort to guard against this bias, the research also looked at the potential of downsides to integration although no significant ones were anticipated. Both the literature and this research failed to support the a priori expectation. "The value of [an ERP system] is that it is totally integrated; and the downside of [an ERP system] is that it is totally integrated" (Strong et al. 2001 citing

Filipczak 1997, p. 1049). Contrary to popular belief, integration may not always be desirable or deemed practical for a variety of reasons including complexity, turbulent business environment, and rapid technological changes. Some of these references argue against seeking a high degree of integration citing a variety of reasons (Hecht 1997; Sasovova et al. 2001). Some seem to think that full integration may not be possible (Dearden 1972 cited in Markus & Tanis 1999, p. 173).

> "The notion that a company can and ought to have an expert (or group of experts) create for it a single, completely integrated supersystem—an "MIS"––to help it govern every aspect of its activity is absurd."

Others echo Dearden's sentiment that the demands imposed by integration might be too great in some circumstances (Sasovova et al. 2001; Goodhue, et al. 1992). Consequently, it appears reasonable that we need to know more about the specific nature and benefits of integration in order to intelligently evaluate various integration strategies and arrive at prudent decisions.

Enterprise Systems Literature

Much of the literature regarding enterprise systems is about ERP or EAI (enterprise application integration). Several authors have lamented the lack of empirical research for enterprise systems. The available literature does not explicitly address integration or the associated benefits. Yet, from the literature, a number of integration attributes and ascribed benefits of enterprise systems can be found. Integration appears to be intimately related to the success of enterprise systems and is therefore considered a critical success factor. Most of the available literature about EAI and ERP is found in books and practitioner articles. Until recently, only a few refereed academic articles were available. Examples of ERP literature include Boudreau and Robey (1999) who proposed theoretical choices for process

research for ERP and Brown and Vessey (1999) who proposed a contingency framework for ERP implementations.

Case studies are a popular research methodology, which describe successes and failures of ERP projects (Clemons 1998; Puschmann, et al. 2001; Themistocleous and Irani 2002). Popular books about enterprise systems have been written by David Linthicum (1999); Ruh, et al. (2000); and Thomas Davenport (2000). Much of the available literature is either descriptive or prescriptive in nature. Most enterprise systems literature is not directly related to this research. However, most of the literature does contain implicit knowledge about perceived benefits and integration attributes that bear on this research.

CHAPTER 3 – THE CONCEPTUAL MODEL FOUNDATION

This chapter describes three models. The discussion begins with the big picture by discussing a comprehensive model of integration in terms of an integration infrastructure which has been named the Information Technology Integration Infrastructure Model. This is followed by a description of the conceptual model and ideas that guided this research. The third model is an expanded version of the conceptual model that resulted from the qualitative research phase described in Chapters 5 and 6. The components of the models are described. However, the foundation for the theory and comprehensive model are discussed first.

Proposed Integration Theory

"Nothing is quite so practical as a good theory" (Van de Ven 1989, p. 486 quoting Lewin 1945). Van de Ven goes on to write, "Good theory is practical…because it advances knowledge…[and] guides research…" There appears to be a general lack of theory about IT integration and infrastructures, especially IT integration infrastructures. The proposed IT integration infrastructures theory is still very much in the theorizing stage and this dissertation represents only a small step in validating the theory. Nonetheless, it appears that the proposal meets many of the tests of theorizing as suggested by Karl Weick (1995, p. 398) who writes, "The process of theorizing consists of activities like abstracting, generalizing, relating, selecting, explaining, synthesizing, and idealizing." The next section describes the model's elements and relationships that are important for organizations that create IT integration infrastructures.

Model 1: Information Technology Integration Infrastructure Model

"A theory is the attempt by man to model some aspect of the empirical world" (Dubin 1976, p. 26). The proposed theory attempts to model integration infrastructures so that we

can better understand these artificially created mechanisms. IT integration is defined in terms of specific constructs and is the basis of perceptions about integration which directly lead to integration decisions. Integration decisions are responsible for the integration infrastructures that are created. Key motivators also determine decisions. The decisions determine costs and success. A number of environmental issues moderate benefits, decisions, costs, and outcomes. Several stimuli moderate decisions and directly affect motivation. Although not shown in the model, it appears reasonable that certain environmental factors may affect motivation. Finally, there is both a direct and indirect effect between integration attributes and the integration infrastructure.

Information technology integration can be thought of as a super infrastructure—an IT integration infrastructure. This is one of the lenses drawn upon to discuss IT integration. Figure 2 provides a visual model of an ideal unified integration infrastructure. The graphic depicts nine infrastructures that are coordinated and held together by a tenth infrastructure – the integration infrastructure. All the infrastructures exist within a specific domain and are

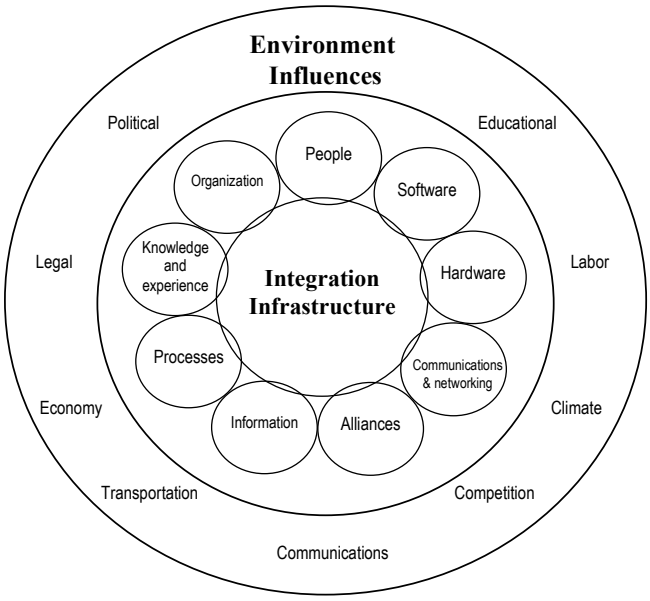

Figure 2: Visualizing an Integration Infrastructure

subject to numerous external and internal environmental influences and pressures. This section describes only the IT components for the infrastructures of an ideal model. The model attempts to represent the various IT infrastructures depicted in Figure 2 along with the relationships between them. Since this is not the primary research model, only a parsimonious description of the model's constructs and relationships are given. Later, a more comprehensive description is given for those components related to this research.

The integration infrastructure theory is described in terms of a graphical model (Figure 3) in order to convey the constructs' antecedents and relationships. At this point, the ideas are more precisely reflected in the proposed model than in a theoretical statement. Besides, there is some debate regarding the relationship between models and theory although most seem to agree that there is a fine line or no line at all between theory and models (Sutton and Staw 1995; Weick 1995; Whetten 1989; Dubin 1976). Even though we have limited data to validate the proposed theory, this concern is eased by Whetten who says, "During the theory development process, logic replaces data as the basis for evaluation" (1989, p. 491).

The contribution of this part of the dissertation is a proposed model that represents the antecedents, components, and relationships of an integration infrastructure. Additionally, an expanded view of IT alignment is described based on past literature. The theory posits that

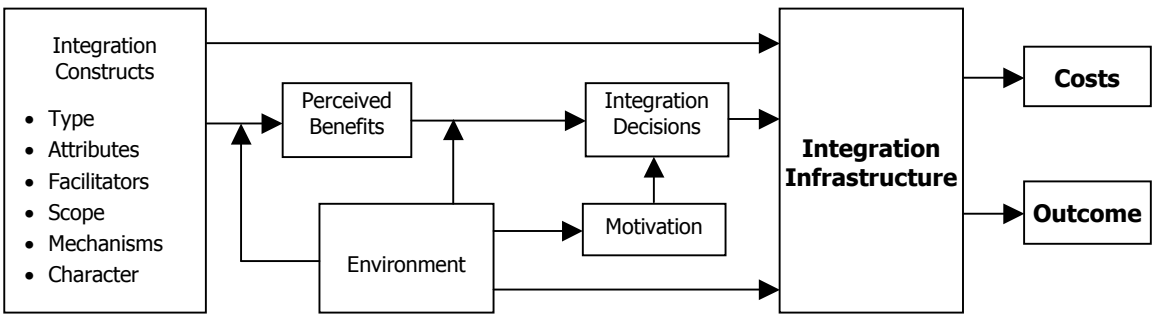

Figure 3: Information Technology Integration Infrastructure Model

(1) there are more IT infrastructures than has been previously discussed in the literature, (2) The need to integrate IT infrastructures is similar to past efforts to integrate islands of data, and (3) The scope of infrastructure integration (alignment) should be greater than previously called for. This dissertation research supports the views of other authors that integration is an ill-defined topic and is not well understood by practice.

Constructs

Each construct is briefly described below along with examples for the construct.

Type

Type refers to a specific IT domain and is typically called an IT infrastructure or infrastructure component. When a discussion of integration is undertaken without specifying the domain, invariably someone asks the question, "What type of integration are you talking about?" Example integration types are data, process, application, platform (hardware & software), and communications. The small circles in Figure 2 depict the infrastructure types.

Attributes

Attributes are the properties that characterize the relationships among integrated components. Example attributes of applications integration include: data sharing, real-time, and seamless. A combination of attributes is generally required to define integration. Data sharing, however, occurs in a number of ways during a variety of time periods. For example, you could share data once a month using paper printouts but doubt this would satisfy integration envisioned by most people.

Facilitators

Facilitators are those things that make integration possible or easier. Examples are software (OS & utilities), communication networks, common database, and standards (industry and firm-specific).

Scope

Scope specifies how much integration, as well as, what it is we wish to integrate. We can also think of scope as the amount of integration and the form that it takes. Examples include: internal (organizational, divisional, departmental), external (customers, suppliers, government, competitors, alliances, industry organizations, the public), and geographic area.

Mechanisms

Mechanisms refer to the strategy and technology employed to achieve integration. We can think of these as alternatives. Examples are: coupling intensity (e.g. continuum from loosely to tightly), component ware, packaged enterprise systems, and database tools.

Character

Character describes the overall operational characteristics of integration. Examples: functionality, flexibility, configurability, performance (efficiency), ease-of-use, human-computer interface, scalability, and maintainability.

Perceived Benefits

Perceived Benefits are the outcomes associated with integration that are valued by individuals. Benefits are different from reasons although the two are often the same. Examples: customer service, competitive advantage, lower costs, functionality, multi-country needs (e.g. accounting standards), scalability, and expanded capacity.

Integration Decisions

Integration Decisions are the choices made to create a specific integration infrastructure.

Environmental

Environmental is the setting and associated influences that directly affect perceptions, decisions, operations, and outcomes. Examples: political and legal (government); cultural

and language (includes religion); knowledge (organization, stakeholders, community); geographic (implies a variety of societal infrastructures like transportation, education, and communications), and economic. Environmental influences and pressures are shown in the other ring of Figure 2.

Motivation

Motivation represents the incentives that trigger and provide the impetus for integration infrastructure projects. These include: perceived need, competition, opportunity, available technology, and pressures (vendors, stakeholders, trends, etc.). Motivation is affected by competition, the economy, budgets, stakeholders, current IT infrastructures, security, and management (style, experience, orientation, knowledge).

Integration Infrastructure

Integration Infrastructure is the set of enabling mechanisms chosen to facilitate coordination among IT components and between IT and all areas of the organization, as well as, the external interfaces to customers, governments, and other organizations. These include standards, policies, procedures, platforms, and guidelines.

Costs

Costs are the actual direct and indirect expenditures of money, time, and other resources to create or modify the integration infrastructure.

Outcome

Outcome is the IT services that are enabled, created, or acquired as a direct result of integration infrastructure decisions. The results can range from total failure to 100% success.

Relationships

The six integration constructs (type, attributes, facilitators, scope, mechanisms, and character) define integration. While these six constructs are undoubtedly related, the

relationships are not considered in the proposed model because they do not appear to bear directly on the primary purpose of the theory.

As discussed in greater detail later, perceptions are based on attributes and attitudes (Fishbein and Ajzen 1975; Ajzen 1991). Stimuli and environmental factors are phenomenon that, in large part, account for a person's attitude toward integration. Decisions result from motivation pressures (e.g. perceived need) and are based on perceived benefits and anticipated outcomes. However, decisions are greatly influenced by a variety of things that include stimuli (e.g. budget, IT infrastructure) and environmental realities (e.g. knowledge, cultural implications). Actual cost and success are directly linked to specific decisions and are influenced by a variety of environmental factors including knowledge and economic realities of the region and the organization.

Model 2: Conceptual Research Model

Figure 4 is the research model proposed for this study. Integration attributes are thought to be associated with perceived benefits. Stakeholder groups appear to moderate perceptions of integration attributes and benefits. The amount of integration is directly related to a set of manifest variables shown in Figure 4 as "degree of integration". The model is described in greater detail below. The description is divided into two parts. The

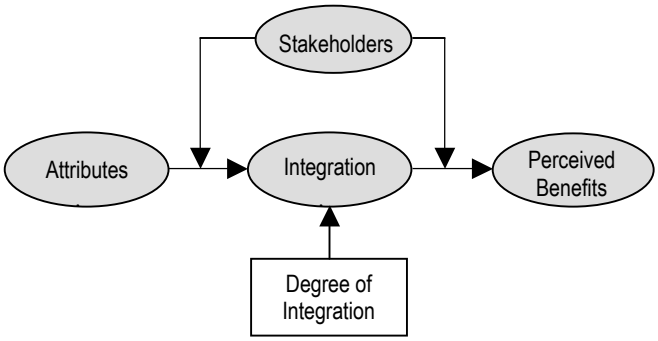

Figure 4: Conceptual Model Guiding Research

first gives a summary of each of the model's components. The next section provides much greater detail for each of the components.

Summary of Model 2 Components

Attributes

Integration attributes (IA) define what integration "is" and are the properties that characterize how IT components interact. Distinct IAs (such as data sharing and real-time) are discussed in the literature. Example IAs are application data sharing, real-time processing, and seamless. See Table 2 for examples of other attributes.

Perceived Benefits

Perceived benefits (PB) are the outcomes valued by people and organizations. Examples of PB are improved customer service, replacement of aging legacy systems, and increased functionality. Table 5 lists additional perceived benefits. Stakeholders are thought to change the perception of benefits. Intuitively, it seems that individuals who are members of one group will differ from those of another group in terms of how they perceive integration benefits. In comparing end-users to IT professionals, it is likely that each will ascribe different benefits to integration.

Stakeholder Groups

Three stakeholder groups are being considered: end-users, IT professionals, and management. The groups differ in many respects—these differences are called characteristics. Characteristics include education and training, type of responsibility, technical knowledge, objectives, and role in the organization. For instance, end-users may be interested in those things that make doing their job (specifics tasks) easier. Management may care about the tasks performed, but are primarily interested in how all the people within their

division work together to achieve objectives. IT professionals tend to concentrate on how well the software function as designed.

Degree of Integration

Degree of integration was operationalized based on a concept borrowed from marketing, which is user satisfaction. This was an attempt to operationalize applications integration at a global level.

Relationship Among Constructs

It is thought that given subsets of attributes define applications integration. Stakeholders have perceptions about the benefits of integration. Perceived benefits are thought to be the basis for decisions regarding applications integration for enterprise systems. Integrations decisions are believed to be one of the ERP success factors.

Model 2 Details

The details for model 2 are based on the literature review. The attributes and benefits that follow are those that were inferred by the literature since, in most cases, they were not implicitly declared. The subsequent research confirmed many of the attributes and benefits but not all. One plausible explanation is that this research was conducted based on the perceptions of practitioners while the literature may be more theoretically based. Lack of support for a particular attribute or benefit does not necessarily mean it is not valid.

Integration Attributes

Recall that attributes define what integration "is". Table 2 contains several implicit integration attributes identified in the literature along with the sources. Example integration attributes include data sharing, connections, and real-time. These attributes explain specifically how applications are integrated. Integration Attribute is defined as "the properties that characterize the relationships among the components to be integrated."

Attributes define integration at a very basic level. Examples include data sharing, seamless, and real-time. If some aspect of integration can be viewed as both a characteristic of integration and as a benefit, then it should be categorized as an attribute.

Before delving into the details of the integration attributes that have been identified from the literature, it would be beneficial to briefly describe selected attributes. Data sharing is an implicit part of nearly every discussion of integration. Applications integration is defined as "unrestricted sharing of information between two or more enterprise applications" (Linthicum 1999). A connection involves establishing a link between applications. There are different types of connections but each has a common objective, which is to permit sharing of information among applications. EWS [enterprise wide systems] package developers pride themselves on the dense set of interconnections that these packages claim to manage (Sor 1999). Real-time interaction implies non-delayed interactions (such as data sharing) among application components. This is in direct contrast to batch processing. Real-time processing is an attribute that apparently has desired benefits. The above examples of integration, along with several others, are described in the following pages.

Data Sharing

Data sharing is an implicit part of nearly every discussion of integration. Thus, we can consider data sharing a fundamental characteristic of integration. Lack of integration means we cannot share information (Kalakota & Whinston 1993). Today, XML is one

Table 2: Example Integration Attributes

Integration Attribute	Source
Data sharing	Linthicum 1999; Kalakota & Whinston 1993; Bhatt 1995
Connections	Sor 1999; Bhatt 1995; Alsene 1994
Real-time processing	Margulius 2002; Shanley et al. 1999
Common database	Cadarette & Durward 2002; Veth 1998; Bhatt 1995
Seamless operation	McGuire 1999; Clemons 1998; Davenport 1998
Interface	Zimmerman 1969; Alsene 1994

proposed solution for sharing data among dissimilar databases (Sullivan, 2000). Data sharing is different from data integration. C. J. Date, a database authority, says that [data] integration is the "…unification of otherwise distinct data files, with any redundancy…wholly or partially removed" (1995, p. 6). From an organizational point of view, data integration refers to common field definitions and codes within an organization (Goodhue, et al 1992). For our purposes, data sharing is the use of the "integrated" data among applications.

Connections

Connections allow applications to "talk" or communicate with each another. There are different types of connections but each has a common objective, which is to permit sharing of information among applications. Fundamentally, a connection is establishing an association between applications. Thirty years ago, Harrington (1973) says, "…Another concept of computerized integration emerged [which]… aimed at linking the numerous 'islands' of computerization which had appeared in…the enterprise" (cited in Alsene 1994, p. 658). The brackets are by Alsene. Bhatt (1995) views connectivity in the context of communication networking and flexibility. The density of interconnections among application components of ES is often a major objective and source of pride for developers (Sor 1999). Connections have traditionally been viewed in the context of cohesion and coupling (see Interface section below). Coupling, and hence connections, can be placed on a scale from loosely coupled to tightly coupled. So can integration.

Real-Time Processing

Real-time implies non-delayed interactions (such as data sharing) among application components. This is in direct contrast to batch processing. Real-time processing is an attribute that has desired benefits. "The ideal setup [for chemical process industries] would integrate business and manufacturing in real time…" (Shanley et al. 1999, p. 76I).

Seamless Operation

This is a frequently encountered term although definitions appear lacking. Davenport tells us that ERP promises "seamless integration of all information flowing through a company" (1998, p.121). Seamless is often reported as a desirable characteristic (McGuire 1999; Clemons 1998; Davenport 1998). For this research, seamless means that users discern little if any break in the handling of their interactions even when crossing business functions.

Interface

Many of today's IT practitioners were trained in structured programming tenets which characterized integration at one end of a continuum (with interfacing at the other end) in which the risk and cost of integration (high coupling/low cohesion) is contrasted with the value of interfacing (low coupling/high cohesion) (Hoffer et al. 1999). Interfacing is the way that integration is often achieved. It is related to connections although there are subtle differences. "It would seem obvious that…integration by interface is not the same as integration through a common data base…" even though both "have similar effects on the overall organization of work" (Alsene 1994 p. 671-672). Traditionally, we have associated interfacing with loosely coupled and integration with tightly coupled. Today, we see terms like "interface integration". This seemingly distorted term is likely the outgrowth of the vagueness that surrounds integration both in practice and in academia.

Interfaces have been a strategy of integration for several decades and its origin can be traced to separately programmed and tested functions (Zimmerman 1969). Linthicum (1999) discusses interfaced-based technologies to achieve application integration. Alsene (1994) says interfaces between systems or common databases increase the degree of integration.

Interfacing, like integration, has become a fuzzy notion. For instance, integrating disparate applications requires some form of interfacing. "Process centric integration deals

with the automation of business processes by integrating functionality from disparate applications" (Themistocleous and Irani 2002, p. vp). Here again, we find caution about the downside of various types of integration. "The tight integration of all processes in an EWS [enterprise wide systems] package reminds one of the butterfly effect as discussed in relation to Chaos theory" (Sor 1999, p. 229).[3]

Coordination

Coordination appears to be a fundamental, yet imprecise characteristic of integration. "…computerized integration is a substitute for traditional coordination mechanisms (Alsene 1994, p. 673). Coordination involves timing, events, and communication. A simple example should help illustrate the coordination concept. A customer makes a purchase on the web. This e-business application transaction triggers a process to assemble the order, package it, mail it, and adjust the necessary data records (accounts receivable, revenue, inventory, etc.). This illustrates that coordination of distinct processes and data sets is required.

Common Database

It is unclear if a common database is an attribute or a facilitator of integration. A common database is the technique originally conceived to achieve integration. This idea may still be valid and the most likely vehicle to attain "true" integration. However, as previously mentioned, some wonder if a single, centralized database is even possible or practical (Dearden 1972; Cadarette & Durward 2002). Perhaps, a single physical database may not be practical. However, a logical database that defines the relationship among several physical databases does seem practical. For years, computer science researchers have investigated semantic databases that are one possible solution to integrate disparate databases.

[3] Sor was referring to Gleick: "…a butterfly stirring the air in Peking today can transform (into) storm systems next month in New York" (1987, p 8).

Perceived Benefits

No literature could be found that attempted to measure integration or perceived benefits although both are frequently discussed. User perceptions have been important in several streams of research. Use of perceptions is a frequent means to gain the cognition of participants regarding the subject matter under investigation. Perceived usefulness and perceived ease of use from TAM (Davis 1986, 1989) and TAM2 (Venkatesh & Davis 2000) are probably the best known uses of perception in MIS. Several disciplines (Table 3) employ perceptions to establish relationships between benefits and beliefs. Examples of perceived benefits found in the IS/IT literature that relate to this research are listed in Table 5.

Decisions are based on Perceptions

As previously discussed, perceptions are grounded in research that produced the Theory of Planned Behavior (TPB) (Fishbein and Ajzen 1975; Ajzen 1991). TPB established relationships between beliefs, attitudes, intentions, and behaviors. "According to the theory, human behavior is guided by three kinds of...beliefs..." (Ajzen 2001, p. vp). Beliefs and attitudes go hand-in-hand. They are learned predispositions to respond in a given manner with respect to some object. Furthermore, they include effect and evaluation. We place an object on an evaluative continuum from good to bad when forming a belief (an attitude). People base perceptions on beliefs and attitudes. Decisions (our learned predispositions to respond in a given manner) are outcomes of our perceptions.

Table 3: Selected Literature Employing Perceived Benefits

Accounting	McGowan, Annie S 1998; Gramling, Audrey A. 1997; Lipe, Marlys Gascho 1993
Decision Science	Guimaraes, et, al. 1992
Management	Holt, Diane 1998; Kaufmann, et al. 1995
Marketing	Higgins, Kevin T. 1998
MIS	Iacovou, Charalambos L. 1995
Oper. Management	Murphy, P. 1996; Ghobadian, A. 1994; Armistead, C. G 1993; Freeland, J. R. 1991
Other	Blumenfeld, Tracy Harmon 1998; Staniforth, David 1995; Cox, Clifford T. 1991

Perceptions are the foundation for decisions. This idea has been heavily researched in marketing (Muthitacharoen & Palvia 2001). The foundation of preferential choice is attributes and attitudes. Individuals employ their general feeling to make choices for attitude-based preference. Attribute-based preference occurs when individuals compare their alternatives. It is unclear how people make integration decisions but it is reasonable to believe that people make choices based on perceptions. Attitudes towards integration coupled with the attributes of integrations should explain why individuals make integration decisions.

Perceived Benefits Definition

Perceived Benefits are defined as the outcomes associated with integration, which are valued by individuals and organizations. Examples: customer service, competitive advantage, lower costs, functionality, multi-country needs (e.g. accounting standards), scalability, expanded capacity, and facilitating operational change. At first, it may appear difficult to distinguish attributes from benefits since many attributes can also be thought of as benefits. The distinction is based on pre-existing requirements. A couple of examples should make the distinction clearer.

1. "Integration permits all users [or applications] to use the same data." This implies the data sharing attribute.
2. "Integration makes it possible for everyone to work together more effectively." This implies coordination among applications and is an attribute.

One might argue that both of the above examples imply benefits since they refer to a situation AFTER an integrated system is implemented. Thus, you could be tempted to classify these as "operational improvement" benefits. Yet, these are clearly defining characteristics of integration that must exist before implementation—They help describe the

behavior of the system. Additionally, the pre-existing nature makes the benefits possible. Therefore, the way to look at this is to ask, is the concept an inherent characteristic of integration or is it the result of integration? If it can be reasoned that the concept is a characteristic then it should be classified as an attribute even though it may also be a benefit. In contrast, lower cost is clearly a result (benefit) of integration. It should be obvious that lower cost does not define how components of a system work together. The same is true for improved customer service.

Reasons to Integrate

It is easy to confuse perceived benefits (Table 5) with reasons for adopting an ES (Table 4). In many cases, they are the same, but not always. A firm may implement an ES to replace hard-to-maintain interfaces. At best, this is an indirect reason whereas decreasing computer operating costs is a more tangible, direct benefit.

Details of Perceived Benefits

The benefits described below were found in the literature. As will be clear later, this group of benefits proved inadequate when the qualitative data was collected and analyzed.

Table 4: Reasons for Adopting Enterprise Systems

Technical Reasons	Business Reasons
• Consolidate multiple, different systems of the same type (e.g., general ledger packages) • Integrate applications cross-functionally • Replace hard-to-maintain interfaces • Reduce software maintenance burden by outsourcing • Eliminate redundant data entry and concomitant errors and difficulty analyzing data • Improve IT architecture • Ease technology capacity constraints • Decrease computer operating costs	• Accommodate business growth • Acquire multi-language and multi-currency IT support • Improve informal and/or inefficient business processes • Clean up data and records through standardization • Reduce business operating and administrative expenses • Reduce inventory carrying costs and stockouts • Eliminate delays and errors in filling customers orders • Provide integrated IT support for merged businesses • Standardize numbering, naming and coding schemes • Standardize procedures across locations • Present a single face-to-the customer • Acquire worldwide “available to promise” capability • Streamline financial consolidations • Improve company-wide decision support

Source: Markus & Tanis 1999

Table 5: Examples of Perceived Benefits in Integrated Enterprise Systems

Perceived Benefits	Source
Lower Cost	Herr 1996; Markus & Tanis 1999; Ross 1998
Customer service	Markus & Tanis 1999
Competitive Advantage	Markus & Tanis 1999
Expanded capacity	Davenport 2000, Markus & Tanis 1999
Operational improvements	Herr 1996
Facilitate organizational change	Boudreau & Robey 1999
Less Maintenance	Kelley et al. 1999
Replace Legacy Systems	Markus & Tanis1999; Boudreau & Robey 1999
Acquire multi-language and multi-currency IT support	Markus & Tanis 1999

Lower Cost

Cost saving is among the six reasons listed by Ross (1998). Organizations that implement enterprise systems achieve lower cost several ways. These include reducing the number of employees required, improving operational efficiency, and reducing or eliminating the cost to maintain mainframes and aging legacy systems.

Customer Service

Enterprise systems allow large companies to present one face to the customer by knowing if finished goods inventory or planned production capacity is available to promise (Markus and Tanis 1999). Davenport (2000) reports how AutoDesk (a supplier of CAD software) was able to reduce cycle time from 2 weeks to 24 hours. DOW Chemical, EIF, and Atochem implemented an ES to improve customer services (Davenport 2000).

Competitive Advantage

As stated above several strategies are available to achieve competitive advantage including improved customer service. In general, "ERP systems have been strongly promoted promising improved competitiveness…" (Huang et al. 2001, p. 1137).

Expanded Capability

Bay Networks desired an ES solution because their current aging legacy systems were seen as a barrier to growth (Davenport 2000). Firms seek a wide array of new abilities not

easily available to them because of aging legacy systems, lack of expertise, and time constraints. Acquiring e-business solutions, ABC accounting capabilities, and multi-language support are among the most commonly cited desired abilities. Markus and Tanis (1999) list increased systems capacity to handle growth as a desired benefit.

Operational Improvements

Benefits of integration are: economies of scale for purchasing, improved order entry (reduced redundancies and simplified data entry procedures), staff reduction potential, increased productivity, increased accuracy, and improved assessment of cost and customer service (Herr 1996). Operational improvements sought also include best practices, customer services, efficiencies, and added capabilities.

Organizational Change

"Many companies are attracted to ERP because it implies fundamental organizational changes (Boudreau & Robey 1999, p. 291). Often ES implementations have been associated with business process reengineering (BPI) and ERPs have been used to facilitate BPI.

Less Maintenance

Aging legacy systems are increasingly difficulty to maintain. Legacy systems are typically written in older languages like Cobol and RPG for which it is difficult to find employees with the necessary skills to maintain the code. Legacy systems often run on a variety of costly mainframe platforms (with varying operating systems) making integration extremely difficult and expensive. "Eventually an organization will reach the stage where it becomes almost impossible to enhance the existing systems further because they are too slow and uneconomic" (Oliver & Romm 2000, p.1040 quoting Kelley et al. 1999).

Replace Legacy Systems

ERP helps solve maintenance headaches associated with aging legacy systems (Markus and Tanis 1999). "ERP permits a company to replace mission-critical legacy systems—notorious for their age, size, complexity, inflexibility, and fragmentation—with fully integrated systems" (Boudreau & Robey 1999, p. 291).

Acquire Multilanguage Support

Doing business internationally usually requires an ES that supports multiple human languages. The ES must also handle several different currencies, governmental regulations, and accounting standards and practices. Because of the complexity and lack of expertise, modification of legacy systems to accommodate international capabilities is probably not practical for the vast majority of global firms. However, a truly integrated, enterprise-wide system requires multi-country support for global firms.

Stakeholders

Inclusion of stakeholders as a moderating variable is consistent with the arguments by some who recommend consideration of the influence of MIS agents on relationships (Lee et al. 1997). Consideration of stakeholder influences is an important consideration for the adoption and use of IS/IT technology. The stakeholders of interest are: End-users, Managers, and IT professionals. It is thought that the perceptions of benefits of integration vary by stakeholder because of the differing roles of the stakeholder groups within the organization. Differences among stakeholders are well established in several disciplines including IT.

> "Perceived Issues and Enacted Dialogue for Stakeholders: Within any organization, each critical actor will develop positive, negative, or neutral representations of the issue involved in the ERP implementations…" (Besson and Rowe 2001, p. 49).

Stakeholder theory has its origins in law although it is routinely applied in economics, management, and business ethics. See Donaldson and Preston (1995), and Freeman and Reed (1983) for more information.

Stakeholder groups have been important in explaining varying behavior in ethics research. Table 6 lists characteristics that delineate stakeholder groups in IS/IT. For this research, no reason could be seen to formally classify individuals into one of the three stakeholder groups based on traditional stakeholder characteristics. The primary interest is with differences in perception among groups rather than why people belong to the group. Admittedly, it may be necessary to reexamine this position at some future point as more is learned about stakeholder perceptions of integration on the success of enterprise systems.

Expanded Conceptual Model

The initial research model underwent a major change due to the outcome of the first phase of the research. The two changes were:

- The integration attributes and benefits constructs were decomposed into subordinate constructs (dimensions) with the original constructs removed.
- The integration attributes construct was replaced with (A) three dimensions that are indicative of the integration and (B) an integration construct. The Perceived Benefits construct was decomposed into six dimensions that flow directly from integration and indirectly from one attribute construct.

Table 6: Partial List of Stakeholder Characteristics

Descriptive Traits	**Cognitive Traits**
Gender Educational background Computer experience Level of expertise with a specific software package.	Intelligence Locus of control Preferred mode of learning Perceived/tested tasks knowledge

Based on "Prior Studies of Personal factors" (Montazemi et al. 1996)

However, the same original ideas still drove the research.

The expanded model (Figure 5) represents the revised conceptual model and depicts all the dimensions and hypothesized paths among the constructs. The revised model was based on what was learned in the qualitative portion of this research.

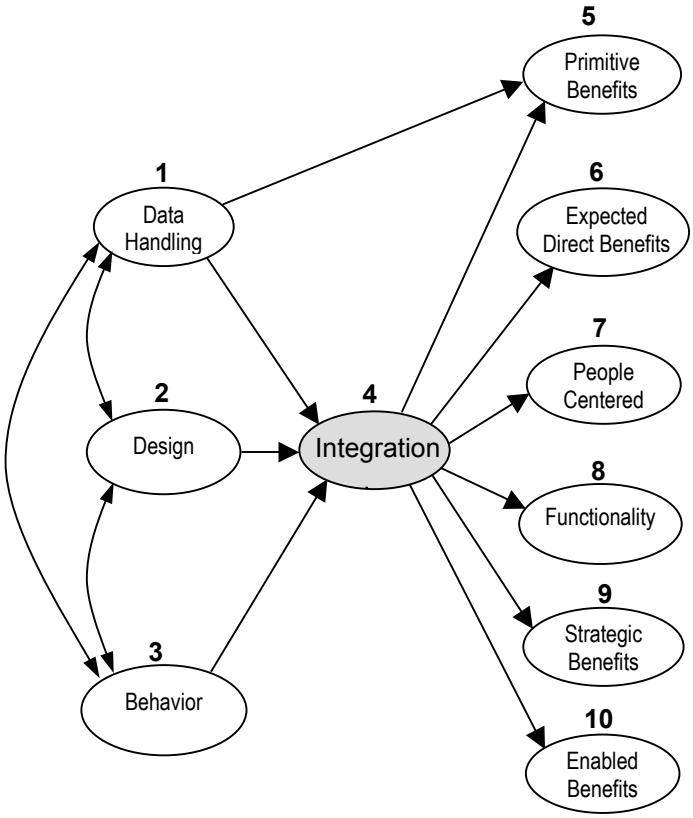

Figure 5: Expanded Conceptual Research Model

CHAPTER 4 – HYPOTHESES

This chapter describes propositions and hypotheses for this research. Hypotheses are tested using structured equation modeling, principal components factor analysis, and T-tests of independent samples. Propositions are not tested directly. Instead, the results from the statistical analysis are used to indicate the validity of a proposition.

General Propositions

As Whetten (1989, p. 492) points out, propositions involve conceptual relationships, whereas hypotheses require measured relationships. The relationship of propositions to research is best summarized by the following description (Trochim 2002):

> "Measures, samples and designs don't 'have' validity -- only propositions can be said to be valid. Technically, we should say that a measure leads to valid conclusions or that a sample enables valid inferences, and so on. It is a proposition, inference or conclusion that can 'have' validity."

The following are the propositions for this research. Testing of the hypotheses and the statistical analysis will provide evidence as to the plausibility of the propositions. The propositions and the rationale for each proposition are discussed next.

P1: A set of attributes that define integration can be derived from practitioners' perceptions of integration.

Questions 1-21 on the survey are manifest variables that are reflective indicators of three or more exogenous constructs. Exploratory factor analysis will be used to produce an initial set of dimensions. The relationship between each set of manifest variables and the associated dimension will be established using confirmatory factor analysis. CFA will also be used to establish reliability and convergent and discriminant validities. Those questions (manifest variables) found to have significant loadings, reliability, and validity represent the common set of items

that practitioners agree define applications integration. The resulting set of items is considered the taxonomy of integration attributes.

P2: A set of benefits of integration can be derived from practitioners' perceptions of integration.

Questions 22-59 on the survey are manifest variables that are reflective indicators of five endogenous variables. The same process described for P1 will be used to establish the dimension, reliability, and validity. Those questions (manifest variables) found to be reliable and valid represent the common set of items that practitioners agree are benefits of integration and therefore represent the taxonomy of perceived benefits of integration.

P3: Integration attributes represent at least three dimensions.

Analysis will begin using exploratory principal components factor analysis to remove any items where there is a lack of evidence showing that the items are part of any hypothesized dimension. Items will be removed one at a time using recommended procedures for principal components factor analysis. See the discussion in Chapter 8 for details. The items not excluded are then analyzed using confirmatory factor analysis to determine if they load as predicted. Adjustments are made as necessary. The resulting dimensions (those with three or more items per dimension) represent confirmed dimensions and can be used to determine the validity of this proposition.

P4: Perceived benefits of integration represent at least five dimensions.

The same procedure described for P3 will be performed for P4.

P5: Perception of integration attributes is significantly different for each stakeholder group.

As discussed in Chapter 3, differences among stakeholders have been studied in several academic areas including MIS. Specifically, differences between end-users and IT professionals have been documented in the MIS literature (Barki and Hardwick 2001). Thus, consideration of stakeholder influences is an important consideration for the adoption and use of IS/IT technology. There is reason to believe that differing perceptions among groups can impact ERP implementations (Besson & Rowe 2001). Thus, it is plausible that different groups have different perceptions about what constitutes integration.

P6: Perception of integration benefits is significantly different for each stakeholder group.

P6 is concerned with the benefits that are derived from integration. The basic arguments for P6 are the same as those for P5. Consequently, it is plausible that different groups have different perceptions about the benefits that are forthcoming from integration.

Hypotheses

The hypotheses described below were derived from the propositions described above. Exploratory factor analysis, confirmatory factor analysis, and various multivariate techniques will be employed to test these hypotheses and to establish reliability and validity.

The constructs and dimensions described for hypotheses H1-H5 are newly theorized ones and are based on perceptions of practitioners. Very little literature was available to support the constructs. In general, perceptions are grounded in the theory of reasoned behavior described earlier. Support was also found for some of the associated manifest variables described in Chapter 3 for the conceptual model. The majority of manifest variables emerged from the qualitative analysis of the interviews described in Chapters 5-6.

Integration Attributes

Integration attributes define what integration "is". The attributes construct is a newly theorized one and was described in detail in Chapter 3.

H1: The 21 attribute items represent at least three distinct dimensions.

H1 is concerned with establishing dimensionality for the items used to assess what integration "is". Questions 1-21 on the survey are manifest variables that are the reflective indicators of the attribute construct. Data sharing, real-time, and seamless are example items. The items that define integration are thought to represent at least three dimensions. The three most likely dimensions are (1) Behavior, (2) Data Management, and (3) Design. Behavior reflects the functionality and exhibits a behavior that is consistent with what people think integration represents. Data management consists of functionality related to the way an integrated system handles data which is the core function of any enterprise system. Design reflects the underlying concepts that enable applications to work together, manage data, and provide the functionality of an integrated system. See the discussion at the end of Chapter 6 for more details.

Confirmatory factor analysis will be used to test the relationship between each set of manifest variables and the associated dimension. Those questions (manifest variables) found to have significant loadings represent the common set of items that practitioners agree constitute the attributes. The combined set of items from all the attribute dimensions will be considered the taxonomy of integration attributes.

H2: The attributes construct is best represented as a higher-order construct that is comprised of at least three dimensions.

This higher-order construct is thought to consist of at least three dimensions thereby making it a multi-dimensional construct. Three newly theorized dimensions determine and define applications integration. The three most likely dimensions as discussed for H1 are Behavior, Data Management, and Design. Summated scales of each dimension will be used to test this hypothesis.

Integration Benefits

Integration benefits are the advantages obtained from integration of applications that constitute an enterprise system. As discussed earlier, this is a newly theorized construct.

H3: The 38 benefit items represent at least six distinct dimensions.

H3 is concerned with establishing dimensionality for the items used to assess integration benefits. Questions 22-59 on the survey are manifest variables that are reflective indicators of the dimensions of the benefits construct. Perceived benefits are thought to have six dimensions. Each of the dimensions consists of items that are reflective of the dimension. The six dimensions likely are (1) Strategic, (2) Functionality, (3) Support, (4) Enabled, (5) Data Usefulness, and (6) Economic. These are described in Chapter 6 although the names have been changed to better describe the dimension.

Confirmatory factor analysis will be used to test the relationship between each set of manifest variables and the associated dimension. Those questions (manifest variables) found to have significant loadings represent the common set of items that practitioners agree define the dimensions of integration benefits. The combined set of items from all the benefit dimensions will be considered the taxonomy of integration benefits.

H4: The Benefits construct is best represented as a higher-order construct that is comprised of at least six dimensions.

This high order construct is thought to consist of least six dimensions thereby making it a multi-dimensional construct. Six newly theorized dimensions represent the benefits that are forthcoming from applications integration. The six dimensions are thought to be Strategic, Functionality, Support, Enabled, Data Usefulness, and Economic. Summated scales of each dimension will be used to test this hypothesis.

Relationship of High Order Constructs

H5: There is a positive relationship between the Attributes construct and the Benefits construct.

If the attributes construct defines integration, then it is plausible that there is a positive relationship between the attributes and benefits constructs. Since an integrated system must exist before benefits can be realized, it stands to reason that attributes are an antecedent of benefits. Path analysis will be conducted using the structural equation modeling feature of Lisrel.

Stakeholders

The results from the qualitative study results (Chapter 6) clearly indicated differences in perceptions of integration and benefits among the three stakeholder groups included in this survey. The stakeholders of interest for this study are End-users, Managers, and IT professionals. Based on the qualitative results described in Chapter 6, several inferences can be made regarding these groups and how they differ in regard to attributes and benefits. Therefore the arguments and observations presented for H6 and H7 are based largely on the qualitative field research.

H6 Each stakeholder group will have a different overall perception of integration attributes.

The three stakeholder groups of interest have different roles within the organization, different education and training, and different backgrounds. These differences likely cause each group to view integration differently. Managers tend to have a high-level view and are interested in profits. This leads them to plan strategically, to seek competitive advantage, and to desire all divisions, departments, and groups to work together effectively regardless of geographic location. Information technology is just one of several tools employed to achieve organizational objectives. IT professionals, on the other hand, have a much narrower and, necessarily, a more focused view. While they may share some of the same views as management, their primary responsibility causes them to concentrate more on how the enterprise systems work. End-users are task oriented. They desire system functionality that helps them get the job done and therefore are less concerned with how systems work or with the overall objectives of the organization.

Several strategies are available to support these hypotheses. The simplest is to use T-test of independent samples to look at the equality of the means for the summated dimensions and the constructs. Another approach is to compare the overall principal components factor structure to the factor structure of each group. Finally, CFA can be used to determine if the fit for each group is significantly different from the overall fit. The combinations to be examined are:

A. Manager and IT professionals

B. Managers and end-users

C. IT professionals and end-users

H7 Each stakeholder group will have a different overall perception of integration benefits.

The arguments for H6 also apply to H7. Users are more likely to be concerned with functional and empowerment related benefits more than the other two groups because of their responsibility. Managers will likely value strategic and enabling benefits. IT professionals will value the overall functionally of the system to the extent they perceive it to meet the requirements of management and end-users. They will also likely value the technical advantages such as scalable platforms more than the other groups.

The same analysis as described for H6 can also be performed for H7. Differences for benefits will likely be greater than for attributes because benefits is the primary concern of users and managers whereas IT professionals are more likely concerned with attributes. Also, managers and end-users tend to describe attributes in terms of benefits more than IT professionals do.

CHAPTER 5 – METHODOLOGY: QUALITATIVE COMPONENT

This chapter describes the qualitative methodology. Chapter 6 reports the data analysis and results for this component along with the interpretation of the results. Recall that this research investigates the very essence of information technology integration although the focus is on applications integration for enterprise systems. Integration is thought to be the most important and distinguishing characteristic of enterprise systems. This qualitative component was a necessary first step to better understand applications integration and to facilitate the development of a new instrument to measure perceptions of integrations attributes and benefits Netemeyer et al. 2003).

As noted in Chapter 1, little is known about practitioner perceptions of applications integration and benefits. Virtually no empirical evidence is available that defines integration. No measures could be found to assess user perceptions of integration and benefits. Furthermore, no instruments could be located to assess the degree of applications integration or the value of integration. This research component had two objectives. More information was sought regarding practitioner perceptions so that their perceptions could be compared to what could be found in the literature. The second objective was to create an instrument to assess practitioner perceptions of integration and benefits.

The idea was to surface practitioner interpretations (assumptions, knowledge, and expectations) of applications integration. Similar to work on the social construction of technology (e.g., Barley 1986) and technological frames (e.g., Orlikowski and Gash 1994; Tan and Hunter 2002), the position is taken that interpretations of applications integration by practitioners are socially constructed and subject to multiple interpretations (Berger and Luckmann 1966), and that these interpretations shape organizational outcomes. This

research component was an exploratory study to develop an initial understanding of sense-making and perceptions of applications integration by three stakeholder groups – managers, IT professionals and end-users. As the findings indicate, there is no generally accepted definition of what applications integration is or ought to be. While it is generally assumed that the value of integration is "obvious," the results of this study indicate multiple interpretations of the key characteristics, benefits, and disadvantages of applications integration.

A secondary objective was to examine the downside of integration and obtain ideas about measuring integration. The ultimate goal of this stream of research is to find a way to measure or assess the degree of applications integration for an enterprise system. "If you can't measure it, you can't manage it!"

Content analysis was the method chosen for this part of the research because it is well suited to surface themes and concepts from interviews and it summarizes great volumes of qualitative data. A total of 1,759 sentences from the interviews of 51 practitioners were analyzed. The 1,759 sentences were coded into four categories consisting of 128 concepts. See Appendix H for the complete results of the analysis. The remainder of this chapter describes the content analysis methodology and the procedure used to conduct the qualitative study.

Content Analysis Background

Content analysis is a method used to analyze qualitative data such as interviews, magazines, and speeches. In some ways, content analysis is similar to factor analysis in that both are data reduction techniques. Content analysis "uses a set of procedures to make valid inferences from text" (Weber 1990, p. 9). The following quote probably best summarizes the concept.

> "Content analysis is a research tool used to determine the presence of certain words or concepts within texts or sets of texts. Researchers quantify and analyze the presence, meanings and relationships of such words and concepts, then make inferences about the messages within the texts…To conduct a content analysis…, the text is coded, or broken down, into manageable categories on a variety of levels…Conceptual analysis can be thought of as establishing the existence and frequency of concepts…" (Colorado State University 2001).

Content analysis is often used as the first step or in conjunction with other methodologies. The output of conceptual content analysis is typically a frequency tally for words, phrases, or concepts. Frequencies can then be used with traditional quantitative statistical methods.

Participants

The qualitative study consisted of in-depth, semi-structured interviews with 51 people representing three stakeholder groups (managers, IT professionals, and end-users) from four different organizations. The organizations that participated included two universities and two global firms. Below is a brief description of these organizations.

Major Research University (MRU)

This internationally known land-grant university is located in the Southern United States. Since the 1800s, MRU has served the people of the state, the region, the nation, and the world through extensive, multipurpose programs encompassing instruction, research, and public service. The university brings in more than $50 million annually in outside research grants and contracts. MRU is a community of faculty, staff, and some 31,000 students from every state and more than 120 nations. At any given time, MRU's faculty and graduate students are conducting about 2,000 sponsored research projects.

Regional University (RU)

RU is regional university located in the Southeastern part of the U.S. The university enrolled more than 13,000 students in Fall 2001. It offers 65 undergraduate and graduate (masters) degree programs. This regional university attracts a diverse family of students from over 30 states and approximately 50 foreign nations.

Large Petroleum Firm (LPF)

LPF is a multi-billion dollar global company organized into three major groups (upstream, downstream, and chemical). The organizational structure is built on a concept of global businesses and is designed to allow the firm to compete most effectively in the ever changing and challenging worldwide energy industry. The company employs over 100,000 people, does business in nearly 200 nations, and boasted earnings in 2001 greater then eight billion dollars. [Actual amount changed to protect the firm's identity].

Large Chemical Firm (LCF)

This century-old company evolved from a local specialty mining company to a global leader in the chemical industry. It has more than 200 offices and production sites in 40 nations around the world. The company has 20,000 employees worldwide. In 2001, the firm had sales of over 6 billion dollars and enjoyed a net profit of about a billion dollars. [Sales & profit figures changed to protect the firm's identity.]

The firm evolved from coal mining and processing to chemicals and fertilizers that later comprised the company's primary activity after they abandoned the coal industry. Petrochemicals eventually took center stage and profits from raw materials for plastics grew enormously. Today, the firm is publicly listed.

The Procedure

The data collection method for the study was semi-structured interviews. Fifty-one participants were interviewed from four organizations ranging from the public sector of higher education to large and mid-size private sector petrochemical firms. Each organization included members of three stakeholder groups – senior/mid-level managers, IT professionals, and end-users. Group interviews of 3-5 individuals from the same stakeholder group were conducted. An interview guide (Appendix E) was used. It consisted of 12 semi-structured, open-ended questions designed to surface practitioner perspectives related to the topics shown in Table 7.

Recognizing that articulation of what constitutes integration might be difficult for participants, multiple questions were designed to explore the same idea – e.g., what are the attributes of integration? What is the difference between an integrated and non-integrated system? Interviews were approximately one hour in length and were tape-recorded. Each interview session was opened by reading a brief statement about the research and the purpose of the interviews. During the interviews, care was taken to avoid asking additional questions that might bias the responses. Additional unscripted questions were asked primarily to ensure that the interviewer understood a person's input or to help get the discussion started again following a period of silence.

Table 7: Interview Topics

1. From an enterprise systems perspective, what constitutes integration of applications — what are the attributes?
2. What are the benefits of applications integration?
3. What are the downsides, or disadvantages, of applications integration?
4. How should applications integration be measured? How do you determine the extent of the integration?

CHAPTER 6 – DATA ANALYSIS AND RESULTS: QUALITATATIVE COMPONENT

As described in Chapter 5, content analysis was used to surface themes in the interview data that reflected practitioner understandings related to applications integration. The approach suggested by Weber (1990) was used to code the interview data. A set of codes used to classify the data was developed based on concepts from the research literature and augmented with major additional concepts (emergent ideas) discovered by the researchers during the coding.

Each session was recorded on audiotape and later transcribed for electronic storage in a Word document. The Word document was converted to Excel and reformatted so that each sentence from the participants was numbered. The interview questions were bolded with participant sentences indented underneath. The formatted transcript was printed and coded on to a code sheet with predetermined items.

Using the content analysis coding form developed for the study, each sentence from the interview transcripts was assigned one or more codes. See Appendix F. Each data element (sentence) was coded by two different coders, the primary researcher and an IS doctoral student. Average overall inter-coder agreement was 67%. However, the inter-coder agreement for the last two organizations coded was 74% reflecting much learning by the coders. Krippendorf (1980) recommends that inter-rater reliabilities be at least 70%. Considering this is the first known study that uses content analysis to investigate perceptions of integration, 67% is considered acceptable.

Development of Coding Sheet

An initial code sheet was created based on the literature and from notes taken during the interviews. This code sheet consisted of 25 concepts (items) organized into four

categories (Table 8). It was expanded to 128 items by the end of the coding. Concept items represent unique ideas that are substantively different from other concepts. Some concepts are clearly different from others such as real-time and common database while others are more similar and call for a great deal of thought and judgment. For instance, lower costs and increased efficiency can be construed to represent the same concept since greater efficiency should lower costs. However, while this is true, efficiency and costs are each distinct ideas.

Table 8: Number of Items (Concepts) by Category

Category	Initial Count	Final Count
Attributes	7	20
Perceived Benefits	9	38
Integration Downsides	4	41
Measuring Integration	5	29
Total	25	128

The two coders began by coding the first interview using the initial form. It quickly became apparent that several new concepts were needed. Space was allocated on the initial code form to write in new concepts (items). However, this presented two problems. First, the coders varied in their coding and addition of new concepts. This created major problems for coding similarities. Second, items on the code form were numbered and this number was used as a unique identifier on the interview transcript. After coding the first interview transcript, the two coders met to assess the level of agreement in code assignments. The ensuing discussion resulted in the addition of numerous items to the coding sheet. The changes were so great that the transcript had to be recoded, independently, by the two coders. This process continued for the next two transcripts: Code interview, modify coding form, and recode. This proved very time-consuming although absolutely necessary in the beginning stages.

After coding and analyzing the third group, a joint 2½-hour meeting was held to resolve the differences. By this time, the number of concepts had more than doubled. This resulted in a major shift in strategy and approach to the code sheet. For the first time, the concepts were organized into dimensions within categories. This required totally recoding the first organization (all three of the previously coded and recoded transcripts). However, this was a major breakthrough. The coding comparison greatly improved and averaged around 60% agreement.

After coding the first group for the 2nd organization, a 1½-hour meeting was held to resolve differences. Again, another major revision to the coding sheet was required and recoding was once more necessary. At this point, two significant steps were taken. First, the resulting revised coding sheet was designed such that further versions would not require recoding. Second, a reconciliation process was established that was more efficient and did not require face-to-face meetings. Reconciliation is an important learning process and reduces future incompatible coding.

The coding and reconciliation for the remaining two organizations was completed. Each time minor changes to the coding sheet were necessary although the number of changes dropped greatly. Coding agreement averaged around 70% for the last eight groups and was over 80% for one group. As noted previously, 70% is considered acceptable.

The number of concepts to be coded was dramatically greater than initially thought. The final code sheet contained 128 items, which is more than fives times the 25 items on the initial code sheet. This certainly accounts for much of the initial confusion and lack of agreement for the coding. Upon reflection, this iterative process of developing the code sheet could probably not have been avoided because of the lack of prior research in this area upon which to base the code categories. Only a few of the 128 items are explicitly discussed in the

literature so it was not apparent that most items should have been placed on the code sheet. Furthermore, no references could be located that discussed the dimensions of integration attributes and benefits.

Analysis Procedure

A frequency was calculated for each item that represented the number of times that item (concept) was mentioned in the interviews. Totals and averages were computed for each item, dimension, stakeholder group, and category. A standard deviation was computed for each item. This data provides a good indication of the relative importance of the ideas to the participants. However, this does not mean that infrequently mentioned items are unimportant. A review of the final coding sheet and the data resulted in the reorganization (combining and deletion) of a few items and dimensions.

Table 9 lists the most frequently cited attributes and benefits of integration. Frequencies can provide an indicator of the relative importance of the ideas related to applications integration for each of the stakeholder groups. The final step in the analysis was to review all transcripts, results of the coding, and notes made by the researchers during the data collection/analysis process. A more detailed summary showing category/dimension frequencies for each stakeholder group is shown in Appendix H. Fifteen major themes, described in a later section, were identified.

Terminology Definitions

This section describes the basic terminology used to report and discuss the analysis and findings.

Categories

- Integration Attributes — represent the four major topics of interest. They are fundamental, core-defining characteristics of what application integration "is".

- Perceived Benefits — desired benefits that people believe are derived directly or indirectly from applications integration.
- Downside — The opposite of benefits; the negative side of applications integration (e.g. risks).
- Integration Assessment — How to measure or assess application integration.

Dimensions — major groups of ideas within a category (also known as factors, latent constructs).

Items — unique ideas (concepts) within a dimension. The interviews were analyzed and translated based on the coder's judgment of the thought that the participant was attempting to communicate. Example: Data sharing is an item. There are several ways to communicate the same idea: share information; use the same data; etc. A common database is a related but distinct idea because it is how data is stored rather than how it is used. An attempt was made to develop a parsimonious, yet unique set of items.

Themes — unique topics or subjects that emerged from the interviews and analysis. A theme may involve multiple categories, dimensions, or items. However, a theme may also represent a topic considered important even though it may not have surfaced during any interview.

Findings: Attributes and Benefits

This section reports what was discovered about integration attributes and benefits. The findings indicate that there is no generally accepted definition of what applications integration is or ought to be, and that there are significant differences among the stakeholder groups regarding the potential benefits and downsides of applications integration. Table 9 lists the five most frequently cited attributes and benefits.

Table 9: Top Five Attributes and Benefits

Top 5 Attributes		
Item	**Count**	**% of Cat**
Applications work together	53	16.8
Data sharing	36	11.4
Common database	29	9.2
Real-time processing	25	7.9
Record once, use everywhere	24	7.6

Top 5 Benefits		
Item	**Count**	**% of Cat**
Improved data accuracy/reliability	61	12.6
Lower Costs	49	10.1
Greater efficiency & productivity	47	9.7
New or increased functionality	38	7.8
Better management, decisions, & analysis	33	6.8

The number of unique items (concepts) uncovered for integration and benefits exceeded a priori expectations and greatly exceeded the items found in the literature. Only 16 attributes and benefits had been identified at the beginning of the coding process. By the end of coding, 42 new items were added bringing the total to 58 items (Table 11). This does not include another 70 items for the downside of integration and for ways to measure and evaluate integration.

Attributes

The latent construct, integration attributes, was determined to actually be composed of at least three dimensions that have been labeled: Intrinsic Core Characteristics, Behavior, and Design Concepts and Standards. All are considered exogenous constructs (see Figure 5 in Chapter 3). These dimensions are briefly described below.

a. **Intrinsic Core Characteristics** – universally identified characteristics of integration consisting of both basic data handling and fundamental functionality/behavior

b. **Functionality & Behavior** – Important characteristics of integration in addition to the core items

c. **Design Concepts and Standards** – those things that, by design and standards, enable integration and the other items in "a" and "b"

Note that "a" contains a mixture of data handling and functionality behavior.

Benefits

It seems reasonable to group all benefits into three categories regardless of dimension. These are Direct, Indirect, and Enabling.

a. **Direct examples** – Cost savings and all data more readily available to everyone firm-wide.

b. **Indirect examples** – Easier to train others and greater understanding of organization and processes.

c. **Enabling examples** – Competitive advantage and new opportunities.

Direct and indirect benefits seem to occur even if you do nothing to achieve the benefit. However, unlike direct and indirect, some benefits must be intentionally sought and integration capabilities exploited to achieve them. Another way to organize the benefits is the way Markus and Tanis (Table 4 in Chapter 3) did. They organized benefits of ERPs into Technical Reasons and Business Reasons. However, for theoretical purposes, benefits were organized by dimensions, which are described next.

The high order construct, perceived benefits, seems to be made up of 6 dimensions (subordinate constructs). Five dimensions were identified for coding purposes. However, the dimensions were reorganized into the more theoretical dimensions described below.

a. **Primitive Integration Benefits** – These benefits are so basic that they are often taken for granted and it is assumed that they naturally result from integration. Consequently, there appears to be a direct effect between this dimension and the "intrinsic core characteristics" attributes dimension.

b. **Expected Direct benefits** – These are the most frequently mentioned benefits that people desire beyond the fundamental ones. They are considered direct benefits because they can be quantified and linked to integration. Discovery that this

dimension is also directly affected by the "intrinsic core characteristics" attributes dimension seems likely.

c. **People-centered primary benefits** – These are frequently cited primary benefits that affect people. Interestingly, it seems that these benefits become available naturally from integration even if not sought.

d. **Functionality and Operational Benefits** – These are organizational level benefits rather than people-centered ones. Several of these benefits also appear to automatically result from integration even if not sought.

e. **Enabled Benefits** – These benefits can be obtained but only if management creates a specific plan to achieve the benefits.

Table 10: Number of Items per Dimension

Category & Dimension	Item Count	Explanation and example items for dimensions
Integration Attributes		
Inherit Core Characteristics	6	Common database & data sharing
Functionality & Behavior	8	Real-time & record once, use everywhere
Integration Enablers	6	Applications work together & industry std interfaces
Subtotal	**20**	34.5% of the items for attributes and benefits
Perceived Benefits		
Primitive Benefits	7	Increased efficiency & new/better functionality
Expected Direct Benefits	6	Lower costs & improved customer service
People Centered Benefits	6	Management decisions/analysis & coordination of depts.
Functional Benefits	5	Expanded computing capacity & easier software upgrades
Enabled Benefits	6	Empower employees & new or expanded opportunities
Strategic Benefits	5	Facilitate organizational change & competitive advantage
Subtotal	**38**	65.5% of the items for attributes and benefits
Integration Downside Dimensions not yet determined	41	Security, data–function non-fit, complexity–monolithic system, single-point failure impact, software cannot adapt to business
How to Measure Integration Dimensions not yet determined	29	Look for dup data entry, number of interfaces, number of reconciliations, compare actual to expected (e.g. processes)
Lines not coded	N/A	Represent consecutive duplicated ideas, spurious comments, or information not directly related to topic being studied.
Grand Totals	*128	Count of all sentences from all interviews–a few may be duplicated if sentence contained multiple unique ideas.

* 128 is the number of unique items (ideas) that were identified for all categories and dimensions

f. **Strategic Benefits** – Like enabled benefits, strategic benefits require a purposeful effort and philosophy to obtain.

Table 10 lists the count of items per dimension and category. Example items for each dimension are not repeated here. See Appendix H for a list of items. Note that there are almost twice as many benefit items as there are attribute items.

Content Analysis Summary: By Category, Stakeholder, and Dimension

Table 11 summarizes how the interviews were coded. Each sentence was examined to determine the idea that was being conveyed. Each idea was matched to one of the items within a dimension and category. A few sentences conveyed multiple ideas and were coded into multiple categories. About 31% of all sentences were not coded either because they

Table 11: Summary of Sentences Coded by Category and Dimension

Category & Dimension	Management			IT Professionals			End-users			Sub Total
	Freq	% of Sub Tot	% of Cat Tot	Freq	% of Sub Tot	% of Cat Tot	Freq	% of Sub Tot	% of Cat Tot	
Integration Attributes										
Inherit Core Characteristics	37	40.7	33.0	33	36.3	25.0	21	23.1	29.2	91
Functionality & Behavior	40	34.2	35.7	51	43.6	38.6	26	22.2	36.1	117
Integration Enablers	35	32.4	31.3	48	44.4	36.4	25	23.1	34.7	108
Category Total	112	35.4		132	41.8		72	22.8		316
Perceived Benefits										
Primitive Benefits	78	35.3	44.6	64	29.0	48.5	79	35.7	44.1	221
Expected Direct Benefits	33	40.2	18.9	22	26.8	16.7	27	32.9	15.1	82
People Centered Benefits	29	27.1	16.6	33	30.8	25.0	45	42.1	25.1	107
Functional & Oper. Benefits	7	77.8	4.0	1	11.1	0.8	1	11.1	0.6	9
Enabled Benefits	21	37.5	12.0	9	16.1	6.8	26	46.4	14.5	56
Strategic Benefits	7	63.6	4.0	3	27.3	2.3	1	9.1	0.6	11
Category Total	175	36.0		132	27.2		179	36.8		486
Total: Attributes + Benefits	**287**	**35.8**		**264**	**32.9**		**251**	**31.3**		**802**
Other Categories										
Integration Downside	66	37.7		57	32.6		52	29.7		175
How to Measure Integration	43	35.5		49	40.5		29	24.0		121
Miscellaneous	25			21			23			69
Sentences not coded	197	33.3		213	36.0		182	30.7		592
Grand Totals	**618**	**35.1**		**604**	**34.3**		**537**	**30.5**		**1,759**

represented consecutive duplicated ideas, were spurious comments, or were ideas that did not relate directly to the topics under investigation. The frequency in the tables gives us an idea of the relative importance of one dimension to another and dimensions by stakeholder and category. Importance means the frequency that the topic was voiced.

As expected, there is a disconnect among the three stakeholder groups though not as varied as originally thought. From Table 11, we see that IT professionals, with 41%, account for the greatest frequency of integration attributes cited followed by management with 35.4%. End-users trailed a distant third with 22.8% which is nearly 18% fewer than the IT professionals. Not surprisingly, management had the most to say in the interviews with end-users saying the least. However, when it came to benefits, management and users were about the same at about 36% which is nearly 9 % more that the 27.2% for IT professionals.

Participants described twice as many benefits as they did attributes even though there is about three times the number of attribute eliciting questions. This is strong indication that people tend to describe attributes in terms of benefits rather than what constitutes integration.

Findings: Themes

This section describes the major themes that emerged from phase I of the research. These themes are based on comments by participants, analysis of the interviews, and a review of the literature.

1. **Articulation of applications integration** – A priori belief was confirmed that people, even those with tremendous knowledge, experience, and responsibility have a difficult time articulating what integration "is". They invariably describe integration in terms of outcomes (benefits) rather than what constitutes integration. Yet, everyone seems to have a perspective of what applications integration "is". This perception, in many cases, is likely influenced by software vendors and marketing literature.

Describing integration is like describing the taste of a banana to someone who has never tasted one—a very difficult thing to do. The reason is that integration is a latent construct and like the taste of a banana, it cannot be directly observed. Typical replies when asked to list the attributes of integration were:

"Real-time" and "Data is only stored in one place in the system…stored once"

2. **Meaning of applications integration** – People tend to over simplify what integration means. Integration has become so ubiquitous that it seems that everyone has a mental working definition of it that has never been (or rarely) challenged. Most agree that integration means "working together." However, this very simple idea, while correct, is far too general to have any practical or theoretical meaning or use.

The following example should illustrate the point. Suppose we have two applications, A and B. A is a batch application written in BAL (basic assembler language) that stores data in a sequential flat file. B is an interactive, online application written in Cobol that uses a relational database to store data. Once a quarter, a batch job, written in Visual Basic, updates the relational database from the flat file. Clearly, we see that applications, A and B, "work together". However, this is not consistent with what most people associate with integration. This scenario is typically considered an outdated legacy system.

The problem is that we lack a clear working definition of what integration means. This clearly implies that no two people share the exact idea about what integration is, how to achieve it, or how to measure it. While two people on the same team, in the same shop may share a general idea about the meaning, there is a disconnect among managers, IT professionals, end-users, vendors, consultants, and organizations. This lack of a clear definition is likely to be partially responsible for numerous failed

integration projects, cost overruns, and adds to the complexity of an already difficult undertaking.

The following remarks from the three stakeholder groups illustrate the differences and similarities among the three groups regarding what constitutes integration and is based on direct observations from the interviews.

End-users

> "I think of integration as you having this one system that everybody does everything in. Real-time [and] creates synergy."

Management

> "Seamless, tightly coupled, shared databases, [and] single transactions [that] spawn multiple update."

IT Professionals

> "Seamless, combined, single point of entry, fewer number of systems, real-time, and non-duplicated data."

3. **Dimensions** – As described below, it became obvious that both integration attributes and perceived benefits actually represent multiple dimensions. Surprisingly, no mention of such dimensions was found during the literature review. For example, two dimensions of integrations are data handling and behavior. Two benefit dimensions are economic and support.

4. **Amount of Integration Practical/Desirable** – This is important for at least three reasons:

   - Justifying integration
   - Determining feasibility of applications integration
   - Deciding the difference between theoretical and practical benefits of integrations.

   There appears to be general agreement among practitioners that 100% integration is not practical or desirable for a variety of reasons, most of which are fairly realistic.

Participants were asked to estimate the degree of integration that was practical. The average of their response was 85% (Range: 65%-100%). This seems reasonable from comments made. For instance, in a university, is there any purpose for integrating plant maintenance with student admissions? Is it worth the cost and complexity to integrate desktop applications with enterprise systems?

5. **Packaged Enterprise Systems —** Applications integration for enterprise systems is often attempted by purchasing a commercial software package from vendors such as SAP, Oracle, and PeopleSoft. The comments that follow are related to such packages. While the comments are related to commercial software, many of the same issues likely exist for internally developed, large-scale systems. Large-scale means systems can contain hundreds (or even thousands) of applications and hundreds of millions of lines of program code.

   Most Frequently Cited Problem

   Many think that commercial enterprise systems lack flexibility. They say that a firm must adapt its business practices to fit the software because the software cannot be configured to adapt to the firm. One participant described it this way:

   > "With an integrated system, you have to adjust the way you do business to the system—not the other way around."

   However, the software can be modified or interfaced to other applications to overcome this deficit. Few firms do so because of the enormous complexity and magnitude of the software. Besides, custom alterations may become obsolete or no longer work with the next release of the software. Some believe this is actually a management decision and not related to characteristics of integration.

Chief Complaint

The complaint heard the most was that constant upgrades were required. This proves to be costly, time consuming, and disruptive. It is not clear who benefits the most: the vendor, the customer, or the consultants. In any event, the irony is that desired new and improved functionality requires new software versions. Here too, some feel this is a management decision and not a characteristic of integration.

6. **Knowledge and Perceptions of Integration** – The people who appeared to know the least about integration were more likely to feel that 100% integration was practical. Just the opposite was true of knowledgeable people who felt that integration was not always practical. Both groups recognized the need for integration.

7. **Knowledge and Integration Downside** – People with the most enterprise experience tended to be pragmatic. They appeared to understand and readily admit the downside and limits of integration. They readily understand that compromises must be made between cost, benefits, and risks. Example integration downside remarks were:

> "If someone puts in garbage, it ricochets through the system as garbage." [This is a good example of how integration is both good and bad. The opposite of garbage is good data and it is desirable for data to permeate the entire system.]
>
> "If the end-user doesn't know what they are doing and what impact their little piece of the pie is, it can really be bad."
>
> "You have to make numerous changes instead of one change to correct bad data."

8. **Unanticipated Benefits of Integration** – People desire integration for reasons that were unanticipated and therefore initially somewhat surprising. Some of the more interesting ones not considered in advance of this study are:

a. Reputation and prestige attainment or enhancement

b. Support for legal matters

c. Become independent organizationally and geographically

d. Leverage size to influence better deals and support

e. Paperless or reduced paper operations

f. Empower employees.

9. **Emergent vs. Sought Benefits** – Some benefits appear to emerge from integration rather than being initially sought. Examples are:

a. Average person gains a much better understanding of the overall organization and process

> "In an integrated environment, users have a wider view of the organization because of the integration with other departments. They have a better understanding of how what they do affects other people and how what other people do affects them."

b. Employees become less dependent on other people and departments for information

> "I start to think back about the evolution of integration. To look back at the days when you had to fax stuff. They had to look at it and fax it back. Then, you store it or mail it. Now everyone just goes into the system and look at the information for themselves."

c. Reduced skill set of employees required although the employee had to be more talented/capable. Some have an opposite view and felt that a downside of integration was that greater skill was required even though they did not contradict the reduced skill set claim. They expressed concern that an integrated system created a problem for hiring and retaining qualified staff.

d. Some felt that it was easier to train staff, easier to learn, and easier to support an integrated system. Part of this is because standard core training can be established for

everyone regardless of the department they work in. Also this makes it easier to move people around and do cross training.

10. **Major Advantages/Benefits –** A major advantage cited by several people was establishing standardized processes and business practices firm-wide. It is not clear if this was a sought benefit or an emergent benefit. It may be that integration is an enabler of standardization. The following are examples of benefits cited by the participants.

> "Integration actually helps people to analyze the business and make better business decisions."
>
> "You can see yesterday's sales first thing this morning as opposed to the end of the month."
>
> "The ability to make processes efficient. Process efficiency gives you lower costs."
>
> "Information is more real-time."
>
> "Improved process efficiency, increased business knowledge, [and] standardization of individual processes through out the organization."
>
> "The benefit is you get a lot of new functionality." [Talking about packaged software]

11. **Integration Desirable in Spite of Problems** – For the most part, people with commercial enterprise systems felt that integration was still desirable even though they fully understood and acknowledged the numerous problems and downside to integration.
12. **Alternatives to Integration –** Surprisingly, no one could think of any practical or desirable approach to integration other than the build your own (enterprise system) or buy an enterprise system package from a vendor. Building your own integrated enterprise system may not be practical these days. This finding is puzzling and surprising since a number of alternatives are available to achieve applications integration. For instance, componentware is one alternative. However, upon reflection, it may be that the interview question was poorly worded.

13. **Integration Downside Exaggerated –** While many of the downsides are legitimate concerns, many are not. Integration merely for the sake of integration is not desirable because it clearly implies expenditure of resources for no good reason. On the other hand, objecting to others using your data because they might misinterpret the data does not appear legitimate. For instance, one end-user remarked that, "If you mess up, everybody knows about it immediately." Although the user viewed this as negative, this could be interpreted as positive from the organization's viewpoint because such problems are more readily identified and therefore can be corrected.
14. **Integration Dependent on Need –** Some feel that integration is a context driven concept and depends on the size and needs of a firm. An opposing view is that integration (in the context of applications) is a fundamental concept that transcends specific applications and domains. However, it does appear that organizations create an integration infrastructure to meet their specific needs. The idea of an integration infrastructure is a more abstract idea that was discussed in detail in Chapter 2.

Findings: Integration Downside

The downside to integration is not the topic under investigation although it is related. The a priori belief was that integration was desirable in the great majority of situations. The reason for this question was to look at integration from as many perspectives as possible in order to discover what integration "is". Surprisingly, one question yielded forty-one concepts (items). For coding purposes, the items were organized into four groups (Table 12). Further analysis is needed to organize the items by dimension.

Table 12: Integration Downside

Coding Group	Number of Items
Data Related	8
Complexity and Turmoil	12
Costs and Risks	10
Undesirable, inadequate, or unnecessary	11
Total	**41**

The opposite of integration is non-integration. Thus, the downside of integration could be viewed as negative if you are pro-integration. However, there are some seemingly legitimate reasons not to seek integration or to avoid it. The eight most frequently cited downsides to integration are provided in Table 13.

Findings: Measuring Integration

Like integration downsides, measuring integration is not the primary focus of the research although the hope is that this stream of research will eventually lead to a measure of integration. This question (about measuring integration) was originally conceived to help identify what integration "is". However, measuring integration is, in and of itself, a very significant and promising revelation. Additional analysis and research is necessary to create an instrument to measure integration.

A priori belief was that it would be difficult if not impossible to measure integration. Perhaps the emphasis on measuring was distracting. A number of ideas were suggested as to how to assess integration. For a simple example, suppose you develop a checklist of 20 items that represent integration. If an audit determines that you pass 15 of the 20 tests, then you are 75% integrated. Some ideas for assessing or measuring integration were:

> "The first thing that comes to mind when you ask if you can measure something is do we know what it is. [You can] look at how information is shared among departments…electronically. Measure the relationship between departments."

Table 13: Eight Most Frequently Cited Integration Downsides

Reason	Frequency
Software maintenance becomes more difficult; prevents quick fixes to problems	14
Broader knowledge and skill required; Harder to use the software	13
Security and access control concerns	12
High cost can cause diminishing returns	11
Too restrictive; lost functionality	11
Data needed only by one area—not firm wide data	9
Single point failure has greater impact	8
Complexity to implement and operate	8

> "Look at how many interfaces you have between individual component systems. The less you have, the better you are integrated."
>
> "Cost of reconciling. Count the user interfaces as well as the systems interfaces."
>
> "Degree of automation. Number of [data] transformations."

An early study measured the degree of integration for data (Ein-Dor and Segev 1982). They used a three-category scale (low, medium, and high) to measure the following items:

- Proportion of data in shared databases
- Number of applications using common files
- Number of functions served by application

Twenty-nine unique ideas to assess or measure applications integration emerged from the qualitative analysis of the interviews. See Appendix H for a complete list. The top six most frequently cited ones are presented in Table 14. For coding purposes, the items were organized into three groups: Data flow, use, and storage; Expected results and process; and Computer program code inspection.

Table 14: Top Six Ways to Assess or Measure Applications Integration

Concept	Frequency
Verify availability of and access to all data as necessary	13
Verify that system facilitates workflow steps working together	11
Look for unjustified inefficiencies and low productivity	9
Determine workflow process and track steps	8
Trace data flow to confirm non-duplicated data	7
Determine number of application interfaces required to exchange data	7

Implications and Interpretation

The comments in this section are based on a review of the subject matter as a whole. This includes a careful and detailed analysis of the interviews, a review of the literature, and countless discussions with several colleagues. Although the interpretations represent an opinion, they are based on observations and facts.

It is essential to recognize that the interview responses are based on the perceptions of the individuals interviewed, and that their ideas are typically based on their specific domain and past experience with enterprise systems. Hence, we can expect some degree of variance in opinions. However, the overall findings are deemed valid and useful because the majority of integration characteristics and perceived benefits are thought to be independent of a given domain.

Integration Complex and Multi-Dimensional

Integration does mean, "working together," but this idea is far too simple to be of any practical or theoretical use. This research supports the a priori belief that integration is complex and revealed that integration is also multi-dimensional. However, integration is much more complex than previously thought. Some people don't have a clue what integration is, but profess that it is good and desirable. As one user put it, "I would not know if the system was integrated unless someone told me or unless it said so on the box." So how did this person arrive at the conclusions that integration is good, desirable, and that integration of 100% of all applications is practical? The bandwagon effect may explain the response. Another explanation is that the response was given to provide an answer deemed socially acceptable to meet the expectation of the interviewer or others present.

As previously mentioned, there are a variety of perspectives for applications integration. Recall the earlier comment, "I think of integration as you having this one system

that everybody does everything in." Another description of integration was, "Integrated is one system, one maintenance, one upgrade, and I find the data only once in my system."

Future of Integration

The future of integration appears likely to evolve dramatically from the one system, one database idea to a new model…a paradigm shift of sorts. In fact, this shift appears to have been underway for sometime. The emphasis in the future will likely be on logical integration vs. the traditional physical integration which has proven to be an illusion at best. Cadarette and Durward (2002) probably said it best:

> "…from the dawn of the computing age, integrated automation has been the Holy Grail of computing. And like the Holy Grail, achieving full integrated automation remains elusive, despite huge investments in a wide array of technologies that promise integration…"

True, Pure Integration Does Not Exist

It appears almost certain that integration is a logical concept rather than a physical concept. Once we thought of an enterprise system or integrated system as one system that provides ALL the needs of an organization. This idea persists even today based on the comments cited earlier. This led to the idea of integration as a tightly coupled system with all parts designed to work together.

Interfacing was thought to be the opposite of integration. This conjured up thoughts of batch jobs created to interface disparate applications that were not designed to work together. Actually, it appears that interfacing techniques infiltrated the domain of enterprise systems a long time ago and, ironically, it now appears that interfaces are required to integrate the applications. It is just that this was done without fanfare and most people have not even noticed.

Interface vs. Integration

During one particular interview session of IT professionals, the question was asked if integration and interfacing meant the same thing. The extremely knowledgeable and talented group of individuals categorically declared that the two ideas were most definitely different. They went on to describe how integration and interfacing were different with interfacing representing the "old" way of doing things in a legacy system which was the opposite of integration. Then a few minutes later, after discussing the matter, they sheepishly retreated from the clear distinction of integration and interfacing. Finally in a complete reversal of their initial stance, they explained how interfacing is used to achieve integration. So, interface integration is not nearly the paradox once thought. This is like fresh-frozen! One person described the difference between integration and interfacing this way.

> "Integration would say that modules naturally talk to each other. The buzz [word] would be plug and play vs. interfacing that requires understanding of the pieces by someone [who can] map them together."

Rationale for Researching Integration

Firms seem to be spending millions of dollars striving for an illusion. Clearly, firms strongly believe that applications integration is desirable and has numerous benefits. Why else would they spend tens or hundreds of millions of dollars pursing integration fully realizing the enormous risk and barriers faced? Yet, ironically, they have pursued integration based mainly on faith, without any clear way to judge:

- When it is achieved
- The cost/benefits of integration
- What is it precisely that they are achieving or seeking

None of the above is surprising because we lack a clear definition and understanding of what an integrated system is or ought to be. Complicating and confounding the issue is

the view of integration that it is fluid and continues to change as vendors and academia attempt to accommodate new fads or strategies under the integration umbrella. This has been done for years without objection.

No attempt is made here to argue that integration is good or bad, desirable or undesirable, or whether or not it is a worthwhile effort. The a priori, biased opinion was that integration is good, desirable, and worthwhile. But, there has been difficulty articulating what this truly means. So much so that it has become impossible to do complete ROI or cost/analysis benefits.

Refined Research Model

Figure 6 (next page) adds the manifest variables to the expanded model (Figure 5) described in Chapter 4. The manifest variables represent the items (concepts) revealed during the coding and analysis of the interviews. The manifest variables shown here were changed in the final model based on the result of statistical analysis.

Conclusions

The qualitative research phase supported a few a priori expectations although some a priori expectations were not supported. Support was found that:

- Integration is ill defined
- People have difficulty articulating integration
- People tend to define integration in terms of benefits
- Integration is generally desirable
- There are notable differences among stakeholder groups as to what constitutes integration and the benefits of integration.

A priori expectations fully or partially not supported include: integration cannot be measured, integration and interfacing are entirely different concepts, and 100% (or near

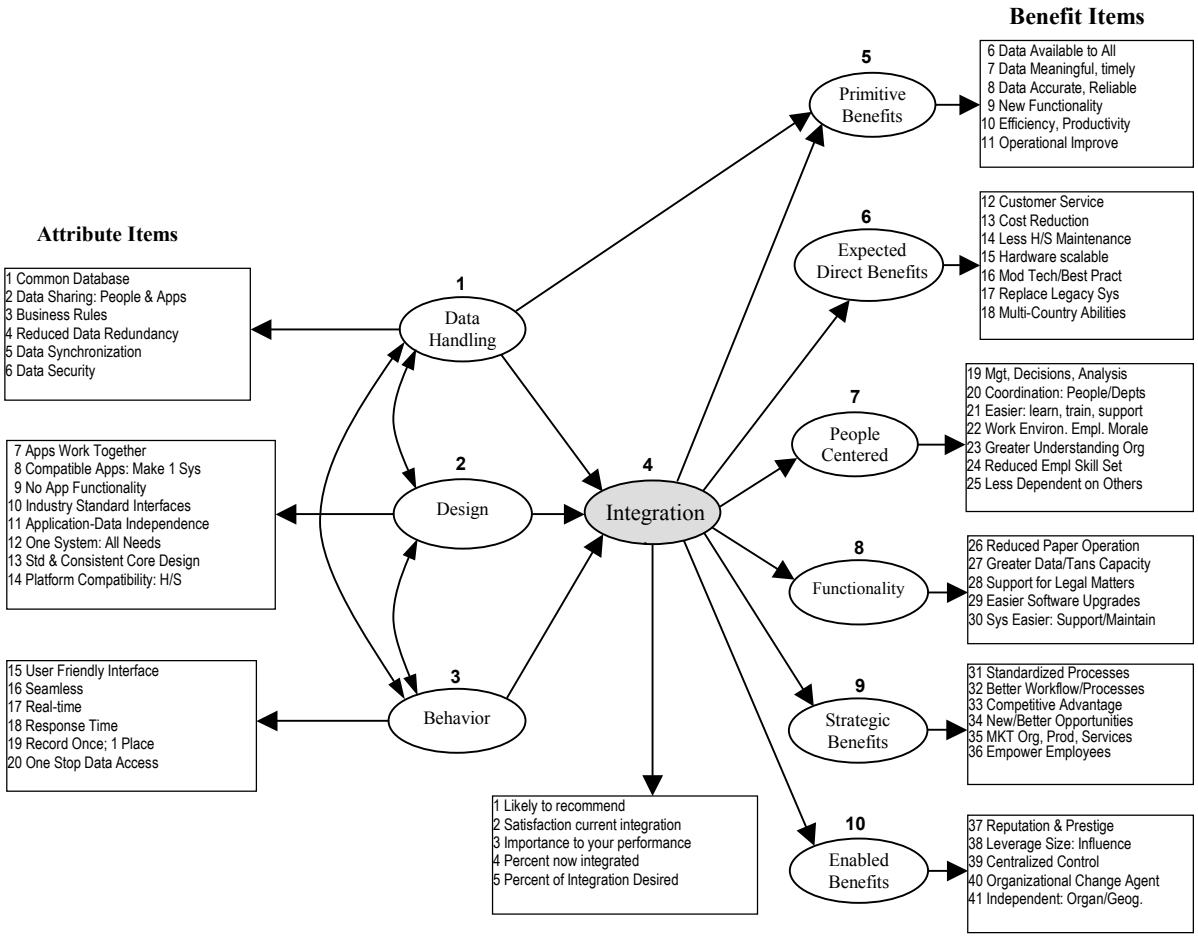

Figure 6: Expanded Research Model With Manifest Variables

100%) integration is desirable. Finally, and most importantly, applications integration is much more than the simplistic idea of applications working together.

Summary of Findings

The qualitative research from the analysis of in-depth interviews of 51 practitioners from four different organizations that represent three stakeholder groups produced several key findings. The data confirms that integration is a ubiquitous and fundamental concept important to all areas of information technology including applications integration, which is the focus of this dissertation. However, as noted above, integration is a fuzzy notion that

varies by person and group. Most people believe that integration is desirable although not for all situations.

So, the question remains, "What is applications integration?" The simplistic idea that applications integration means, "working together," while accurate, is too vague to be of any practical value. Based on this research, a suggested definition of applications integration:

> "Applications integration is an infrastructure represented by a set of applications for a specified domain that share data without any appreciable delay and work together in a coordinated manner to perform all functions required by an organization."

The major contributions of the qualitative phase are:

- It enabled the development of items for the questionnaire
- Dimension for integration attributes and benefits emerged
- Suggestions were surfaced regarding how to assess or measure integration
- Provided a much richer understanding and appreciation of the complexity of applications integration.

CHAPTER 7 – METHODOLOGY: QUANTITATIVE COMPONENT

Chapter 7 describes the development of a new instrument used to collect data on practitioner perceptions of attributes and benefits of applications integration. Details are given about the subjects, survey administration, and the development of the instrument.

Research Design

The research was divided into two parts. Part I is the qualitative component that was described in Chapters 5 and 6. Part II is the quantitative part and is described in Chapters 7 and 8. In part I, interview data was collected and analyzed which provided the foundation for part II. The quantitative part required the development and validation of a new instrument. The instrument was operationalized as a questionnaire and was used to collect practitioner perceptions of attributes and benefits of applications integration from over 399 people. [4]

Subjects

926 people representing three stakeholder groups in three different organizations were surveyed. The stakeholder groups consisted of senior managers, IT professionals, and end-users. The organizations that participated include RU and MRU described in Chapter 5 plus a large retail independent grocery association. The stakeholder groups are described next.

Senior Managers

Senior managers include top-level managers and upper-level middle managers. For universities, this represented vice-presidents, division heads, deans, department heads (academic and administrative), and directors. Looking at an organizational chart, management in the top three to five levels were considered senior managers. The lowest

[4] The total number of questionnaires returned was 512 (55%) as of the final draft of this document. However, 113 were received too late to be included in the results.

level depended on the division. For example, President/chancellor → provost → academic VP → college dean → academic department head represents 5 levels.

This group was considered important to the study because they ultimately must approve and allocate resources for applications integration. Thus, when it comes to applications integration, this research allows us to understand what it is they think that they are authorizing and/or supporting. A key concern is that top management may view this topic much differently than IT professionals or end-users. The strategy of many ERP vendors is to sell a "solution" to top management rather than to IT professionals. Thus, management's view of applications integration is deemed critical.

IT Professionals

IT professionals were originally classified as anyone who worked in a position within the organization who performed IT related tasks. The definition of IT professionals was modified following the pilot testing to include only those who performed tasks that were related to applications design, programming, or database management. Essentially, those who performed IT related functions were divided into two groups: Design/Programming and Technical/Support. These groups are described in greater detail below.

- Design/Programming — This is the group that was considered IT professionals for the purpose of the study. People in these positions were thought to have knowledge regarding applications integration for enterprise systems. The group includes programmers, analysts, database administrators, systems programmers, project leaders, and managers. Positions excluded were operators (computers or any equipment), clerical staff, lab managers, web masters, network and communications employees, data entry people, and user services (unless they support administrative systems).

- Technical/Support — These people were identified on the survey as a second group of IT professionals. However, for analysis purposes they were included with the end-users. They were thought to have similar knowledge about enterprise systems as users because of their position and knowledge of IT. This group included people whose title indicated they were operators, web masters, network, communications, LAN management, user services, lab managers, etc. Positions excluded were clerical and entry level positions.

End-Users

This became the most difficult group to identify. Initially, anyone with a computer on his or her desk was considered an end-user. It became readily apparent that everyone did not have sufficient knowledge to answer the questions on the survey. Thus, end-users were defined as those who had a working knowledge of the organization's administrative applications. They included supervisors, first level management, power users, and IT personnel from group two described above. People excluded from this group were senior management, IT professionals, and entry level positions such as clerks, receptionists, and secretaries. Other groups excluded were faculty, maintenance and custodial workers, and those in similar positions unless they were management or were heavy users of administrative applications.

Potential Sample Bias

Integration is thought to be a universal concept. However, this may not be true. It may be that integration, like government structures, is influenced by philosophical positions and political realities. Those with homegrown systems may wish to protect their turf and are likely to have a different view (probably biased) from those who implemented packaged software like SAP. Of course, the opposite is also possible. Those who have chosen

packaged software over homegrown development probably have a bias for packaged software.

Most people are influenced (positively and negatively) by their experience with computer applications which is reflected in their view. The majority of the questionnaires were from people in higher education, so they may reflect a different opinion than those in private industry. The qualitative study, however, did not indicate any major differences based on industry. Finally, a person's role within their organization may bias their view. While differences between stakeholder groups were expected, differences within groups were also a possibility.

Scale Development

Scale development is a time consuming and complex task not usually undertaken by Ph.D. students. However, development of a new instrument was necessary to address the research questions. The information obtained from the field research and the literature provided the basis for the survey instrument. Analysis of the field study results revealed many of the issues, problems, and possible solutions for integration challenges.

Scale Development Steps

Several authors have described procedures for scale development (Netemeyer et al. 2003, Nunnally and Bernstein 1994). Netemeyer and associates describe four major steps for scale development. Each major step is further subdivided into 3-8 smaller steps. The major steps are summarized below.

Step 1 – Constructs and content domain are defined as part of theory development or extension. The literature review and construct dimensionality are also part of step 1.

Step 2 – Measurement items are created and pre-tested during step 2. Thus, content and face validity are important issues in this step.

Step 3 – The new measure is pilot tested, evaluated, and refined is step 3. Sample data is analyzed (typically with exploratory factor analysis) and rough assessments are made of validity and reliability. A major issue is adjusting the scales items: deleting, adding, and rewording.

Step 4 – Data is collected and fully analyzed in step 4, the final step. Several samples, requiring multiple studies, are necessary to adequately establish the validity of a new instrument.

The scale developed for this study is described throughout this dissertation. Specific issues related to scale items, procedures, and validation are primarily described in this chapter and the one that follows. This dissertation is only one study and additional studies are required to fully validate the proposed scale.

Procedure Overview

The research commenced once a suitable topic was chosen. Development of a new instrument began with a review of the literature (step 1). The initial literature review was undertaken to locate information about applications integration for enterprise systems. A model was created that reflected the constructs and relationships of interest. The first literature search suggested some items that were reflective of the constructs. A second search of the literature was conducted to locate support for the constructs, theoretical grounding, and items to measure the constructs. Again, little was found and only partial support could be located. Additional items related to each construct were found however. The goal of the next literature search was to locate a measure for applications integration or for some of the constructs of the new model. Related measures could not be found. It became clear that a new instrument would have to be created.

The qualitative field study of practitioners was undertaken to better understand the issues involved and to provide ideas for questionnaire items. The first draft of the questionnaire was created based on the analysis of the qualitative data and the information found during the literature searches. The initial questionnaire draft was circulated to enterprise systems domain experts and questionnaire creation experts for their evaluation and input (step 2). The questionnaire was modified based on the feedback from these experts. The next step was pilot testing the instrument to obtain preliminary analysis regarding validity and reliability (step 3). The instrument was revised and the new instrument in its current form was created. Chapter 8 describes the data analysis that is part of step 4.

Scale Items

Considerable detail was provided in Chapters 5 and 6 regarding the origin of the initial scale items. Appendix I contains the questionnaire which lists the items in the instrument. This section briefly describes the dimensions for each set of items. All items are divided into three major groups: Attributes, Benefits, and Degree of Integration.

Attribute Dimensions

Attributes represent a high level construct that defines integration. This construct is made up of four dimensions although originally only three dimensions were thought to exist. Refinement of the scale through further testing may still result in only three dimensions. The current four dimensions are Behavior, Data Handling, Design, and Intrinsic. Each one is described below.

Behavior Attributes

An integrated system is thought to behave in a way that denotes that components are working together. If the system is integrated then functionality of the system should be predictable in a macro sense. The items that constitute behavior are (A) enter data once, (B)

real-time operation, (C) single point of access for all data and functionality, (D) adequate response time, and (E) user-friendly interface to the system.

If components of a system truly work together then it is reasonable to expect that sharing of information takes place. Thus, data can be entered only once and used throughout the system. Closely related to this idea is the notion of real-time. Real-time refers to the fact that all components of the system are immediately aware of and have immediate access to all data as it is entered or to data values as changed by some process. Thus, integration means that all parts have equal and immediate access to changes made to any other part. This notion is the very heart of integration.

Single point of access takes advantage of components working together and data sharing as described above. The idea is that if a system is truly integrated, then all parts have access to all other parts (functionality or data). Thus, an accounts payable clerk should have access to any needed data regardless of the origin of that data. This might include purchasing, inventory, general ledger, and etc. Timely access, as reflected in adequate response time, to data and functionality are important parts of realistic integration. Delays imply either lack of integration or lack of processing power. Either situation is an impediment to components working together. Finally, a system is, for all practical purposes, useless unless the people who use it are able to accomplish the tasks needed or desired. A complex or inconsistent user-interface is an impediment to using any computer system especially a sophisticated enterprise system. While user-friendly may be a stretch in terms of integration attributes (in the purely technical sense), it is a behavioral trait that does bear directly on the practical implementation, use, and subsequent success of integrated systems.

Data Handling Attributes

The concepts associated with a common database have been widely proclaimed by numerous authors during the past 30 years (Date 1995, Hoffer et al. 1999, McFadden and Hoffer 1991, Silberschatz et al. 1977). Based on this research, practitioners agree with many of the database concepts. Specific items included in this dimension are (A) database, (B) data sharing, (C) business rules, (D) data synchronization, and (E) reduced data duplication.

Databases facilitate integration by making it possible and practical for applications and people to share information. This is a fundamental requirement if components are to work together. Business rules define the requirements of organizations for data and processing which greatly helps to ensure consistency in terms of understanding and programming. A shared common store of data reduces and/or eliminates the need for duplicate data. Data synchronization is related to real-time processing and the notion that if data changes anywhere all other parts have immediate knowledge and access to the changed data. Thus, as soon as payroll is run, the results are reflected in accounting and human resources, as well as, payroll. If the organization has a project management system, then actual project costs are updated as well.

Design Attributes

This dimension is somewhat technical and theoretical in nature, which might account for the low reliability and number of items rejected. This dimension and the next one, intrinsic, were originally conceived as one dimension that was named intrinsic. The idea is that integrated systems must be conceived and designed to function as if one system and all the components are to work together. The design dimension has three items: (A) design standards, (B) one system, and (C) a compatible hardware and software platform.

The design standards represent the philosophical approach to design of applications so that they will work together initially and be adaptable to future needs. Typical issues are how applications interact, how data is shared, and how algorithmic functionality, user interfaces, and external system interfaces are implemented and maintained. Returning to the consistent theme of working together, the one system appearance is accomplished only through a well-thought out plan and design. Finally, the system must be designed to operate with a specified set of hardware and software platforms.

Intrinsic Attributes

As mentioned above, this construct was originally conceived to include the design dimension. The notion that integration means working together implies that there should be something about a set of applications that constitutes integration. If so, this notion would be the fundamental incarnation of what it means to be integrated. Thus, the items that comprise the dimension could be thought of as intrinsic or central to an integrated set of applications. Intrinsic is operationalized for integration as (A) applications talk, (B) compatible applications, and (C) seamless.

Clearly applications cannot work together unless some mechanism is provided for the applications to interact and communicate. A database provides a way to communicate data. Yet, coordination of functionality requires other mechanisms. Compatible applications also mean that applications must work together to accomplish required tasks and implies that duplicate functionality among applications is not needed. Seamless means that the components appear to work together as if all the applications were one application. This also implies that a set of applications work together as one system.

Benefits

Benefits were originally conceived as a unidimensional construct. The results from phase I suggested that benefits were multidimensional constructs that consisted of at least six dimensions.

Strategic Benefits

Strategic benefits consist of six items (1) new opportunities, (2) reputation and prestige, (3) leverage size, (4) marketing, (5) competitive advantage, and (6) empower employees. It should be obvious that these are business benefits. These particular items are possible although not necessarily automatic benefits. Organizations must enact policies and actively pursue these benefits. As such, these are types of enabled benefits but are delineated from the other enabled benefits because of the strategic nature of the items.

Many new opportunities become available because of the very nature of integration that improves coordination and facilitates data sharing and data quality in a real-time operational mode. These include improved customer services, lower inventories, and reduced cycle times. Practitioners believe that improved operations and new functionality can lead to enhanced reputation due, in part, to a more modern and responsive organization. Even small organizations have more leverage if operations are coordinated. For instance, price savings and concessions are more likely if items needed by all departments are purchased in bulk at one time.

Marketing is improved on at least two fronts–the organizational image and the products and services. Accurate and timely information makes it possible to be more price competitive, understand customer needs, and improve distribution, along with similar capabilities. Competitive advantage can be achieved because of a more efficient and effective organization–one where all operations are well coordinated, and duplication of

effort and processing is eliminated or greatly reduced. Employees are empowered when they have a system that provides all their needs through a single interface. Something as simple as access to all data empowers an employee to solve problems and answer customer inquiries without having to bounce customers from one place to another.

Functionality Benefits

Basic business benefits that flow from integration are those that enhance routine operations and provide additional and/or improved functionality. For this dimension, practitioners thought the following are important: (1) Efficiency, (2) new functionality, (3) operational improvements, and (4) customer service. Clearly, all of these items can affect functionality in a positive manner. Efficiency means lower costs and increased productivity. New functionality includes numerous capabilities like web enabled applications and real-time access to data. Operational improvements result from better standard business processes, improved coordination among departments, and workflow improvements. A frequently cited advantage is customer service that covers a range of possibilities. These include shorter cycle time, new services (e.g. online purchases and access to product information), and problem resolution.

Support Benefits

All computer applications require support. People perceived that integration improved support in three ways: (1) the system was easier to support, (2) software upgrades were easier, and (3) it was easier to train staff. It is unclear why users felt that the system was easier to support or why software upgrades were easier because many IT professionals cited both of these items as a downside to integration. It may be a matter of impression over fact. An integrated system could appear more like a "well-oiled" modern machine. The uniformity and consistency of the user interface and system functionality seems to account

for the perceptions about easier training. This, like many other benefits, however, frequently seems tied to a commercial software package rather than to integration per se.

Enabled Benefits

Enabled benefits are those benefits made possible by integration. They include (1) standard business practices, (2) better processes and business practices, (3) improved overall understanding of the organization, and (4) an improved work environment. While these benefits are possible, organizations must intentionally seek them and establish polices and practices to achieve the benefits. Standard business practices are made possible because integration means all parts work together regardless of location or division. Naturally, the same set of applications must be implemented everywhere if standard practices are to become a reality. Better business practices, like standard business practices, are made possible by implementing a common set of applications firm-wide. Both benefits are due, in part, to consistency across organization units and geographic locations. This is necessary if the organization is to work together effectively, as a whole, as integration denotes.

Employees can gain a better overall understanding of an organization if the organization takes advantage of the capabilities offered by integration. This empowers employees and makes them less dependent on other people and departments. Access to more relevant data and newly acquired capabilities require learning about the data and processes involved. This leads to employees gaining an increased understanding of the organization.

Data Use Benefits

Integration is the mechanism that binds components together and facilitates the coordination of functionality. In this sense, integration is like a water supply infrastructure with all the pipes and the pressure whereas data is like the water—the substance and object of the infrastructure. Effective data management and use is required to accomplish

organizational objectives and conduct routine operations which are the real objective of an enterprise system. Data is the very heart of this endeavor.

The data use dimension is the complement of the data-handling dimension of the attributes construct. Since an integrated system is expected to manage data in a given way, it stands to reason that associated benefits should be expected. Practitioner perceptions of this dimension are (1) timely data, (2) accurate data, (3) meaningful data, and (4) non-duplicated data. Timely data is tied to the idea that all components work together in a real-time mode to share data without delay. Accurate data is expected because data is defined according to business rules, data is non-duplicated, and all components work together.

Accuracy has a temporal implication. Clearly, the funds available for expenditure are not accurate unless it reflects the payroll that was run 20 minutes ago. Whether or not that degree of accuracy is needed is another question, although it does not change the reality of the accuracy. Data becomes more meaningful because it is more timely and accurate. Therefore the variety of uses for the data becomes greater. For example, sales people can serve customers with greater confidence and reliability if they have up-to-date information about all orders, inventory, and production scheduling. Finally and ideally, a fully integrated system has no need for duplicated data, which is a fundamental principle of a common database.

Economic Benefits

Cost savings or economic advantages are the set of primary benefits that typically first come to mind when one talks with practitioners about the benefits of integration. That is probably true because it implies cost savings and people often seem to equate money with benefits (e.g. cost/benefit analysis). Practitioners agreed on four economic related benefits: (1) Less hardware and software maintenance, (2) more scalable hardware, (3) lower cost in

general, and (4) utilization of modern technology and best practices. It seems that a well-integrated set of applications requires less hardware and software to achieve desired functionality. Additionally, successful application integration techniques utilize a scalable hardware platform that is cheaper to acquire and maintain than the very expensive mainframes used by older legacy systems. Also, newly developed systems tend to capitalize on the latest and best technology and employ the most recently proven best practices for the industry.

Degree of Integration

Degree of integration was an attempt to operationalize integration with scales borrowed partially from marketing. The idea was to obtain a global measure of integration in order to have a baseline for analyzing the relationship of attributes and benefits to integration. This scale item proved unreliable and this part of the model requires revision.

Instrument Validation

"The term 'validity' denotes the scientific utility of a measuring instrument…in terms of how well it measures what it purports to measure" (Nunnally and Bernstein 1994, p. 83). So, one can conclude that instrument validation must ensure that the instrument measures what it claims to measure. Several types of validity have been suggested. The three major ones are content, construct, and predictive (Nunnally and Bernstein 1994). Other ones include external validity, discriminant validity, and convergent validity. Netemeyer et al. (2003) suggest validation for each of the four scale development steps. Initial validation of the instrument is described in this chapter for steps 1-3. Face validity and content validity are discussed is greater detail below. Chapter 8 describes validation for step 4.

Face Validity

Face validity is the degree to which participants believe the questions pertain to the purported target of the inquiry. Questions about math would have low face reliability on an English composition exam. However, questions asking you to compute areas for various geometric shapes would have high face validity for a geometry math test. The process of pre-testing and pilot testing the questionnaire supported face validity. Reviewers of the questionnaire and pilot test participants both reported that the questions were appropriate for the topic. No one complained that the questionnaire contained items that were irrelevant to applications integration. However, some questions were raised in the survey administration about one item. One person could not see the relationship between applications integration and employee morale.

Content Validity

Content validity is how well the instrument is representative of the subject domain (Kerlinger and Lee 2000). Adequate content validity is a matter of judgment and usually experts in the field are called upon to render a judgment. Content validity was supported several ways during the pre-test and pilot test. Academic domain experts with extensive experience and knowledge of enterprise systems, programs, and systems analysis were consulted several times at various points during the development of the instruments. Five Ph.D. students who studied ERP systems were also consulted. Additionally, practitioners with extensive knowledge and experience reviewed the instrument while it was under development. These include a computer center director, database administrator, two programmer/analyst, director of MIS, and a project leader. The questionnaire was modified to reflect the feedback received from all groups.

Threats to Validity

Major threats to validity for this particular study included those issues related to statistical analysis and methodology. Statistical issues include sample size and required assumptions for the selected statistical technique. Both of these issues are discussed in the next chapter along with the data analysis.

Methodology issues included the selection of participants, survey administration, and a faulty survey instrument. The survey instruments and validity checks at various stages are described in the next sections and to some extent in other chapters. Survey administration is discussed in the last section of this chapter.

Pre-Test

Pre-testing is part of step 2 for scale development. This step helps to ensure face and content validity of the instrument. The initial draft of the survey was circulated to faculty (as described earlier) who had expertise in enterprise systems, systems analysis and design, methodology, research design, statistical analysis, and questionnaire writing (Netemeyer et al. 2003). Also, several practitioners (as previously described) reviewed the questionnaire and provided valuable feedback. The questionnaire was revised based on the feedback received.

The above process was repeated multiple times. Therefore, the survey instrument development became an iterative process that spanned several months. In many cases, feedback required additional literature review to investigate various aspects of integration, enterprise systems, survey design, and methodology. A major issue all along was the best way to analyze the data. Therefore, the questionnaire was designed with statistical analysis in mind.

Pilot Test

Step 3 requires pilot testing to gain additional support for content validity and to obtain initial indications about construct validity and reliability (Netemeyer et al. 2003). The questionnaire was pilot tested with 51 people, which is less that the 100 recommended. 37 were Executive MBA students and 14 were from various organizations. 20 represented management, 7 were IT professionals, and 10 were end-users. The sample was not taken from the target audience due to lack of opportunity and to avoid cannibalizing the primary source of data for the main survey. Also, the concept of integration was thought to be universal and thus the data source not critical.

The data were analyzed with exploratory factor analysis to determine how well the items loaded and to determine if items factored as predicted. Then confirmatory factor analysis, using Lisrel, was run to determine how well the data fit the theoretical model. The pilot test indicated that, in general, the questions were valid and that most items factored according to the theorized dimensions. The CFA fit was poor and several wording problems were discovered. The initial analysis seemed to support content and face validity for the survey items.

Analysis of the pilot results indicated a need to modify 17 questions. Three questions were split into two questions because they were "double-barreled" questions meaning that each question contained more than one idea. For example, the original question, "A benefit of integration is data is more meaningful and timely" was split into separate questions that read:

"A benefit of integration is data is more meaningful"

"A benefit of integration is data is more timely"

Two questions were deleted because they were determined not to relate well to any dimension or the idea was sufficiently captured by other questions. Twelve questions were reworded to shorten them and improve the clarity in an attempt to improve how they loaded. These questions did not load on any factor, loaded on the wrong factor, or had very weak loadings. The low sample size was considered in making the changes.

The Final Instrument

The questionnaire consisted of four pages (Appendix I). Page one contained a brief statement about the research, instructions, definition of key terms, and a statement to the effect that completing and returning the survey constituted consent of the participant. This last part was necessary in order to comply with the requirements of the internal review board that oversees the use of human subjects in research.

The two inside pages were divided into four parts. Part I contained 22 Likert 7-scale questions about integration attributes. Part II contained 38 Likert 7-scale questions about integration benefits. Part III contained five questions about the degree of integration related to the participant's organization. Part V asked five questions about the participant's position and IT related background. The last page provided space for participants to write comments for three opened-ended questions.

Survey Administration

The questionnaire was made available on both paper and on the web. Most people had three choices:

- Fill in the paper questionnaire and return it in the enclosed envelope
- Fill in the questionnaire on the web
- Fill in the paper questionnaire and return it by fax.

Dillman's tailored design method (TDM) was followed to create and administer the survey (Dillman 2000).

The Five Elements of Dillman's TDM

The Dillman TDM plan has five elements: (1) Respondent friendly questionnaire, (2) Five contacts, (3) Return envelopes with real stamps, (4) Personalization of correspondence, and (5) Token prepaid financial incentives. The five elements are suggested to achieve a high response rate. These elements are described below along with how the plan was adapted for this research.

Element 1: Respondent Friendly Questionnaire

Through careful design and layout, the questionnaire was professional in appearance, easy to ready, and required only a few minutes to complete. To comply with this element, the survey was printed on 11x17 attractive light blue, quality parchment paper, which was folded in half to form an 8½ x 11 booklet. Each question was brief and took no more than one line. Questions averaged less than ten words each (661 words / 69 questions). An average of twelve minutes was required to fill in the questionnaire (based on pilot testing).

Element 2: Five Contacts

The plan called for four contacts by first-class mail with an additional special contact. Dillman recommends a pre-announcement, initial mailing, follow-up postcard, a second follow-up containing a replacement survey, and a final contact by telephone, overnight express, or similar means. The procedures implemented for this research were:

1. First contact — A pre-announcement signed by the Ph.D. advisor was sent by email about one week before the surveys were mailed.
2. Second Contact — The surveys were mailed in a 10x13 white envelope that contained a cover letter on ivory paper signed by the Ph.D. advisor, a pre-

addressed return envelope, and a raffle ticket. The delivery and return method varied by organization. One university allowed use of campus mail so no postage was necessary. The initial packet at the other university was hand delivered to departments although the return envelopes contained a real stamp. The private organization would only participate using the web survey and therefore no stamps or packets were required.

3. Third Contact — A reminder postcard signed by the Ph.D. advisor was sent the week following the initial mailing. Postcards sent via the U. S. postal service contained real stamps.
4. Fourth Contact — The second and final follow-up was delayed a week due to spring break and therefore was not sent until three weeks (instead of the two weeks recommended by Dillman) after the postcard follow-up. This follow-up included a replacement survey and return envelope.
5. Fifth Contact — Due to the excellent response rate and costs of the recommended procedure, the final special contact was not made.

Element 3: Return Envelopes With Real First Class Stamps

As described above, those envelopes that were to be returned by U. S. mail contained real stamps. The return envelopes were white and pre-addressed.

Element 4: Personalization of Correspondence

All correspondence with participants was addressed to the individuals and signed. Each correspondence was printed in upper and lower case as if addressed to only the one person. Care was taken to reduce the appearance that correspondence was a form letter.

Element 5: Token Pre-Paid Financial Incentives

Financial incentives have been found to increase response rates for mailed questionnaires. Dillman cites evidence that incentives must accompany the survey to be effective. The promise of an incentive, despite of value, has little or no effect on response rate. Incentives become expensive when surveying a large group of people. A raffle ticket was included with each survey. The raffle ticket offered a chance to win one of eight prizes:

First Prize — One $50.00 gift certificate to a restaurant of choice
Second Prizes — Two $25.00 gift certificates to a restaurant of choice
Third Prizes — Five "mystery" prizes valued at $10.00 or more

The term "raffle" was a poor choice of words since (1) the tickets given away are not true raffle tickets by definition because participants did not pay for them and (2) true raffles are a form of gambling that requires a permit from the state in many instances. A better choice of words for "Raffle" would have been "Free Drawing." An informal follow-up interview suggested that the raffle ticket did increase participation but only marginally. Some did not return the raffle ticket while others thought the raffle ticket helped get people to at least consider filling out the questionnaire. One person had no opinion about raffle tickets.

Additional Measures Taken

As described earlier, three options to participate were provided. A few days after each mailing, a brief email was sent that provided the url for the web survey along with any other information deemed appropriate. For instance, by the time the reminder postcard was sent, a couple hundred surveys had been returned and several emails about the survey were received. Comments from both sources indicated that some people wondered if they were qualified to fill out the survey. In response, a website was created with typical questions and answers. The website was announced via email following the postcard reminder.

CHAPTER 8 – DATA ANALYSIS AND RESULTS: QUANTITATIVE COMPONENT

In this chapter, the data analysis of the questionnaire data is described and discussed. The procedures that were followed are also explained, along with the appropriate literature to support the data analysis technique. Then, the results of the questionnaire data analysis are discussed.

Level of Analysis

Analysis is at the individual level. Individual perceptions are important because people make decisions about integration as described in previous chapters. While the primary focus of the data analysis was at the individual level, some analysis was performed at the group level for stakeholders. The group analysis was made to determine if differences among groups exist. Groups tend to behave differently than individuals. "The potential for the group and individuals to have incompatible goals clearly exists" (Hellriegel et al. 1995, p. 269). A pronounced difference of perceptions about integrations among stakeholder groups is thought to have implications for success, costs, and effectiveness of enterprise systems.

Data Analysis Strategy

Data analysis was organized into five stages. Stage one focused on data quality. Exploratory factor analysis was performed in stage two. The dimensionality of the items was investigated in stage three. In stage four, confirmatory factor analysis was conducted to analyze higher model using summated scales of the dimension. Stage five analyzed the structural model for the higher order constructs. Stages three and four provided the results to test hypotheses and assess the propositions. Initial analysis of stakeholder differences was then examined. The remainder of this chapter describes the data analysis and the results obtained. The chapter ends with a discussion of the results.

Stage 1: The Data

Data Inspection

Data analysis began with an inspection and review of the data to assure it was suitable for analysis. The guidelines suggested by Hair, et al. (1998) were followed. These included missing data patterns, adherence to statistical assumptions, identification of outliers, and a review of skewness and kurtosis.

Visual Inspection

First the data was visually inspected. Twelve surveys were eliminated due to what appeared to be reverse coding. The 7-point Likert scale ranged from 1 (strongly disagree) to 7 (strongly agree). A visual inspection of the data suggested that those removed were using 1 as strongly agree and 7 as strongly disagree. This assertion was reinforced because a couple of participants made comments that the scale should have been reversed. Also, a visual inspection of several surveys indicated that people began reverse coding but after a few questions, went back and changed their response to the proper scale as reflected on the questionnaire. Three surveys were removed because the numbers of items left blank exceeded 30% (Hair et al. 1998). Thus, a total of fifteen surveys were deemed unusable.

Missing Data

The data was examined for missing data and action was taken as indicated by the situation (Hair et al. 1998). Two types of missing data patterns were examined. The first type has to do with the number of variables that have missing data for each person. One case had data missing for seven items which was 11% but below the 30% cutoff (where cases should be discarded). The other type of missing data pattern required reviewing the number cases that had missing data for each variable. One variable had missing data for nine cases which was 2.3% of all cases (9 / 399) and is considered insignificant. For the 399 cases

across 62 variables, 82 items were missing. This was .033 %. Therefore, it was concluded that missing data was not a problem. Missing data was filled in based on the mean substitution imputation method. This is a procedure where missing data is replaced with the average of the data from the cases where complete data is available as recommended by Hair et al (1998).

Normality Assessment

The data was examined for normality including linearity. Normality is an assumption for many multivariate techniques such as multiple regression and SEM. For factor analysis and SEM, the main concerns were outliers, linearity, and homoscedasticity. Kurtosis and skewness are the two main tests normally conducted for univariate normality. However, normal distribution is not as critical for factor analysis and CFA as for many multivariate statistical techniques like multiple regression (Hair et al. 1998). This is not to say that lack of normality does not affect the analysis because correlations, which are the basis of factor analysis, can be affected.

Descriptive statistics were also inspected for signs of normality violations. Appendix J contains the descriptive statistics for all items including those items that were removed during factor analysis. The frequency distribution of all Likert scaled items is contained in Appendix K. The data was found to be consistently negatively skewed. This was likely the result of the nature of the Likert scales for questionnaires of the type used for this research. After a careful review the data and the results of all tests, the data was considered suitable for further analysis

Descriptive statistics are also helpful for detecting outliers and assessing univariate normality. The recommended test for outliers is to convert the data to standardized scores to check for values > 2.5 for small samples and > 3 or 4 for large samples (Hair et al. 1998).

Table 15: Outliers (> 3.5 standard deviations)

Occurrences	Cases		Variables	
	Count	% of total Cases	Count	% of variables
1	15	3.8%	3	5.1%
2	16	4%	6	10.2%
3	7	1.8%	3	5.1%
4	4	1.0%	2	3.4%
5	0	0%	5	8.5%
6	1	0.2%	2	3.4%
7	0	0%	0	0%
8	0	0%	0	0%
9	1	.2%	1	1.7%
Total	44	11%	22	37.3%

Outliers were examined by case and by variable. The results are summarized in Table 15. Although several outliers were detected, the data was considered acceptable because of the very small percent (3%) of cases with multiple outliers involving only 9% of the variables. Besides, Hair et al. (1998) cautions against eliminating outliers because of generalizability reasons unless the outliers are considered indicative of erroneous data.

Multivariate normality was determined by inspecting scatter plots after ensuring that univariate normality was acceptable. The data was inspected based on the above guidelines and was considered satisfactory for factor analysis and SEM (Hair et al. 1998; Kline 1998).

Sample Size and Response Rates

Sample size is important for most types of statistics. For factor analysis, a minimum of five cases is required per variable (Hair et al. 1998). For this research, the minimum number of cases was 295 (5 cases x 59 variables). Thus, sample size was judged adequate because the number cases available were 399 which was 6.8 cases per variable and well above the minimum. The number of cases required for SEM is between 200-400 (Kline 1998) and thus considered adequate.

Table 16 shows the survey response rates. Initially, 915 surveys were mailed. An additional 40 people were requested to complete the survey on the web but were not mailed a

Table 16: Survey Response Rate

Organization	Number Solicited	Surveys Returned	Response Rate	Not Usable	Participation Declined
Major Research University	598	252	42.1%	11	29
Regional University	288	145	50.3%	4	11
Grocery Association	40	17	42.5%	0	0
Total	926	414	44.7%	15	40

survey. Of the 915 mailed, 29 people were removed for a variety of reasons including bad addresses, no longer with the organization, and selection mistakes. A total of 454 people responded of which 414 completed the survey and 40 indicated they did not wish to participate. The average response rate of 44.7% was higher than for some studies published in top journals (e.g. the response rate for Susaria, et al. 2003 was 25%).

Stage 2: Exploratory Factor Analysis

The 59 items were analyzed to access dimensionality. Twenty-one of the items pertain to attributes and the other 38 are concerned with benefits. The qualitative results suggested there were three dimensions for attributes and six dimensions for benefits. Initial analysis was performed with exploratory factor analysis (EFA) using the principal components method. This step was taken to remove items where there was a lack of evidence indicating that the items were part of a hypothesized dimension. Items were removed one at a time using the following procedure.

1. Items with a communality values < .450 were removed.
2. Items with a MSA (measure of sampling adequacy) < .500 in the anti-image matrix were removed.
3. Items that did not load with any other item were removed.
4. Items that had loadings < .450 were removed.

Table 17: Items Dropped During Exploratory Factor Analysis

Higher Level Constructs	Item Dropped (in order dropped)	Reason Dropped
Attributes 4 out of 21	Security	Loaded in wrong factor
	Dup application function	Loaded in wrong factor
	Standard interfaces	Two item factor
	Application/Data Independence	Low communality < .400
Benefits 13 out of 38	Independent organ/geog	Would not load (loading < .400)
	Dependence on others	Only 2 items in factor
	Data available to everyone	Single item factor
	Computing capacity	Would not load
	Reduced paper	Communality < .450
	Central control	Communality < .450
	Employee skill set reduced	Only 2 item factor
	Organizational change	Double loaded
	Replace legacy system	Single item factor
	Multi-country support	Double loaded
	Management and decision support	Loading < .450
	Legal support	Single item factor
	Software upgrade easier	Loading < .450
Degree of Integration All	Likely recommend integration	Only two items would factor which has a low alpha (reliability) of .540.
	Satisfied cur integration	
	Integration import to job	
	Satisfaction = Current % integrated / % thought possible	

5. Items that double loaded were removed. Double loading occurs when the factor score >= .500 on more than one factor.
6. Items were removed if an item loaded on a factor where it seemed unreasonable for that item to be associated with the other items in the factor.

The above process was repeated if an item was removed. Thus the final solution was the result of several iterations of item analysis and evaluation. The items dropped during the process described above are shown in Table 17 along with reason why they were dropped.

Initial construct and discriminant validities were supported by performing Principal Component factor analysis with Varimax rotation. All items loaded on the appropriate factor with loading typically above .600 (greater than the recommended .500 minimum). Table 18 contains the factor solution for attributes. Table 19 contains the factor solution for business

benefits. The factor solution for core benefits is contained in Table 20. The last two columns in each table show reliability. Alpha is Cronbach's alpha. AIC is average inter-item correlation

Table 18: Exploratory Factor Loadings: Attributes

Item	Behavior	Data Handling	Design	Intrinsic	Alpha	AIC
Enter data once	.690				.753	.383
Response time	.685					
Single access	.618					
Real-time	.609					
User friendly	.566					
Bus rules		.729			.746	.378
Dup data		.707				
Data sharing		.706				
Database		.641				
Data sync		.521				
Design stds			.762		.577	.325
One system			.717			
Com H/S platform			.540			
Apps Talk				.748	.619	.353
Comp apps				.700		
Seamless				.647		

New measure scales should have reliabilities of at least .60 (Nunnally 1978). Alphas of at least .70 are widely advocated (Netemeyer et al. 2003). However, some authors argue that higher alphas of at least .80 are necessary (Straub 1989, Clark and Watson, 1995). The alphas ranged from .577 to .851 with only one factor less than .60. Alphas can be affected by the number of items that represent the factor. Simply increasing the number of items can increase the alpha. The survey instrument contained at least five items per dimension although most dimensions consisted of six or more items. The final EFA solution resulted in an average of four items per dimension with three dimensions having only three items. Thus, the reliabilities were considered acceptable.

Table 19: Exploratory Factor Loadings: Business Benefits

Item	Strategic	Functional	Support	Alpha	AIC
New opportunities	.763			.851	.492
Reputation/prestige	.748				
Leverage size	.745				
Marketing	.710				
Competitive advant	.697				
Empower empl	.662				
Efficiency		.824		.795	.495
New functionality		.752			
Op improvements		.736			
Cust service		.701			
Sys easier support			.870	.790	.554
Soft upgrade easier			.816		
Easier train & learn			.703		

Another measure of reliability is average inter-item correlation (AIC) which some feel is a better indication of reliability than Cronbach's alpha (Netemeyer et al. 2003). AICs in the range of .30 to .50 are desirable for narrowly defined factors (less than 7 items). The AIC ranged from .325 to .554 with only four out of ten below .40. Thus, the AIC values further supported the reliability of the constructs. Interestingly, the four constructs below .40 were the four dimensions of integration attributes. This was not too surprising because, as noted all along, people seem to have difficulty articulating what integration "is".

Table 20: Exploratory Factor Loadings: Core Benefits

Item	Enabled	Data Use	Efficiency	Alpha	AIC
Std bus practices	.774			.761	.448
Better processes	.773				
Understand organ	.685				
Imprv wrk environ	.617				
Data Timely		.787		.782	.480
Data accurate		.768			
Data meaningful		.743			
Dup Data		.682			
Less H/S maint			.809	.810	.517
Hardware scalable			.801		
Lower costs			.769		
Mod tech & pract			.516		

Table 21: Confirmatory Factor Analysis: Scale Development

Construct	Indicators	Std. Loading	Std. Error	T Value	P Value	Indicator Reliability	Composite Reliability
Behavior	Enter data once	.48	.76	11.12	< .01	.23	.75
	Response time	.71	.50	8.70	< .01	.50	
	Single access	.54	.71	7.59	< .01	.29	
	Real-time	.62	.61	8.21	< .01	.38	
	User friendly	.74	.46	8.86	< .01	.55	
Data Handling	Bus rules	.59	.65	10.01	< .01	.35	.75
	Dup data	.67	.55	9.59	< .01	.45	
	Data sharing	.59	.66	8.81	< .01	.35	
	Database	.61	.62	9.07	< .01	.37	
	Data sync	.61	.62	9.09	< .01	.37	
Design	Design stds	.57	.67	7.26	< .01	.32	.58
	One system	.48	.77	7.13	< .01	.23	
	Com H/S platform	.64	.59	8.60	< .01	.41	
Intrinsic	Apps Talk	.49	.76	8.44	< .01	.24	.62
	Comp apps	.61	.62	7.10	< .01	.37	
	Seamless	.67	.55	7.29	< .01	.45	
Strategic	New opportunities	.75	.43	17.55	< .01	.56	.85
	Reputation/prestige	.68	.54	13.27	< .01	.46	
	Leverage size	.64	.59	12.46	< .01	.41	
	Marketing	.72	.48	14.14	< .01	.52	
	Competitive advant	.73	.47	14.32	< .01	.53	
	Empower empl	.69	.53	13.28	< .01	.48	
Functionality	Efficiency	.78	.39	13.91	< .01	.61	.80
	New functionality	.67	.55	13.05	< .01	.45	
	Op improvements	.72	.49	13.94	< .01	.52	
	Cust service	.66	.57	12.70	< .01	.44	
Support	Sys easier support	.82	.32	18.22	< .01	.67	.81
	Soft upgrade easier	.82	.33	16.72	< .01	.67	
	Easier train & learn	.64	.60	12.73	< .01	.41	
Enabled	Std bus practices	.65	.58	11.93	< .01	.42	.77
	Better processes	.69	.53	11.62	< .01	.48	
	Understand organ	.66	.57	11.17	< .01	.44	
	Imprv wrk environ	.69	.53	11.58	< .01	.48	
Data Use	Data Timely	.79	.37	15.13	< .01	.62	79
	Data accurate	.72	.48	14.16	< .01	.52	
	Data meaningful	.70	.52	13.59	< .01	.49	
	Dup Data	.57	.67	11.00	< .01	.32	
Efficiency	Less H/S maint	.82	.33	15.01	< .01	.67	.81
	Hardware scalable	.72	.48	14.99	< .01	.52	
	Lower costs	.68	.54	13.99	< .01	.46	
	Mod tech & pract	.67	.55	13.87	< .01	.45	

Stage 3: Dimensionality of Items

Confirmatory factor analysis differs from exploratory factor analysis in that CFA requires you to specify factors whereas EFA produces a factor structure (Netemeyer et al.

2003). CFA is useful to validate dimensionality of scale items and to discover possible threats to dimensionality (Hair et al. 1998).

Measurement Model Fit

The initial measurement model was analyzed with CFA using LISREL 8.50 (Jöreskog and Sörbom 2002). The items that survived exploratory factor analysis were entered into CFA. Table 21 contains the results. The overall fit was examined and found to be mixed. The normed Chi-Square (NCS) of 2.49 was calculated by dividing Chi-Square (1,828) by the total degrees of freedom (734). NCS values between 1 and 3 are considered statistically significant and indicate that the model should hold (Raghunathan et al. 1999). Chi-Square is the only true statistical test and therefore this value is important. X^2 is closely related to sample size which was judged adequate. However, X^2 was significant indicating a potential fit problem. Because X^2 was significant the other goodness of fit indicators were given more consideration.

The Root Mean Square Error of Approximation (RMSEA) was .061. This is the accuracy of the fit measures taking into account the approximated error of the population. RMSEA < .10 is recommended (Netemeyer et al. 2003). Thus, .061 was considered acceptable.

The remaining indicators were lower than the recommended .90 (Netemeyer et al. 2003). Normed Fit Index (NFI) was .75. The Non-Normed Fit Index (NNFI) was slightly higher at .81. NNFI is an indicator of the goodness of the total variance explained by the model. The Comparative Fit Index (CFI) was .83 and the Adjusted Goodness of Fit Index (AGFI) is .79. CFI provided an estimate of the model's relative misfit to a baseline model. Higher numbers indicate a lower misfit.

Reliability

Measures of reliabilities that have been used in MIS research are indicator reliability and composite reliability (Susaria et al. 2003). Indicator reliability is the standardized factor loading (lambda values) squared which varied from .23 to .67 for this model. This is also a measure of the variance explained by the indicator for the construct. Composite reliability (CR) was also considered. As noted earlier, reliabilities for new scales should be at least .60 with .70 being a more widely accepted value. The composite reliabilities for this model ranged from .58 to .81 with Intrinsic < .60 at .58 and Design < than .70 at .62. The CFA reliabilities were comparable to the reliabilities calculated in SPSS using Cronbach's alpha and average inter-item correlations (Table 18, Table 19, and Table 20). Thus, the reliabilities of the scales were considered acceptable.

Validity Testing

The validity and reliability of the revised conceptual were examined. Content and face validities were addressed in Chapter 7. Construct validity, convergent validity, discriminant validity, and statistical conclusion validity are described in this section.

Construct Validity

"Construct validation is concerned with validity of inferences about unobserved variables (the construct) on the basis of observed variables (their presumed indicators)." Pedhazur and Schmelkin 1991). Some questions to be answered are have the correct constructs been selected to explain the phenomenon and have the constructs been correctly operationalized to represent the constructs? Neither of these questions can be answered with absolute certainty and it may take years to find sufficient evidence to adequately support the contention that constructs are valid and have been properly operationalized.

A variety of procedures allow the investigation of construct validity. They include discriminant and construct validities both of which are described later in this section (Kerlinger and Lee 2000). This means that support for construct validity exists if there are relatively high correlations between measures of the same construct using different methods (convergent validity) and low correlations between measures of different constructs (Straub 1989).

For CFA, convergent validity can be demonstrated if T values are > 2 for P = .05 (Kline 1998). All loading and T values exceeded the minimum requirement (see Table 21). Also the loadings were acceptable although a few were marginal at .48 and .49. However, data from Table 18, Table 19, and Table 20, shows that all loadings from principal component factor analysis were >= .500 as recommended (Hair et al. 1998).

Discriminant Validity

Discriminant validity was tested to determine the degree of correlations among the different constructs. Low correlations are expected if each construct is unique and measures a different dimension. EFA correlations among integration and benefit indicators were low. All were below .52 and most were below .40 implying initial discriminant validity. However, this test was not conclusive and the more formal CFA test was performed which is described next.

Confirmatory factor analysis provides a more rigorous test of discriminant validity based on Average Variance Extracted (AVE) (Kline 1998). Table 22 contains the correlations for the ten dimensions (four attributes and six for benefits). This data is needed to calculate AVE. The calculated AVE is presented in Table 23. Confirmatory factor analysis was used to test an unconstrained model. Co-variances across a pair of factors are reviewed to determine if the factors are sufficiently different. This is accomplished in a

Table 22: Correlations Among Dimensions

	Behavior	Data Hand	Design	Intrinsic	Strategic	Function	Support	Enabled	Data Use	Efficient
Behavior	1.00									
Data Hand	0.58	1.00								
Design	0.78	0.47	1.00							
Intrinsic	0.51	0.53	0.54	1.00						
Strategic	0.57	0.42	0.50	0.44	1.00					
Function	0.56	0.43	0.39	0.50	0.57	1.00				
Support	0.42	0.23	0.51	0.36	0.54	0.45	1.00			
Enabled	0.61	0.54	0.59	0.52	0.86	0.66	0.71	1.00		
Data Use	0.61	0.51	0.32	0.33	0.55	0.78	0.44	0.60	1.00	
Efficient	0.61	0.37	0.59	0.30	0.67	0.63	0.77	0.69	0.56	1.00

three-step procedure. In step 1, the sum of the squared correlation for the indicators of the constructs was calculated. Second, for each pair of constructs, the AVE is calculated by averaging the sum of the squared correlation from step 1. Third, discriminant validity would be supported if the AVE was greater than the squared correlation for the two constructs.

Of the 45 possible combinations for the ten dimensions, discriminant validity was found for all combinations except six. However, the AVE test supported discriminant validity for only two of the ten dimensions. The four AVEs printed in bold did not pass the test completely (Table 23). These represent pairs of dimensions and therefore eight dimensions are affected. One problem was among two of the four integration attribute dimensions (design and behavior) indicating that the two dimensions were not sufficiently distinct. The other three problems were among the six benefit dimensions. All the dimensions are considered unique and conceptually sound even though not statistically supported. Consequently, this implied the presence of some unidentified confound. The confound is likely related to stakeholder group differences which is discussed in detail in the next section.

Table 23: Average Variance Extracted (AVE)

	Behavior	Data Hand	Design	Intrinsic	Strategic	Function	Support	Enabled	Data Use	Efficient
Behavior	1.00									
Data Hand	0.38	1.00								
Design	**0.36**	0.35	1.00							
Intrinsic	0.36	0.35	0.34	1.00						
Strategic	0.39	0.39	0.39	0.42	1.00					
Function	0.41	0.41	0.42	0.45	0.50	1.00				
Support	0.43	0.44	0.45	0.48	0.53	0.54	1.00			
Enabled	0.43	0.44	0.45	0.48	**0.51**	0.51	0.52	1.00		
Data Use	0.44	0.45	0.46	0.48	0.50	**0.51**	0.51	0.47	1.00	
Efficient	0.45	0.46	0.47	0.49	0.51	0.51	**0.51**	0.49	0.51	1.00

As described above, AVE shows that discriminant validity is completely supported for two attribute dimensions: Intrinsic and Behavior. However, only partial discriminant validity support was found for Design and Behavior even though the correlation between the two was low at .46. The test failed to demonstrate that Design and Behavior are distinct although they are conceptually different dimensions. Only partial discriminant validity could be established for the benefit dimensions. Discriminant validity could not be established between Strategic and Enabled, Data Use and Function, or Efficient and Support. Thus, each dimension could not be delineated statistically from one other dimension. The implication was that only partial support could be found for eight of the ten dimensions leaving only two that were fully supported.

Convergent Validity

Convergent validity of an item can be used to assess whether individual scale items are related. Both principal components and confirmatory factor analysis can be used to test convergent validity. For principal components factoring, high factor loadings (usually .500 or higher) for the construct's items indicated convergent validity. Support was found for items not dropped (Table 18, Table 19, and Table 20). Convergent validity was further established with CFA see Table 24 which indicates loading > .5 for all dimensions.

Statistical Conclusion Validity

For quantitative analysis, statistical conclusion validity is a statistical inference issue. It is concerned with the reasonability of the conclusions reached about relationships in the data (Cook and Campbell 1979). Some authors feel that statistical conclusion validity is the most important of the four major validity types. The data analysis was conducted in accordance with established procedures. The results were presented and discussed in detail earlier in this chapter. Thus, statistical conclusion validity was supported. SEM path analysis can also be used to test for statistical conclusion validity which is described in the next part.

Hypotheses and Propositions

The support found for hypotheses H1 and H3 and for propositions P1 and P2 was mixed. Below, the statistical criteria to pass each of these are described. Then, the results of tests of the hypotheses to the criteria are discussed. First, the criteria common to both H1 and H3 are described.

Common Criteria for H1 and H3

Both of these hypotheses are concerned with establishing dimensionality of the items on the questionnaire. The criteria for this is:

1. Related items must appear in the same factor when analyzed with principal components factoring and Varimax rotation. Items must load on the correct factor and only one factor with a load of .450 or higher.
2. CFA for the factors derived from #1 must have loadings of .450 or higher.
3. Cronbach's alpha should be .600 or higher and/or AIC > .300.
4. Composite reliability should be .600 or higher.

5. Convergent validity is established if #1 and # 2 are passed and the T values from CFA are > 2.00.
6. Discriminant validity is established if the AVE for a pair of dimensions is greater than the squared correlations between the pair of dimensions. Failing this test, low correlations among the pair of dimensions along with the factor solution from EFA and CFA will be considered.

H1 and P1

P1 was considered satisfied if H1 was satisfied. Four dimensions were derived for attributes representing 16 of the 21 items thereby supporting the general requirement for H1 which stated that the attributes items represented at least three dimensions. The resulting dimensions were Behavior, Data Handling, Design, and Intrinsic.

Test 1 was satisfied because the EFA loadings for each dimension ranged from .52 to .76 indicating satisfactory loadings (Table 18). The CFA loadings ranged from .48 to .74 thereby satisfying test 2 (Table 21). Table 18 shows that the alpha ranged from .58 to .75 and AIC ranged from .33 to .38 which satisfies test 3. Support for test 4 was demonstrated with composite reliabilities that ranged from .58 to .75 (Table 21). Test 5 was satisfied because test 1 and 2 were satisfied and because T values are > 2.0 (Table 21). The results for test 6 were mixed. From the discussion above regarding discriminant validity, the AVE test fully supported test 6 for Intrinsic and Design. However, the AVE was not supported for Behavior and Data Handling because of the AVE test between the two. However, the other criteria for evaluating discriminant validity indicated some support for test 6.

Given that the great majority of the tests were supported, H1 was considered supported. Hence, P1 was also considered supported. This means that dimensionality of integration attributes was supported.

H3 and P2

P2 will be considered satisfied if H3 is satisfied. Six dimensions were derived for benefits representing 25 of the original 38 items thereby generally supporting H2 which stated that benefits items represented at least five dimensions. The resulting dimensions were Strategic, Functionality, Support, Enabled, Data Use, and Economic.

Test 1 was satisfied because EFA loadings for each dimension ranged from .52 to .87 indicating satisfactory loadings (Table 19 and Table 20). The CFA loadings ranged from .64 to .82 thereby satisfying test 2 (Table 21). Table 19 and Table 20 show that the alpha ranged from .77 to .85 and AIC ranged from .45 to .55 which satisfies test 3. Support for test 4 was demonstrated with composite reliabilities that also ranged from .77 to .85 (Table 21). Test 5 was satisfied because test 1 and 2 were satisfied and because T values are > 2.0 (Table 21). The results for test 6 were disappointing. From the discussion above regarding discriminant validity, the AVE test did not support test 6 for any of the six dimensions. However, the other criteria for evaluating discriminant validity indicated some support for test 6.

Given that the great majority of the tests were supported, H3 was considered supported. Hence, P2 was also considered supported. This means that dimensionality of integration benefits was supported.

Stage 4: Higher Order Model

The dimensionalities of the constructs were marginally acceptable but the fit for the overall measurement model as described above was mixed. This problem called for another approach. The indications were that the model had potential to better explain integration and benefits that the CFA model results illustrated. So, summated scales were created for each of the ten dimensions. Figure 7 contains the revised conceptual model for the summated scales.

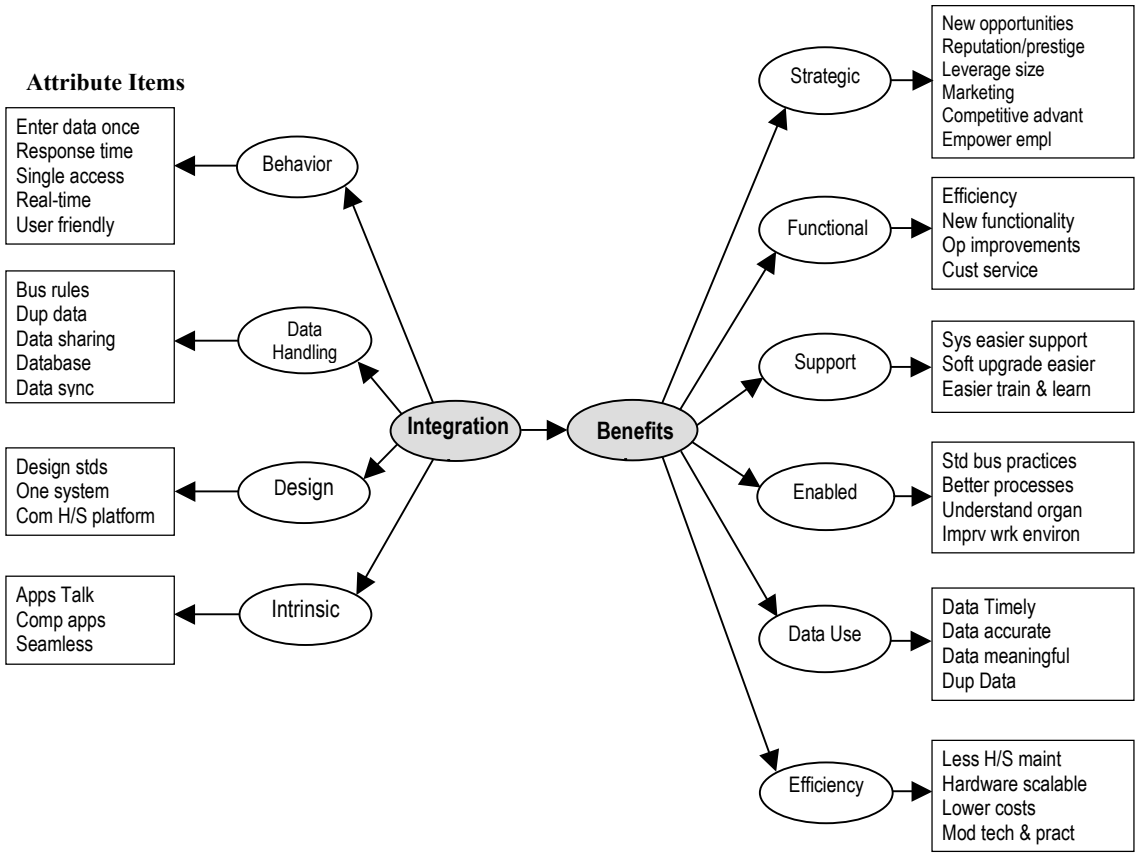

Figure 7: Revised Conceptual Model

Model Fit and Reliability

Confirmatory factor was run using the summated scales as indicators. The results are shown in Table 24. The composite reliabilities were .70 and .87 which meets the generally agreed upon guidelines as detailed earlier. All the fit indicators were acceptable except AGFI which was lower than .90 at .84 but deemed acceptable (NFI = .92, NNFI = 91, CFI = .93, AGFI = .84). However the normed X^2 was 6.56 which was higher than the maximum of 5 (1 to 3 is desired). Given the early stages of the construct validation and the uncertainty of the homogeneity of the sample population, X^2 was deemed marginally acceptable. The high RMSEA of .118 was of some concern since it exceeded the .10 recommended value.

Table 24: Confirmatory Factor Analysis: Summated Scales

Construct	Dimension Indicator	Std. Loading	Std. Error	T Value	P Value	Indicator Reliability	Composite Reliability
Integration Attributes	Data Handling	.58	.66		.01	.34	.70
	Behavior	.80	.37	10.45	.01	.63	
	Intrinsic	.51	.74	8.04	.01	.26	
	Design	.54	.71	8.40	.01	.29	
Benefits	Strategic	.76	.43		.01	.57	.87
	Functionality	.69	.53	13.52	.01	.47	
	Support	.68	.54	13.29	.01	.46	
	Enabled	.80	.35	15.97	.01	.65	
	Data Use	.65	.58	12.66	.01	.42	
	Efficiency	.77	.41	15.21	.01	.59	

Confirmatory factor analysis suggests that the model's constructs and dimensions are valid. This raises the question of discriminant validity between the two constructs, which is discussed later in this section. The remaining question to answer is the validity the structural model? This aspect of the analysis is explored in the next section.

Convergent Validity

Recall that convergent validity suggests that individual scale items are related. Loading > .5, T values > 2, and composite reliabilities > .6 all support convergent validity for the high order constructs, attributes and benefits (Table 24).

Discriminant Validity

The factor solution in Table 25 was calculated using the principal components method and Varimax rotation. The measure of sampling adequacy (MSA) was .841 as computed with the Kaiser-Meyer-Olkin method. The only caveat was that the communality for design was .346. Values above .4 and preferably above .5 are desired (Hair et al. 1998).

The results from the factor analysis of the summated scales (Table 25) demonstrated that the dimensions loaded on the appropriate construct. This was initial indication of discriminant validity for the two constructs. Correlations among the summated dimensions were also low which was a further indication of discriminant validity. However, more formal

Table 25: Rotated Component Matrix
of Summated Dimensions

Dimension	Component	
	Benefits	**Integration**
Efficient	.829	
Support	.812	
Enabled	.746	
Strategic	.709	
Function	.634	
Data Use	.601	
Data Hand		.780
Intrinsic		.707
Behavior		.651
Design		.524

tests were performed to establish discriminant validity. The first test was AVE described earlier. The second test correlations between a constrained and unconstrained model to determine if the correlation is significantly less then 1.0. The results of these tests are described next.

First Test of Discriminant Validity

The AVE test for discriminant validity was calculated from the CFA results in Table 24. The AVE failed to demonstrate discriminant validity between integration and benefits (AVE = .445 which was not < $.79^2$). The Pearson's correlation between the two constructs was also high at .656. However, conceptually integration attributes and benefits are different. One or more confounds was suspected. In one respect, this was not too surprising because as noted through out this thesis, people have a difficult time delineating between integration attributes and benefits. They invariably describe integration in terms of benefits instead of what integration "is". The differences among groups are discussed in the next section and seem to support the confound argument.

Table 26: Chi Square Differences Test of Discriminant Validity

Parameter	Unconstrained Model	Constrained Model	Differences
Minimum fit Chi-Square	243	294	51
Weighted least squares Chi-Square	223	222	1
Normed Chi-Square	6.56	7.34	.78
Correlation between constructs	.79	1.00	.21

Second Test of Discriminant Validity

Because of unsatisfactory results from the first test, the second test of discriminant validity was performed. The X^2 comparison was made between the constrained and unconstrained models (Table 26). The constrained model was run after setting PHI to 1.0. The chi-square increased from 243 to 294 (an increase of 51). Since these are nested models, this is a change of degrees of freedom of 1 between the two models. Thus, anything greater than 3.58 (significant chi-square with 1 df) shows that the constraint (PHI equal 1) significantly decreases fit. Thus we can say that the PHI value is not equal to 1.0. These results demonstrated weak discriminant validity between the two constructs.

Hypotheses and Propositions

Support was found H2 and H4 and for propositions P3 and P4. Below, the statistical criteria to pass each of these are described. Then, the results of tests of the hypotheses to the criteria are discussed. First, the criteria common to both H2 and H4 are described.

Common Criteria for H2 and H4

Both of these hypotheses are concerned with establishing the two higher constructs, Attributes and Benefits, based on dimensions established with H1 and H3. Discriminant validity was established for the two constructs using the weak test described above. The remaining criteria to support H2 and H4 are:

1. Related items must appear in the same factor when analyzed with principal components factoring and Varimax rotation. Items must load on the correct factor and only one factor with a load of .450 or higher.
2. CFA for the factors derived from #1 must have loadings of .500 or higher.
3. Composite reliability should be .600 or higher.
4. Convergent validity is established if #1 and # 2 are passed and the T values from CFA are > 2.00.

H2 and P3

Test 1 was supported since the loadings ranged from .52 to .78 (table 11) and the dimensions loaded on the appropriate factor (attributes construct). The four dimensions were Behavior, Data Handling, Design, and Intrinsic. The CFA loading ranged from .51 to .80 thereby supporting test 2 (table 10). Support for test 3 was established since the composite reliability (table 10) was .70 which is greater than the .50 minimum. Test 4 was satisfied because test 1 and 2 were satisfied and because T values are > 2.0 (table 10).

Given that all tests were supported, H2 was considered supported. Hence, P3 was also considered supported. This means that the higher order construct, attributes was supported.

H4 and P4

Test 1 was supported since the loadings ranged from .60 to .83 (table 11) and the dimensions loaded on the appropriate factor (benefits construct). The six dimensions were Strategic, Functionality, Support, Enabled, Data Use, and Economic. The CFA loading ranged from .68 to .80 thereby supporting test 2 (table 10). Support for test 3 was established since the composite reliability (table 10) was .87 which is greater than the .50 minimum.

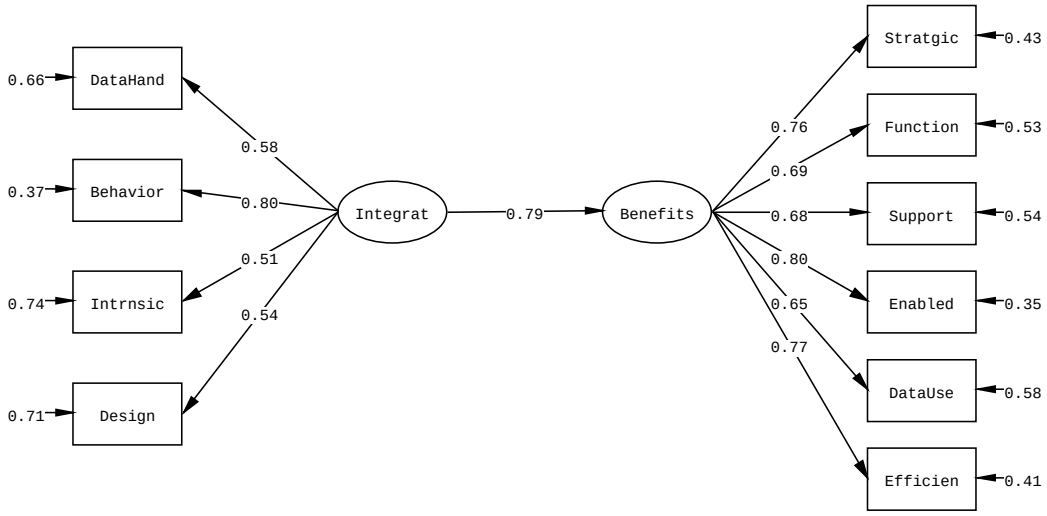

Figure 8: Revised Path Model

Test 4 was satisfied because test 1 and 2 were satisfied and because T values are > 2.0 (table 10).

Given that all tests were supported, H3 was considered supported. Hence, P4 was also considered supported. This means that the higher order benefits construct was supported.

Stage 5: Structural Model

The revised structural model is shown in Figure 8 and includes the loadings for the indicator variables (summated scales) for both constructs and the path between two major constructs: Integration and Benefits. The reliabilities and indicator loadings are the same as those shown in Table 24 for CFA model. The fit indices are also the same as described for the summated scale in the previous section. The difference between the CFA model and the structural model was the path between Integration and Benefits. The path loading was high at .79. This is also a measure of correlation between the two constructs. The issues of reliabilities and validity are the same for the structural model as for the measurement model

discussed in stage 4. The path was positive. Reliability and validity were established in stage 4. Thus, support was found for hypothesis H5.

Stakeholder Groups

Differences among stakeholders have been studied in several academic areas including MIS. As discussed in Chapters 2-4, dissimilarities between end-users and IT professionals have been documented in the MIS literature (Barki and Hardwick 2001). The results from the qualitative study results (Chapter 6) clearly indicate differences in perceptions of integration and benefits among the three stakeholder groups surveyed.

The original assumption was that integration was a universal concept that transcended organization or stakeholder group. The evidence does not support that proposition. Thus, the original plan to conduct the analysis using stakeholder group as a moderator could not be performed because the differences among stakeholder groups are more pronounced than anticipated. Consequently, differences were analyzed using factor analysis and T-tests.

T-Tests for Equality of Means

First, simple T-tests for equality of means for independent samples were performed to assess the differences among the three stakeholder groups. Next, IT professionals were compared to non-IT personnel (management and end-users). The differences between IT professionals and end-users were significant at .004 and .034 for the 2-tail test ($p < .05$ and the confidence interval does not contain zero) (Table 27). This supports hypothesis H5 and H6 along with propositions P5 and P6. This also supports the contention by Barki and Hardwick (2001) and others that there are differences between users and IT staff. Likewise, these results support the assertion that there are differences among stakeholder groups. Differences among the other group combinations were not significant and so consequently there is only partial support for H4, H5, P5, and P6. However, the 2-tail test (table 14)

Table 27: Independent Samples t-test for Equality of Means

Group	Construct	Type of Variance	t	df	Sig. 2-tailed	95% Confidence Interval of the Difference	
						Lower	Upper
Management N = 127	Integration	Equal var. assumed	1.571	239	.118	-.0370	.3287
		Equal var. not assumed	1.560	226.54	.120	-.0383	.3300
IT Prof. N = 114	Benefits	Equal var. assumed	.244	239	.807	-.1847	.2369
		Equal var. not assumed	.245	238.41	.807	-.1840	.2362
Management N = 127	Integration	Equal var. assumed	-1.480	283	.140	-.2815	.0398
		Equal var. not assumed	-1.485	272.86	.139	-.2810	.0394
End Users N = 158	Benefits	Equal var. assumed	-1.876	283	.062	-.3713	.0089
		Equal var. not assumed	-1.857	257.91	.064	-.3734	.0109
IT Prof. N = 114	Integration	Equal var. assumed	-2.994	27	**.003**	-.4420	-.0913
		Equal var. not assumed	-2.946	228.42	**.004**	-.4450	-.0883
End Users N = 158	Benefits	Equal var. assumed	-2.143	27	**.033**	-.3978	-.0169
		Equal var. not assumed	-2.131	238.45	**.034**	-.3990	-.0157
IT Prof. N = 114	Integration	Equal var. assumed	2.705	397	**.007**	.0581	.3675
		Equal var. not assumed	2.580	189.35	**.011**	.0501	.3755
Non IT Prof. N = 285	Benefits	Equal var. assumed	1.408	397	.160	-.0501	.3033
		Equal var. not assumed	1.416	210.73	.158	-.0496	.3028

showed that differences between IT staff and non-IT staff are significant (.011, $p < .05$) for the attributes construct but not for the benefits construct (.158, $p < .05$) which supports H6 and P5 but not H7 or P6.

Separate Factor Solutions: IT vs. Non-IT Staff

The problems encountered with model fits suggested a confound because the statistical results did not support the theoretical dimensions as strongly as expected. One explanation would be that there is a different model for each stakeholder group. If this is true, the research model that combines all stakeholders would be expected to have problems with fit and validity.

To examine this argument, separate factor solutions for the same dimensions were derived for IT and Non-IT groups using principal components factor analysis and Varimax

Table 28: Rotated Component Matrix (IT vs. Non IT)

Item	All		Non IT		IT	
	Factor		Factor		Factor	
	1	2	1	2	1	2
Efficient	.829		.823		.786	
Support	.812		.798		.840	
Enabled	.746		.716		.723	
Strategic	.709		.698		.619	.512
Functionality	.634		.720			.763
Data Use	.601		.712			.836
Data Handling		.780		.802		.791
Intrinsic		.707		.679	.497	
Behavior		.651		.679	.529	.534
Design		.524		.589	.526	
N=	399		285		114	

Note: Numbers that are shaded indicate that the items loaded on a factor are different from the ALL solution.

rotation. The separate factor solutions were compared to the factor solution for all groups (Table 28). For IT, the Strategic and Behavior dimensions double loaded on both the Attributes and Benefits constructs. Additionally, the Intrinsic and Design dimensions switched from the Attributes construct to the Benefits construct while Functionality and Data Use switch from a benefit to an attribute. Thus, 40% of the dimensions loaded on different construct and 20% double loaded. The results clearly demonstrate there are factor structures for IT and non-IT are significant dissimilar. Clearly, this should be sufficient evidence to support the argument that the groups are different. Furthermore, the differences probably introduced a confound into the analysis of the overall model.

The non-IT factor structure is very similar to the ALL structure with all dimension loading on the same constructs (Table 28). The similarity is likely because non-IT cases dominate the ALL solution having more than twice the number of cases.

Separate Factor Solutions: Each Stakeholder Group

As a final step, factor solutions were derived for each stakeholder group and compared to the overall solution (Table 29). The extent of the difference was quite evident. Three factors were derived for management and only one for end-users. For management, the Data Handling and Intrinsic switched from the Attribute construct to a third unnamed construct (Table 29). All other dimensions loaded on the same construct as the ALL factor structure. The result for End Users was a unidimensional factor structure with the dimensions for both attributes and benefits loading on a single factor. This implies that end-users could not delineate between attributes and benefits. Results for IT professionals were the same as discussed in the previous sub-section. The conclusion was that each stakeholder group was clearly different in their perceptions of integration and benefits. So much so, that direct comparison between the groups for the same dimensions seem impossible.

The different factor structures described above for the different groups provided additional supported H6, H7, P5, and P6. Another approach to explore dissimilarities among

Table 29: Rotated Component Matrix Among 3 Stakeholder Groups

Item	All		Management			End Users	IT Professionals	
	Factor		Factor			Factor	Factor	
	1	2	1	2	3	1	1	2
Efficient	.829		.816			.749	.786	
Support	.812		.817			.759	.840	
Enabled	.746		.706			.833	.723	
Strategic	.709		.648			.751	.619	.512
Functionality	.634		.747			.741		.763
Data Use	.601		.735			.750		.836
Data Handling		.780			.715	.688		.791
Intrinsic		.707			.795	.622	.497	
Behavior		.651		.593		.794	.529	.534
Design		.524		.894		.583	.526	
N=	399		127			158	114	

Note: Numbers that are shaded indicate that the items loaded on a factor different from the ALL solution.

groups would be to compare CFA for each group to the ALL CFA. Significant differences in fit would strongly support the related hypotheses and propositions.

Discussion

A great deal of analysis and results has been presented in this chapter. The analysis has focused on dimensions, higher order constructs, the structural model, and stakeholder differences. The purpose of this last section is to synthesize the various analyses and findings in order to make sense out of what all the results means including the implications of the results. All the analyses were aimed at understanding applications integration. The overall questions have been:

- What is integration?
- What benefits does integration offer?
- Do the perceptions about integration (attributes and benefits) vary by key stakeholder groups?

For the most part, the research has been successful because critical knowledge about applications integration has been advanced. Clearly, refinement of the methodology and instrument is needed. Additional research is also definitely required to fully answer the research questions and to further validate the instrument and affirm the findings of this study. The remainder of this section briefly discusses several key topics that include implications, questionnaire items, integration dimensions, high order constructs, problems encountered and data issues, and some final thoughts. The next chapter will summarize the research, draw some conclusions, describe several limitations, and offer suggestions for further research.

The Implications

Applications integration for enterprise systems is a reality of nearly all organizations. Therefore, understanding what constitutes integration and the benefits it offers is paramount

to integration decisions, policy development, and future investments. A major goal of this stream of research is to establish a way to perform accurate cost/benefit analysis for various integration strategies. This requires understanding what integration "is" and what benefits are associated with integration. This research has made advances toward the cost/benefit analysis goal by establishing dimensions and constructs of integration. An initial taxonomy of attributes and benefits of integration has been created.

The Questionnaire Items

For the most part the questionnaire items proved valuable to understanding integration. The one major disappointment was that the items included to access the overall degree of integration did not yield satisfactory results. Therefore, this part of the questionnaire requires revision. Having an independent global measure of integration is important because integration can serve as a dependent variable. Having integration as an independent construct permits analyses to establish a stronger relationship between attributes and integration and between integration and benefits.

Dimensions

Ten dimensions of integration were found and partially validated. Even though problems were encountered with discriminant validity other validities and reliabilities were established. Additionally, distinct dimensionality of integration was first suggested by the qualitative field research. Conceptually, each of the dimensions appears distinct and valid. The lack of statistical support for discriminant validity can likely be resolved with refinement of the instrument, more careful selection of participants, and creating separate models for each stakeholder group.

Although factor analyses suggested four attribute dimensions of integration, three dimensions appear theoretically sounder. The separate dimensions for Design and Intrinsic

should likely be combined into one dimension and named Enablers. Ironically, Design and Intrinsic are the only two dimensions where discriminant validity was fully established. Further improvement of the scale, methodology, and participant selection should confirm the argument for three dimensions.

High Order Constructs

Support was found for the two high order constructs, attributes and benefits. This confirms the earliest and most fundamental concepts for this research. Integration has much in common with intelligence because both represent abstract ideas. Benefits flow from each. You cannot measure either directly. There is a tendency to define each in terms of the benefits that are derived rather than what constitutes each. Both are fundamental concepts. Yet, unlike intelligence, virtually no research has been conducted on the essence of integration.

Some Problems and Data Issues

Paradoxically, a major objective of this research (stakeholder differences) also caused most of the analysis problems. The difference in perceptions among stakeholder groups appeared to be so great that the difference introduced a confound into the data analysis. Separate models are strongly indicated for each group. The extensive differences prohibited analysis using stakeholder as a moderator.

Integration may be a universal concept but based on the results of this research, it is much too early to address that issue. First, dimensionality, high order constructs, and operationalization of integration must be fully established. Then, stronger relationships between attributes and benefits must be established. Next, causality of benefits should be investigated. Once these objectives are established, the role of stakeholders can be better addressed.

Several confounds likely interfered with this research. Significant differences in perceptions among stakeholders have already been discussed. Other possible confounds include type of organization (public vs. private business) and enterprise system philosophy (home grown vs. packaged software). Finally, much of the data reflect views about a software package rather than the primary topic of applications integration. Future research must be careful to request participants' perceptions about what ideally constitutes integration and ideally what is expected from integration rather than perceptions based on current systems.

CHAPTER 9 – CONCLUSIONS

Chapter 9 summarizes and discusses the research performed to investigate applications integration. The contributions to theory and practice are described. The research limitations are described and suggestions are offered for future research. Finally, the chapter ends with conclusions that can be drawn from this research.

Contributions

This dissertation investigated applications integration, a previously neglected MIS research area. This research could potentially trigger a new stream of research. A two-part study enhanced our understanding of applications integration by examining the associated attributes and benefits in great detail. Two new models were created. The first one was a comprehensive model of IT integration infrastructures that served as the foundation for the second one. The second model is a small subset of the first one and was created to measure practitioners' perceptions of integration. It served as the research model for this research and was partially validated.

Although not part of the research design, the research also surfaced downsides to integration and ways to assess or measure integration. Both of these hold great promise for managing and establishing policies for applications integration. However, both depend heavily on the basic research question that sought to understand what integration is and what benefits are forthcoming from integration.

The door of integration knowledge has been cracked opened a little more. Much work remains to fully open the door. The following is a brief discussion of the more important contributions this research offers for theory and practice:

The importance of this new stream of research (application integration for enterprise systems) was established. Little specific information was known about this topic prior to this

study. The findings show that applications integration is ill-defined and difficult for people to articulate although desirable for a number of reasons.

Two new high order constructs (attributes and benefits) have been established and operationalized. The evidence strongly supported the view that applications integration is multi-dimensional with attributes consisting of at least three dimensions and perceived benefits consisting of some six dimensions. Sixteen items were found to operationalize the four attribute dimensions. For the six benefits dimension, 25 items were found.

A number of specific downsides to integration were documented. Many were perceptions that appeared invalid (at least on the surface) while others appeared factual. Yet, most people preferred integration even when accompanied by these shortcomings. The significance of this was that while integration was beneficial for many applications, 100% integration does not appear practical or desirable in some instances.

Several ideas were found that might allow for the development of a metric to assess and/or measure applications integration. This could lead to a new function for auditors.

The necessary first steps have been taken towards developing a means to assign value to applications integration. The ability to identify specific attributes and benefits should permit the assignment of values to each. The next logical step was to establish a link between specific benefits and attributes. This should provide the ability to establish cost/benefits of applications integration.

Integration and benefits have been defined in terms of taxonomies each of which represent a set of indicators (items). This should augment the MIS vocabulary, which should in turn allow for more precise dialog about applications integration. The taxonomies are all important to further investigation of types of IT integration.

Finally, this research was conducted in the context of an integration infrastructure and should help augment this emerging concept. Even though applications integration is only one IT infrastructure, many of the same concepts should apply to all types of IT infrastructures. Ultimately, the idea that IT integration infrastructure has much in common with applications integration will likely be confirmed.

Limitations

As far as is known, this research is the first to investigate the very essence of applications integration for enterprise systems. For this and other reasons, the reader is cautioned that this research has several limitations. Some of the limitations are:

- First study– As indicated above, this is the first study of its type and additional research is needed to confirm the results.
- The results were mixed and full support was obtained for some hypotheses. Additional research is needed to resolve the problems described in Chapter 8.
- Organizations in study – While it initially appeared that the notion of integration was universal regardless of industry or size, this research provided reasons to question that assertion. Only three industries were studied: Higher Education, Petroleum, and Chemical.
- Need to validate dimensions and items – Additional research is necessary to confirm the dimensions and items suggested by this study. Specifically, better support is needed for discriminant validity.
- Lack of prior relevant research – this means that this research is not as strongly grounded as usual due to a lack of prior research.
- Confounds – differences in stakeholder groups, industry, and approach to enterprise systems may have introduced confounds that affect some of the results.

- Global measure of integration – Lack of a global measure of integration limited the ability to establish stronger relationships between the attributes and benefits.

Future Research

Additional investigation is needed for this stream of research. Numerous opportunities are available to study a wide range of topics. Some specific ideas are:

1. Create a global measure to operationalize integration.
2. Replicate this study after refinement of the scale. Much additional work is needed to create a valid scale of applications integration.
3. Investigate and test ways to measure or assess integration. This research could easily evolve into a new sub-discipline related to computer auditing.
4. Use a refined scale to investigate each of the stakeholder groups separately.
5. Investigate differences of perceptions about integration for different industries.
6. An interesting and practical study could look at differences of those who implement packaged enterprise systems versus those who create their own systems.
7. Investigate other aspects of information technology integration including enablers of integration, integration infrastructure, and process integration in relation to information technology.
8. Further investigate the downside of integration to establish guidelines for integration decisions. Establish dimensions for the downside of items revealed in this research.
9. Investigate various components of the proposed IT integration infrastructure model.

Conclusions

Integration is a complex and sizeable subject. Applications integration appears to be multi-dimensional consisting of ten dimensions and at least two higher order constructs (attributes and benefits). Applications integration appears to have much in common with

infrastructures. Unfortunately, integration has become ubiquitous, especially in the information technology arena. This is troubling because of the enormous expenditure of funds and human resources to achieve an ill-defined objective.

Evidence suggests that since applications integration is ill-defined, many organizations may have pursued integration projects based largely on faith without any means to ascertain the benefits. Those who have pursued "pure" integration in the tightly coupled sense have probably been chasing the illusive holy grail of integration in vain.

This research has illuminated many of the practical and theoretical issues of applications integration. There are reasons to be positive and continue to pursue applications integration. However, practitioners should proceed with the caution that unbridled pursuit of integration, especially just for the sake of integration, must be avoided. The MIS research community is invited to continue this initial investigation of applications integration.

Integration is an abstract concept like intelligence…you cannot see either, but we know both exist. We have learned to assess intelligence, but not integration. Integration likely has value although it could cost more than it is worth. Integration is risky, but offers great rewards for those who succeed. Integration is a strategy, not a panacea. Integration is the glue that holds components of IT infrastructures together. It is the communication and coordination mechanisms that permit the combination of all IT infrastructures so that IT can effectively be integrated with organizational, industrial, global, and societal infrastructures.

This stream of research appears promising. Initial results are encouraging although not perfect. Practitioners can now look at integration with more concrete ideas to couch their dialogue and decisions. If knowledge is power, then the additional knowledge from this research should provide researchers and practitioners with greater power to make more intelligent and informed decisions.

Two interesting revelations emerged during this research. First, the great majority of practitioners, regardless of role, have a very limited idea about what specifically constitutes integration or least they have been unable to articulate their understanding very well. The implication is that people in academia and industry have little common ground for dialog and decision-making when it comes to applications integration. Clearly, the lack of a common language or vocabulary or definition of terms is a barrier to effective communication, planning and decisions. Apparently, practitioners have relied heavily on their intuition and judgment for application integration decisions which have served many remarkably well.

The second interesting finding was the ubiquitous bandwagon effect. This is the idea that integration must be good because everyone seeks integration. Yet, little thought seems to have been given to what integration is, what is necessary to achieve integration, and what benefits can be realistically expected. Equally perplexing is that apparently only a few people have stopped to consider that integration is not always desirable for many situations for a variety of reasons. Likely, this can and does lead to costly integration decisions that are not needed or justified. Finally, the tunnel vision resulting from the bandwagon effect seems to inhibit people's ability to "think outside the box". Many, especially those with packaged software, do not seem to be able to envision alternatives to accomplish integration objectives other than with packaged software. A new paradigm shift is emerging that will likely render the traditional packaged enterprise system as obsolete as the once indispensable slide rule. Therefore, it appears nearly certain and plausible that the way applications integration is implemented in the future will also change. This will require us to re-think what applications integration "is" in the future before we have completely determined what applications integration "is" now.

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APPENDIX A – IRB APPROVAL

IRB #: 2045 LSU Proposal #: _____

LSU INSTITUTIONAL REVIEW BOARD (IRB) for HUMAN RESEARCH SUBJECT PROTECTION 578-8692; FAX 6792 Office:203 B-1 David Boyd Hall

APPLICATION FOR EXEMPTION FROM INSTITUTIONAL OVERSIGHT

Unless they are qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/projects using living humans as subjects, or samples or data obtained from humans, directly or indirectly, with or without their consent, must be approved in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

Instructions: Complete this form. If exemption seems likely, submit it. If not, submit regular IRB application. Help is available from Dr. Robert Mathews, 578-8692, irb@lsu.edu or any screening committee member.

Principal Investigator Les Singletary **Student?** Y Y/N

* **Ph:** 8-9071 **E-mail** LSingle@lsu.edu **Dept/Unit** ISDS

If Student, name supervising professor Ed Watson Ph: 8-2502

Mailing Address 3166B CEBA, B.R., LA 70803 Ph ~~8-9071~~ 8-2502

Project Title IT integration Attributes & Benefits of Enterprise Systems

Agency expected to fund project None

Subject pool (e.g. Psychology Students) Employees in Industry & Higher Ed.

Circle any **"vulnerable populations" to be used:** (children <18; the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

I certify my responses are accurate and complete. If the project scope or design is later changed I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted.

PI Signature Les Singletary **Date** 7/10/2002 (no per signatures)

==========

Screening Committee Action: Exempted ✓ Not Exempted ____

Reviewer ABE BISWAS Signature abe biswas Date 7/16/02

Part A: DETERMINATION OF "RESEARCH" and POTENTIAL FOR RISK

This section determines whether the project meets the Department of Health and Human Services definition of "research" and if not,

* I can best be reached @ (985) 507-0995

APPENDIX B – IRB INTERVIEW CONSENT FORM

Invitation to Participate in Research Study

Application Integration Characteristics and Perceived benefits of Integration

Purpose of this study

Because integration is a key goal and perhaps the most touted characteristic of enterprise systems, it deserves our attention. It is generally assumed that the value of integration is obvious although we lack supporting evidence. My research seeks to identify the characteristics and benefits of integration among applications within the information system of organizations.

Participation in the study

Your help is needed to gather information regarding what people think about information technology integration along with the perceived benefits. The data collected from the interviews will be used to create a questionnaire to survey a much large audience.

Benefits

Participating organizations will be provided with a copy of the completed study. This research should help organizations address the following issues:

1. Is integration a worthwhile goal
2. What should be integrated
3. How much integration is needed

Confidentiality Statement

We want to assure you that this information is sought for research purposes only and your responses will be strictly confidential. Only summary data will be provided. No individual's responses will be identified as such and the identity of persons responding will not be published or released to anyone.

Researcher

This research is being conducted by Les Singletary, a doctoral student in the Information and Decision Sciences Department at Louisiana State University. He can be contacted at **Lsingle@lsu.edu** or (985)-507-0995 or (225)-578-2511 (fax).

Participant

I have read and understand the above information and I agree to participate in this study.

Signature Date Email/Phone

Name, Title, Address

APPENDIX C – IRB PILOT TEST CONSENT FORM

Invitation to Participate in Research Study

Enterprise Systems: Applications Integration Research

Purpose of this study

Because integration is a key goal and perhaps the most touted characteristic of enterprise systems, it deserves our attention. It is generally assumed that the value of integration is obvious although we lack supporting evidence. My research seeks to identify the characteristics and benefits of integration among applications that comprise the enterprise systems that are used by various organizations.

Participation in the study

Your help is needed to gather information regarding what people think about information technology integration along with the perceived benefits. The data collected from the questionnaire will be used to create a taxonomy of integration attributes and benefits and to establish the relationship between attributes and benefits. A follow-up study will help establish methods for measuring integration and alternative ways to achieve integration.

Confidentiality Statement

We want to assure you that this information is sought for research purposes only and your responses will be strictly confidential. Only summary data will be provided. No individual's responses will be identified as such and the identity of persons responding will not be published or released to anyone.

Researcher

This research is being conducted by Les Singletary, a Ph.D. candidate in the Information and Decision Sciences Department at Louisiana State University. He can be contacted at **Lsingle@lsu.edu** or:

LSU: (985)-507-0995 Cell: (985) 507-0995 Fax: (225)-578-2511

You may also contact Dr. Ed Watson who is directing Les' Ph.D. and dissertation research. He can contacted at <ewatson@lsu.edu> or at (225) 578-2502.

Participant

I have read and understand the above information and I agree to participate in this study.

Signature Date Email/Phone (optional)

Name & Title

APPENDIX D – INTERVIEW SCRIPT

Thank you for helping me with my research. I am investigating the concept of integration. Specifically, I am looking at integration of computer applications within an organization. **First**, I seek to discover those characteristics or circumstances that exist when applications are integrated. **Second**, I also hope to discover the benefits of integration. Ironically, no one has previously researched IT integration per se. Therefore, there are no right or wrong answers. The answers you provide will be used to create a questionnaire to survey about a thousand people from 3-4 organizations. I have three specific objectives: 1) create a list of integration characteristics, 2) create a list of perceived benefits of integration, and 3) understand the linkages between benefits and specific integration attributes.

1. List as many characteristics of integration that you can think of
2. What distinguishes an integrated set of applications from non-integrated applications?
3. Do you feel application integration is desirable or undesirable? Please explain why.
4. Should all applications and data be integrated? Please explain.
5. What are the disadvantages of application integration (if any)?
6. Do you feel we can measure integration? If so, how? What metrics would you use?
7. Is it feasible for a firm to achieve 100% integration of all its applications? If no, what is a feasible percent (your best guess)?
8. Please list any practical alternatives to application integration that you can think of.

9. List as many different integration related benefits as you can that enterprise systems offer.
10. What is it about integration of IT applications that have value to an organization?
11. What benefits do most vendors claim for integrated enterprise systems?
12. Concerning application integration, what benefits have you witnessed or for which you have first hand knowledge? Do they match with vendor claims?

APPENDIX E – CONTENT CODING INSTRUCTIONS

Content Analysis
Information Technology Integration

This document contains:

1. Brief description of the research
2. List of interview questions
3. Coding directions
4. Coding themes/categories
5. Form to record coding

Let me know if you have questions are encounter problems. **Email**: Lsingle@lsu.edu
Telephone—LSU: 578-9071, Home: (985) 386-0638, Cell: (985) 507-0995

Research Description

The purpose of this research is to:

1. Discover a set of characteristics (metaphors/attributes) that can be used to define integration
2. Establish a set of perceived benefits of integration
3. Determine the relationships among integration attributes and perceived benefits
4. Understand why integration has value

Integration can be compared to intelligence—both are abstract ideas that cannot be measured directly. We define intelligence in terms of surrogates like GPA, memory, and reasoning ability. Similarly, we seek to discover surrogates that help us identify and possibly quantify integration.

I have interviewed three stakeholder groups in several organizations in order to obtain answers to the above questions. Additionally, I conducted a comprehensive review of the literature.

Interview Questions

Questions 1-8 ask about integration attributes (defining characteristic of integration) which are also known as metaphors. Questions 9-12 are about benefits of integration. HOWEVER**, the concepts (keywords) are contained in both sets of questions. People often describe integration characteristics in terms of benefits and benefits in term of characteristics. Some organizations could not answer question #12 because they had never implemented a vendor's enterprise system**

1. **List as many characteristics of integration that you can think of**
2. **What distinguishes an integrated set of applications from non-integrated applications?**
3. **Do you feel application integration is desirable or undesirable? Please explain why.**
4. **Should all applications and data be integrated? Please explain.**
5. **What are the disadvantages of application integration (if any)?**
6. **Do you feel we can measure integration? If so, how? What metrics would you use?**
7. **Is it feasible for a firm to achieve 100% integration of all its applications? If no, what is a feasible percent (your best guess)?**
8. **Please list any practical alternatives to application integration that you can think of.**
9. **List as many different integration related benefits as you can that enterprise systems offer.**
10. **What is it about integration of IT applications that have value to an organization?**
11. **What benefits do most vendors claim for integrated enterprise systems?**
12. **Concerning application integration, what benefits have you witnessed or for which you have first hand knowledge? Do they match with vendor claims**

Coding Directions

Your task is to code the transcripts from the interviews using the themes and categories described on the next page. These categories are based on the literature review. You may add additional categories if necessary. Even though the questions are organized by group (attributes, benefits, etc.), you will find that the themes/categories are mixed through out the transcript as people struggled to answer the questions. For instance, people often described integration in terms of benefits even though the question was about attributes/characteristics. This is okay. You are to code according to what people say rather than what is intended. That is, if the person describes a benefit when asked about attributes, you should code the answer as a benefit and NOT as a benefit.

Distinguishing between integration attributes and benefits is challenging. This is because we often think of integration as a benefit. Integration, like intelligence, may be a benefit, but the fact that each is a benefit does little to help us define intelligence or integration. Use the following definitions as a guideline when make decisions about coding attribute/characteristics and benefits:

Attributes – are the properties that characterize the relationships among the components to be integrated. Attributes define integration at a very basic level. Examples include: data sharing, real-time, seamless, connections, and coordination. If some aspect of integration can be viewed as both a characteristic of integration and as a benefit, then code the theme/category as an attribute.

Perceived Benefits – are the outcomes associated with integration that are valued by individuals. Examples: customer service, competitive advantage, lower costs, functionality, multi-country needs (e.g. accounting standards), scalability, expanded capacity, and to facilitate operational change.

You are often required to decide the intention of the participant and interpret their answer to fit one of the predefined themes/categories. At first, this may appear difficult since many attributes can also be thought of as benefits as described above. The distinction is based the preexisting requirements. Some examples should help.
"Integration permits all users [or applications] to use the same data."

This implies the data sharing attribute and should be so coded.

"Integration makes it possible for everyone to work together more effectively."

This implies coordination among application and should be coded as the "coordination" attribute.

You might argue that both of the above examples imply benefits since they refer to a situation AFTER an integrated system is implemented. Thus, you could be tempted to code these as an "operational improvement" benefit. Yet, these are clearly defining characteristics of integration that must exist before implementation. Additionally, the preexisting nature makes the benefits possible. Therefore, the way to look at this is to ask, is the theme an inherent characteristic of integration or is it the result of integration. If you can reason that the theme is a characteristic then you should coded it as an attribute even though it may also be a benefit. In contrast, lower cost is clearly a [possible] result (benefit) of integration. It should be obvious that lower cost does not define how components of a systems work together. The same is true for improved customer service.

A form is provided to record your coding. Use a separate form for each organization and stakeholder group. Refer to the first page of each transcript to obtain the name of the organization the stakeholder group. Record this information in the space provided. Simply make a tic-mark (unless otherwise noted)

APPENDIX F – CONTENT ANALYSIS CODING FORM

Organization ______________ **Stakeholder Group:** [ ] Managers [ ] IT professional. [ ] End-users (ver. 10a) Page 1

Item	Theme/Idea/Category	Line Numbers and Values
A. Defining Integration Characteristics -- Attributes are the things necessary for applications to work together		
Data Manipulation & Processing		
1	**Database**, central/common storage for data	
2	**Data sharing** among **applications**	
3	**Data sharing**, facilitates data sharing among **people** & departments	
4	**Record once**; use everywhere	
5	**Business rules**, consistent regardless of data source or entry point	
6	**Single data entry point**, actually multi external entry points routed to single entry point	
7	Data **Redundancy**, None or Less	
8	Data **Synchronization**	
Applications Work Together		
11	**Generally** does not fit other categories	
12	**Connections: Interfaces** for intra-application interaction	
13	**Coordination**: Applications **talk**, facilitates dialog, **communicating**	
14	**Event** handling among applications	
15	**External Interfaces** (e.g. XML, EDI, interfaces to other sys), external compatibility	
16	**Combined set of applications** that fit together	
17	**Compatibility** of all **applications** to form 1 system	
18		
User Interface		
21	**Generally**, does not ft other categories: Ex consistent interface to sys, user friendly	
22	**Data entry**: consistent user interface	
23	**Data retrieval**: consistent user interface, consistent format	
24	**Seamless**: appears as if one system to the user, transparent	
25	**Response time**, sufficient (transaction processing)	
26	**Data Access**/Retrieval, one-stop access for any combination of data in the system	
27	**One System** for all or most data/functionality	
28		
Architectural		
31	**Real-time** vs. batch processing of transactions	
32	**Platform Compatibility**, hardware and software	
33	**Security**, built-in pervasive and consistent (access control)	
34	**Workflow** and **Processes**, Facilitates	
35	**Core:** Design **concepts**, **Standards**, underlying **structure**, consistency, compatible components	
36	**Redundancy** of **Applications** functionality eliminated	
37	**Applications** and **Data Independence**	

	B. Perceived Integration Benefits -- the outcomes that can only occur after a system is implemented and thus has nothing to do with how components work together	
Strategic — refers to those things that are important or essential to an organization's intended objective		
1	**Cost** Reduction	
2	**Customer Service**: customers and users	
3	**Competitive** Advantage, **Strategic** Advantage	
4	**Organizational Change**	
5	**Reputation** & Prestige improvements	
6	**Leverage Size**—influence better deals, support	
Operational Improvements		
11	**Generally**, streamline operations, easier use, do things better	
12	**Efficiency**, Speed, Productivity improvements	
13	**Process/Workflow/Business Practices** Improvements	
14	**Coordination** of People & Departments improvements	
15	**Marketing**, facilitates better marketing of organization, products & services	
16	**Standardized Processes/Business** practices **Everywhere**	
17	Less **Dependence** on other departments and people	
18	**Centralized Control**	
Human Resource Related		
21	**Teamwork**, facilitates improvements	
22	**Management**, Decision and Analysis, flex to respond to bus environment	
23	**Skill** set required of employees is less	
24	**Easier** to maintain, support, audit, learn & train others	
25	**Moral, Employees** happier, less confusion, Improve work environment	
26	**Understanding** of overall **Processes**, Data, & Organization increased	
27	**Empower Employees** to do more	
28	**Concentration** of **system knowledge** in fewer people	
Functionality or Capacity, New/Additional		
31	**Generally**, **New/Increased** functionality, greater automation, flexibility	
32	**Capacity** Expanded	
33	**Multi-Country** support	
34	**Paperless** or Reduced Paper operation	
35	**Legal** Matters, support for	
36	**Opportunities**, new or expanded, facilitates Creativity	
37	**Independence**, Organizationally & Geographically	
38	**Data** more **Meaningful, Timely, Useful**	
Technology Related		
41	**Legacy Systems** replacement	
42	**Maintenance**, less (hardware & software)	
43	**Reliability**, Integrity, and consistency improvements of data, sys & operations	
44	**Data Availability/Sharing**, data more readily to everyone in organization	
45	**Error Reduction**, data & operations, greater accuracy	
46	**Technology Modern**, use latest technology & processes	
47	More **Scalable**, maximize hardware	
48	Easier Software **Upgrades**	

C. Downside of Integration		
Data Related		
1	**Security**, control, **data access**: Prevent unauthorized access/viewing, privacy	
2	**Data needed** by only **one area or purpose** makes integration unnecessary/undesirable	
3	**Data does not fit** together with enterprise data, makes integration unnecessary/undesirable	
4	**Non firm-wide data** makes integration unnecessary/undesirable	
5	**Misuse**, Misunderstanding of data from other areas, Creates problems	
6	**Information Overload**: Too much information available	
7	**Data quality** requirements too **restrictive**	
8	**Data Errors** more **difficult** & time consuming to **Fix**	
Complexity, Effort Required, Feasibility, Turmoil		
9	**Complexity** to achieve: Makes system to complex/costly to design/implement/operate	
10	**Turmoil/Chaos** created for employees or organization, **Cultural change** necessary	
11	**Geographic Separation**/Location makes full integration impossible or impractical	
12	**Skill Level Required** higher; More difficult to hire & train employees	
13	**Database Size/Complexity** requires too much processing power	
14	**Software Maintenance** more difficult, takes longer, greater skill needed, no quick fix	
15	**Broader Knowledge or Skill** required, More **Difficult** to **use/understand**	
16	**Workload Increased** for employees	
17	**Problem Source** more **difficult** to find, more **time** consuming	
18	**Competition** adversely affected if too complex	
32	Monolithic result, becomes **too large/complex/bureaucratic**	
35	Too **Time Consuming** to operate/maintain	
Cost, Risk, Control		
19	**High Costs**: Cost of integration is too high or diminishing returns for greater integration	
20	**Single failure point has greater impact**: failure in one part adversely affect other parts	
21	**Loss of Control** because dependence on vendor	
22	**Proprietary Solutions**: Makes dependence on a single vendor unacceptable/risky	
23	**Maintenance Control**, who makes changes	
24	Lack of **Local Support**	
33	**Disaster Recovery** more complex, time consuming, costly	
34	**No Need** or **Nothing Gained** by integration, not worth it, **diminishing returns**	
38	**Constant Change,** new software versions, upgrades	
39	**Error Ripple** Effect	
Undesirable, Inadequate, Unnecessary Solution		
25	Forced to use **undesirable software**, **process**	
26	**Not best of breed, software/processes**	
27	**Inflexible, bureaucratic**: slows improvements, prevents quick adaptation to bus changes	
28	**Non-Fit** – some features/functionality does not fit well with integrated solution/systems	
29	**Integration for sake of integration** or integration not needed	
30	**Functionality not Available** in integrated system	
31	**Less/Poor Functionality**, too **restrictive,** lost functionality/flexibility	
36	**Life Expectancy of Applications** too short for integration to be worthwhile	
37	**Business** must **change** to fit software vs. **Software cannot adapt** to **business**	
38	Full **Integration unnecessary**	
39	Not **practical** or **not needed**	

D. Questions that Yield Counts and Values		
1	Desirable: integrate of all data & apps: Answers to Question 3. Record each Yes/No. Ex: Y Y N Y	
2	Possible to measure integration: Answers to Question 6. Record each Yes/No. Ex: Y Y N Y	
3	Feasible to integrate all apps/data: Answers to Quest. 7, Part 1. Record each Yes/No. Ex: Y Y N Y	
4	Percent of integration feasible: Answers to Question 7, Part 2. Record actual % (100 if answer Y above)	
5	Should we integrate all data & apps: Answers to Question 4. Record each Yes/No. Ex: Y Y N Y	
E. How to measure integration		
Data Flow, Use, Storage...Look for or Verify...		
1	**Single data entry point**: See if data items entered more than once; how/where entered	
2	Availability/**access to shared data** (sharing as needed), access to data **automatically**, **Electronic** sharing	
3	**Data duplication,** multiple databases/files containing same data, varying data entry points	
4	**Data sharing quickness** The ways data shared; **real-time** vs. batch; **delays** in sharing	
5	**Common Database(s),** & central storage of data	
6	**Data Errors/Inconsistencies, redundant codes** should be eliminated if integrated	
7	**Hypothetical analysis of process changes** for integrated vs. non-integrated system	
22	**Data sharing** occurs as necessary/desirable, Trace data flow in system/processes	
24	**Data Translation** tables, rules, programming	
29	**Data Standards**	
Expected Results, Process		
8	**Expected results**, test system for expected results	
9	**Flowchart/Verify Processes, Determine/Track/Trace** processes	
10	**Process steps**, verify workflow steps work together; **Coordination** among departments	
11	**Inefficiencies/Low Productivity**, that should not exist with integrated solution; Process Efficiency	
12	**Single interface**: for user to do all work, get what is need from system, enter data	
13	**Duplication of Effort**, look for duplication of effort among people and departments	
14	**Customer Service/Satisfaction**	
15	**Before/After Comparisons or Manual vs. Automated**	
16	**Seamless, One System, one interface point** to system for everything, **Total/One System** Solution	
23	**Timely Completion** of tasks and processes	
25	**Reconciliations,** number and costs	
26	**Cost** of doing business/maintenance too high	
27	Degree of **Automation**	
28	**Amount** of **Maintenance** required	
Code Inspection, computer programs		
17	**Inspect program code**: Look for common interfaces, how data accessed, how programs work together	
18	**Interfaces, number used** among applications to exchange data: more means less integrated	
19	**Program maintenance**: # of programs to be modified with identical changes (more=less integration)	
20	**Programming/Application Duplication**, common function libraries	
21	**Applications Fail/Break** Frequently	
F. Lines Skipped -- because comments do not relate directly to sections A-E		

APPENDIX G –INTERVIEW TRANSCRIPT (EXAMPLE)

Question 3-Do you feel application integration is desirable or undesirable? Why?	
38	Yes, yes, Maybe, yes
39	I think the value of integration outweighs the best in breed benefit.
40	The total cost of ownership is lower
41	You can start to integrate things that don't really need to be integrated.
42	In turn what you get is a very complex difficult modified structure.
43	Where if you integrate things [and] where all you want to do is once a day pass, one piece of information from A to B and you go to the trouble of integrating those things, and in the name of integration, you may have an difficult situation in terms of support of operation of how you to maintenance and all of that stuff
44	You can get led into integration for the sake of integration is what is going on
45	The reason you would say yes, beyond that maybe it is buried under total _____.
46	On the previous page you are talking about, you go back to common interfaces, common data, you go into utilizing that data, the ability to take your organization to the next step by using the next release, all of that kind of stuff kind of flows naturally.
47	That is why we are basically integrating things
48	Yes, total cost ownership is the version of the very pieces you can go into.
49	Provides opportunities for scale that is very difficult to get otherwise
50	Another perspective is it can drive profit commonality.
51	It can be your stick.
52	Limits you when you are integrated, you are only allowed to go along the path of the integrated product.
53	If you want, if the firm is getting the _____ for example, you can't modify some piece of it or it is not interested in servicing a part of the business that you are involved in, you may not be able to service that part of the business.
54	So, it may be limiting.
55	If you spend too much on integration.
56	It may not work for the retail side or it may not do maintenance or.
57	You may have focus on an area with a very poor product, not best of breed, but no functionality.
58	If it didn't have maintenance and we want to use it, you get stuck when you get into a refinery and you want to have integrated with your project, your warehouse, and all of the rest.
59	I think the flip side of that is it can be eye opening.
60	I think there are parts of the business we are looking at a project now that is going to bring it into SAP and that functionality started with some ideas.
61	We can do this in this part of the business so how about expanding it into the supply area.
62	Eye opening in terms of opportunities across businesses sharing how different businesses are doing the same kind of basic functionality.
63	If you get more integrated, lets say you are 85% integrated.
64	It's the things that are niche, like maintenance.
65	It is the other 15% that you have to integrate that becomes harder.
66	The wider the circle is for integration, the things that are not that have to be custom becomes harder
(Les) Increasingly difficult, would that be appropriate?	
67	Yes
68	Again higher entry cost for non-integrated applications the more you are integrated.

APPENDIX H – QUALITATIVE DATA: CONCEPTS AND FREQUENCIES

Category, Dimension, Item	Management			IT Professional			End User			Sub Tot	% of Cat Tot	Grp Avg
	Freq	Percent of		Freq	Percent of		Freq	Percent of				
		Sub	Cat Tot		Sub	Cat Tot		Sub	Cat Tot			
A Integration Attributes												
Inherit Core Characteristics												
1 Common database	14	48.3%	12.5%	10	34.5%	7.6%	5	17.2%	6.9%	29	9.2%	9.7
2 Data sharing	13	36.1%	11.6%	11	30.6%	8.3%	12	33.3%	16.7%	36	11.4%	12.0
3 Business rules; consistent data def	6	75.0%	5.4%	1	12.5%	0.8%	1	12.5%	1.4%	8	2.5%	2.7
4 Less or no data redundancy	2	25.0%	1.8%	6	75.0%	4.5%	0	0.0%	0.0%	8	2.5%	2.7
5 Data synchronization	0	0.0%	0.0%	1	100.0%	0.8%	0	0.0%	0.0%	1	0.3%	0.3
6 Data security: consistent & pervasive	2	22.2%	1.8%	4	44.4%	3.0%	3	33.3%	4.2%	9	2.8%	3.0
Dimension Total	37	40.7%	33.0%	33	36.3%	25.0%	21	23.1%	29.2%	91	28.8%	30.3
Functionality & behavior												
7 Consistent user-friendly interfaces	4	36.4%	3.6%	4	36.4%	3.0%	3	27.3%	4.2%	11	3.5%	3.7
8 Seamless: appears as if one system	9	42.9%	8.0%	11	52.4%	8.3%	1	4.8%	1.4%	21	6.6%	7.0
9 Real-time processing vs. batch	7	28.0%	6.3%	10	40.0%	7.6%	8	32.0%	11.1%	25	7.9%	8.3
10 Response time & performance sufficient	0	0.0%	0.0%	1	100.0%	0.8%	0	0.0%	0.0%	1	0.3%	0.3
11 Record once; single entry; use everywhere	8	33.3%	7.1%	11	45.8%	8.3%	5	20.8%	6.9%	24	7.6%	8.0
12 One-stop access for all data	6	42.9%	5.4%	5	35.7%	3.8%	3	21.4%	4.2%	14	4.4%	4.7
13 One Sys for all/most data/functionality	6	28.6%	5.4%	9	42.9%	6.8%	6	28.6%	8.3%	21	6.6%	7.0
Dimension Total	40	34.2%	35.7%	51	43.6%	38.6%	26	22.2%	36.1%	117	37.0%	39.0
Design Concepts and Standards												
14 Applications work together	21	39.6%	18.8%	23	43.4%	17.4%	9	17.0%	12.5%	53	16.8%	17.7
15 Compatibility apps that fit to form one sys	1	12.5%	0.9%	5	62.5%	3.8%	2	25.0%	2.8%	8	2.5%	2.7
16 Application functionality dup eliminated	0	0.0%	0.0%	1	50.0%	0.8%	1	50.0%	1.4%	2	0.6%	0.7
17 Industry standard external interfaces	6	46.2%	5.4%	4	30.8%	3.0%	3	23.1%	4.2%	13	4.1%	4.3
18 Applications and data independence	0	0.0%	0.0%	1	100.0%	0.8%	0	0.0%	0.0%	1	0.3%	0.3
19 Standard and consistent core design concept	6	27.3%	5.4%	11	50.0%	8.3%	5	22.7%	6.9%	22	7.0%	7.3
20 Platform compatibility: hardware & software	1	11.1%	0.9%	3	33.3%	2.3%	5	55.6%	6.9%	9	2.8%	3.0
Dimension Total	35	32.4%	31.3%	48	44.4%	36.4%	25	23.1%	34.7%	108	34.2%	36.0
Category Total	112	35.4%		132	41.8%		72	22.8%		316		105.3

Category, Dimension, Item	Management			IT Professional			End User			Sub Tot	% of Cat Tot	Grp Avg
	Freq	Percent of		Freq	Percent of		Freq	Percent of				
		Sub	Cat Tot		Sub	Cat Tot		Sub	Cat Tot			
B Benefits												
Fundamental Integration Benefits												
1 Data availability/sharing for entire organ.	9	29.0%	5.1%	7	22.6%	5.3%	15	48.4%	8.4%	31	6.4%	10.3
2 Data more meaningful; timely; useful	2	33.3%	1.1%	0	0.0%	0.0%	4	66.7%	2.2%	6	1.2%	2.0
3. Improved data accuracy; reliability/consistency	22	36.1%	12.6%	22	36.1%	16.7%	17	27.9%	9.5%	61	12.6%	20.3
4 New/Increased functionality	10	26.3%	5.7%	14	36.8%	10.6%	14	36.8%	7.8%	38	7.8%	12.7
5 Greater efficiency; productivity; speed	20	42.6%	11.4%	14	29.8%	10.6%	13	27.7%	7.3%	47	9.7%	15.7
6 Overall operational improvements; easier/better	15	39.5%	8.6%	7	18.4%	5.3%	16	42.1%	8.9%	38	7.8%	12.7
Dimension Total	78	35.3%	44.6%	64	29.0%	48.5%	79	35.7%	44.1%	221	45.5%	73.7
Expected/Sought Direct Benefits												
7 Customer Service:	8	38.1%	4.6%	5	23.8%	3.8%	8	38.1%	4.5%	21	4.3%	7.0
8 Cost Reduction	20	40.8%	11.4%	14	28.6%	10.6%	15	30.6%	8.4%	49	10.1%	16.3
9 Less Maintenance (hardware & software)	0	0.0%	0.0%	1	33.3%	0.8%	2	66.7%	1.1%	3	0.6%	1.0
10 Hardware more scalable; maximize hardware	2	40.0%	1.1%	1	20.0%	0.8%	2	40.0%	1.1%	5	1.0%	1.7
11 Modern technology and best practices	3	75.0%	1.7%	1	25.0%	0.8%	0	0.0%	0.0%	4	0.8%	1.3
12 Replacement of legacy systems	0	--	0.0%	0	--	0.0%	0	--	0.0%	0	0.0%	0.0
13 Multi-Country capabilities	0	--	0.0%	0	--	0.0%	0	--	0.0%	0	0.0%	0.0
Dimension Total	33	40.2%	18.9%	22	26.8%	16.7%	27	32.9%	15.1%	82	16.9%	27.3
People Centered Benefits												
14 Manage; decisions/analysis; respond to changes	13	39.4%	7.4%	10	30.3%	7.6%	10	30.3%	5.6%	33	6.8%	11.0
15 People/department coordination/teamwork	6	27.3%	3.4%	3	13.6%	2.3%	13	59.1%	7.3%	22	4.5%	7.3
16 Easier to learn and train others	3	17.6%	1.7%	9	52.9%	6.8%	5	29.4%	2.8%	17	3.5%	5.7
17 Improve work environment/morale for employees	4	66.7%	2.3%	1	16.7%	0.8%	1	16.7%	0.6%	6	1.2%	2.0
18 Greater understanding of processes/data/organ	2	9.5%	1.1%	6	28.6%	4.5%	13	61.9%	7.3%	21	4.3%	7.0
19 Reduced skill set required of employees	1	14.3%	0.6%	4	57.1%	3.0%	2	28.6%	1.1%	7	1.4%	2.3
20 Less dependence on other departments/people	0	0.0%	0.0%	0	0.0%	0.0%	1	100.0%	0.6%	1	0.2%	0.3
Dimension Total	29	27.1%	16.6%	33	30.8%	25.0%	45	42.1%	25.1%	107	22.0%	35.7
Functionality/Operational Primary Benefits												
21 Paperless or reduced paper operation	5	100.0%	2.9%	0	0.0%	0.0%	0	0.0%	0.0%	5	1.0%	1.7
22 Greater data/transaction capacity	0	--	0.0%	0	--	0.0%	0	--	0.0%	0	0.0%	0.0
23 Support for legal matters	2	50.0%	1.1%	1	25.0%	0.8%	1	25.0%	0.6%	4	0.8%	1.3
24 Easier Software Upgrades	0	--	0.0%	0	--	0.0%	0	--	0.0%	0	0.0%	0.0
25 System easier to support and maintain	0	--	0.0%	0	--	0.0%	0	--	0.0%	0	0.0%	0.0
Dimension Total	7	77.8%	4.0%	1	11.1%	0.8%	1	11.1%	0.6%	9	1.9%	3.0

Category, Dimension, Item	Management			IT Professional			End User			Sub Tot	% of Cat Tot	Grp Avg
	Freq	Percent of		Freq	Percent of		Freq	Percent of				
		Sub	Cat Tot		Sub	Cat Tot		Sub	Cat Tot			
Enabled Benefits												
26 Standard processes/bus practices everywhere	4	25.0%	2.3%	3	18.8%	2.3%	9	56.3%	5.0%	16	3.3%	5.3
27 Improved processes and workflow	3	17.6%	1.7%	1	5.9%	0.8%	13	76.5%	7.3%	17	3.5%	5.7
28 Competitive/Strategic Advantage: gain/maintain	5	50.0%	2.9%	2	20.0%	1.5%	3	30.0%	1.7%	10	2.1%	3.3
29 New/expanded opportunities; allows creativity	5	71.4%	2.9%	2	28.6%	1.5%	0	0.0%	0.0%	7	1.4%	2.3
30 Better position to marketing organ/prod/serv	1	100.0%	0.6%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.2%	0.3
31 Empower Employees	3	60.0%	1.7%	1	20.0%	0.8%	1	20.0%	0.6%	5	1.0%	1.7
Dimension Total	21	37.5%	12.0%	9	16.1%	6.8%	26	46.4%	14.5%	56	11.5%	18.7
Strategic												
32 Reputation & prestige improvements	2	50.0%	1.1%	1	25.0%	0.8%	1	25.0%	0.6%	4	0.8%	1.3
33 Leverage size: influence better deals/support	1	50.0%	0.6%	1	50.0%	0.8%	0	0.0%	0.0%	2	0.4%	0.7
34 Centralized control	0	0.0%	0.0%	1	100.0%	0.8%	0	0.0%	0.0%	1	0.2%	0.3
35 Organizational change agent	3	100.0%	1.7%	0	0.0%	0.0%	0	0.0%	0.0%	3	0.6%	1.0
36 Independent: organizationally/geographically	1	100.0%	0.6%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.2%	0.3
Dimension Total	7	63.6%	4.0%	3	27.3%	2.3%	1	9.1%	0.6%	11	2.3%	3.7
Category Total	175	36.0%		132	27.2%		179	36.8%		486		162.0
C Downside of Integration												
Data Related												
1 Security; control data access	4	33.3%	6.1%	3	25.0%	5.3%	5	41.7%	9.6%	12	6.9%	4.0
2 Data needed by only one area or purpose	2	22.2%	3.0%	3	33.3%	5.3%	4	44.4%	7.7%	9	5.1%	3.0
3 Data does not fit with enterprise data	0	0.0%	0.0%	2	66.7%	3.5%	1	33.3%	1.9%	3	1.7%	1.0
4 Non firm-wide data; integration unnecessary	1	33.3%	1.5%	0	0.0%	0.0%	2	66.7%	3.8%	3	1.7%	1.0
5 Misuse; Misunderstanding of data by others	0	0.0%	0.0%	0	0.0%	0.0%	6	100.0%	11.5%	6	3.4%	2.0
6 Information Overload: Too much info available	0	0.0%	0.0%	0	0.0%	0.0%	1	100.0%	1.9%	1	0.6%	0.3
7 Data quality requirements too restrictive	0	0.0%	0.0%	0	0.0%	0.0%	1	100.0%	1.9%	1	0.6%	0.3
8 Data Errors: difficult/time consuming to Fix	0	0.0%	0.0%	2	50.0%	3.5%	2	50.0%	3.8%	4	2.3%	1.3
Dimension Total	7	17.9%	10.6%	10	25.6%	17.5%	22	56.4%	42.3%	39	22.3%	13.0

Category, Dimension, Item	Management			IT Professional			End User			Sub Tot	% of Cat Tot	Grp Avg
	Freq	Percent of		Freq	Percent of		Freq	Percent of				
		Sub	Cat Tot		Sub	Cat Tot		Sub	Cat Tot			
Complexity and Turmoil												
9 Complexity & cost to implement/operate	3	37.5%	4.5%	5	62.5%	8.8%	0	0.0%	0.0%	8	4.6%	2.7
10 Turmoil/chaos created for employees/organ	3	75.0%	4.5%	0	0.0%	0.0%	1	25.0%	1.9%	4	2.3%	1.3
11 Geog. location separation makes it impractical	1	33.3%	1.5%	2	66.7%	3.5%	0	0.0%	0.0%	3	1.7%	1.0
12 Skill level higher; difficult to hire/train	2	66.7%	3.0%	0	0.0%	0.0%	1	33.3%	1.9%	3	1.7%	1.0
13 Database size/complexity: too much processing	0	0.0%	0.0%	3	100.0%	5.3%	0	0.0%	0.0%	3	1.7%	1.0
14 Software maint difficult/longer; no quick fix	6	42.9%	9.1%	3	21.4%	5.3%	5	35.7%	9.6%	14	8.0%	4.7
15 Broader knowledge/skill required; hard to use	4	30.8%	6.1%	4	30.8%	7.0%	5	38.5%	9.6%	13	7.4%	4.3
16 Workload increased for employees	1	50.0%	1.5%	0	0.0%	0.0%	1	50.0%	1.9%	2	1.1%	0.7
17 Problem source hard/time consuming to find	0	0.0%	0.0%	1	100.0%	1.8%	0	0.0%	0.0%	1	0.6%	0.3
18 Competition adversely affected if too complex	0	0.0%	0.0%	0	0.0%	0.0%	1	100.0%	1.9%	1	0.6%	0.3
19 Monolithic result; becomes too large/complex	1	50.0%	1.5%	1	50.0%	1.8%	0	0.0%	0.0%	2	1.1%	0.7
20 Too time consuming/effort to operate/maintain	0	0.0%	0.0%	1	100.0%	1.8%	0	0.0%	0.0%	1	0.6%	0.3
Dimension Total	21	38.2%	31.8%	20	36.4%	35.1%	14	25.5%	26.9%	55	31.4%	18.3
Cost; Risk; Control												
21 High costs; diminishing returns	4	36.4%	6.1%	7	63.6%	12.3%	0	0.0%	0.0%	11	6.3%	3.7
22 Single failure points has greater impact	1	12.5%	1.5%	4	50.0%	7.0%	3	37.5%	5.8%	8	4.6%	2.7
23 Loss of control due to dependence on vendor	1	100.0%	1.5%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.6%	0.3
24 Proprietary solutions: depend on one vendor	3	50.0%	4.5%	2	33.3%	3.5%	1	16.7%	1.9%	6	3.4%	2.0
25 Maintenance control; who makes changes	1	100.0%	1.5%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.6%	0.3
26 Lack of local support	2	50.0%	3.0%	1	25.0%	1.8%	1	25.0%	1.9%	4	2.3%	1.3
27 Disaster recovery complex/time consuming	0	0.0%	0.0%	1	100.0%	1.8%	0	0.0%	0.0%	1	0.6%	0.3
28 No need; nothing gained by integration	0	0.0%	0.0%	2	50.0%	3.5%	2	50.0%	3.8%	4	2.3%	1.3
29 Constant change; new versions/upgrades	2	66.7%	3.0%	0	0.0%	0.0%	1	33.3%	1.9%	3	1.7%	1.0
30 Error ripple effect	1	100.0%	1.5%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.6%	0.3
Dimension Total	15	37.5%	22.7%	17	42.5%	29.8%	8	20.0%	15.4%	40	22.9%	13.3

Category, Dimension, Item	Management			IT Professional			End User			Sub Tot	% of Cat Tot	Grp Avg
	Freq	Percent of		Freq	Percent of		Freq	Percent of				
		Sub	Cat Tot		Sub	Cat Tot		Sub	Cat Tot			
Undesirable; inadequate; unnecessary solution												
31 Forced to use undesirable software; process	0	0.0%	0.0%	3	100.0%	5.3%	0	0.0%	0.0%	3	1.7%	1.0
32 Not best of breed; software/processes	2	50.0%	3.0%	1	25.0%	1.8%	1	25.0%	1.9%	4	2.3%	1.3
33 Inflexible; cannot adapt to business changes	2	66.7%	3.0%	0	0.0%	0.0%	1	33.3%	1.9%	3	1.7%	1.0
34 Some features/function does not fit integration	5	71.4%	7.6%	1	14.3%	1.8%	1	14.3%	1.9%	7	4.0%	2.3
35 Integration for sake of integration	2	100.0%	3.0%	0	0.0%	0.0%	0	0.0%	0.0%	2	1.1%	0.7
36 Functionality not available in system	3	75.0%	4.5%	0	0.0%	0.0%	1	25.0%	1.9%	4	2.3%	1.3
37 Too restrictive; less/lost functionality/flex	4	36.4%	6.1%	4	36.4%	7.0%	3	27.3%	5.8%	11	6.3%	3.7
38 App life expectancy too short to be worthwhile	0	0.0%	0.0%	1	100.0%	1.8%	0	0.0%	0.0%	1	0.6%	0.3
39 Business must change to fit software	1	50.0%	1.5%	0	0.0%	0.0%	1	50.0%	1.9%	2	1.1%	0.7
40 Full integration unnecessary	3	100.0%	4.5%	0	0.0%	0.0%	0	0.0%	0.0%	3	1.7%	1.0
41 Not practical or not needed	1	100.0%	1.5%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.6%	0.3
Dimension Total	23	56.1%	34.8%	10	24.4%	17.5%	8	19.5%	15.4%	41	23.4%	13.7
Category Total	66	37.7%		57	32.6%		52	29.7%		175		58.3
D Yes/No and Estimated Responses												
1 Desirable to integrate all applications	4			5			4			13		4.3
2 Is it possible to measure integration	6			2			4			12		4.0
3 Is it practical to integrate all applications	4			4			4			12		4.0
4 Percent of integration practical	6			5			6			17		5.7
5 Should we integrate all data & applications	5			5			5			15		5.0
Category Total	25			21			23			69		23.0
E How to Measure Integration												
Data Flow; Use; Storage												
1 Single data entry point	3	50.0%	7.0%	3	50.0%	6.1%	0	0.0%	0.0%	6	5.0%	2.0
2 Availability/access to shared data	0	0.0%	0.0%	6	46.2%	12.2%	7	53.8%	24.1%	13	10.7%	4.3
3 Data duplication; multiple databases/files	3	60.0%	7.0%	2	40.0%	4.1%	0	0.0%	0.0%	5	4.1%	1.7
4 Data sharing quickness; real-time vs. batch	1	20.0%	2.3%	3	60.0%	6.1%	1	20.0%	3.4%	5	4.1%	1.7
5 Common database(s); central storage of data	4	80.0%	9.3%	1	20.0%	2.0%	0	0.0%	0.0%	5	4.1%	1.7
6 Data Errors/Inconsistencies; redundant codes	0	0.0%	0.0%	2	50.0%	4.1%	2	50.0%	6.9%	4	3.3%	1.3
7 Hypothetical analysis of process changes	0	--	0.0%	0	--	0.0%	0	--	0.0%	0	0.0%	0.0
8 Data sharing as needed; trace data flow	5	71.4%	11.6%	1	14.3%	2.0%	1	14.3%	3.4%	7	5.8%	2.3
9 Data Translation tables; rules; programming	1	33.3%	2.3%	1	33.3%	2.0%	1	33.3%	3.4%	3	2.5%	1.0
10 Data Standards	0	0.0%	0.0%	1	100.0%	2.0%	0	0.0%	0.0%	1	0.8%	0.3
Dimension Total	17	34.7%	39.5%	20	40.8%	40.8%	12	24.5%	41.4%	49	40.5%	16.3

Category, Dimension, Item	Management			IT Professional			End User			Sub Tot	% of Cat Tot	Grp Avg
	Freq	Percent of		Freq	Percent of		Freq	Percent of				
		Sub	Cat Tot		Sub	Cat Tot		Sub	Cat Tot			
Expected Results; Process												
11 Test system for expected results	1	25.0%	2.3%	1	25.0%	2.0%	2	50.0%	6.9%	4	3.3%	1.3
12 Determine/flowchart/verify/track processes	3	37.5%	7.0%	3	37.5%	6.1%	2	25.0%	6.9%	8	6.6%	2.7
13 Verify workflow steps work together	5	45.5%	11.6%	1	9.1%	2.0%	5	45.5%	17.2%	11	9.1%	3.7
14 Unjustifiable inefficiencies/low productivity	5	55.6%	11.6%	2	22.2%	4.1%	2	22.2%	6.9%	9	7.4%	3.0
15 Single interface: for user to do all work	1	33.3%	2.3%	2	66.7%	4.1%	0	0.0%	0.0%	3	2.5%	1.0
16 Duplication of effort among people/depts	2	100.0%	4.7%	0	0.0%	0.0%	0	0.0%	0.0%	2	1.7%	0.7
17 Customer service/satisfaction	1	25.0%	2.3%	1	25.0%	2.0%	2	50.0%	6.9%	4	3.3%	1.3
18 Before/after comparisons & manual/automated	2	40.0%	4.7%	2	40.0%	4.1%	1	20.0%	3.4%	5	4.1%	1.7
19 Seamless; 1 system; 1 interface to system	0	0.0%	0.0%	1	50.0%	2.0%	1	50.0%	3.4%	2	1.7%	0.7
20 Timely completion of tasks and processes	0	0.0%	0.0%	0	0.0%	0.0%	1	100.0%	3.4%	1	0.8%	0.3
21 Reconciliations; number and costs	1	20.0%	2.3%	4	80.0%	8.2%	0	0.0%	0.0%	5	4.1%	1.7
22 Cost of doing business/maintenance too high	1	100.0%	2.3%	0	0.0%	0.0%	0	0.0%	0.0%	1	0.8%	0.3
23 Degree of automation	0	0.0%	0.0%	1	100.0%	2.0%	0	0.0%	0.0%	1	0.8%	0.3
24 Amount of maintenance required	0	0.0%	0.0%	2	100.0%	4.1%	0	0.0%	0.0%	2	1.7%	0.7
Dimension Total	22	37.9%	51.2%	20	34.5%	40.8%	16	27.6%	55.2%	58	47.9%	19.3
Code Inspection; computer programs												
25 Inspect programs for interfaces/data access	1	50.0%	2.3%	0	0.0%	0.0%	1	50.0%	3.4%	2	1.7%	0.7
26 Number app interfaces to exchange data	3	42.9%	7.0%	4	57.1%	8.2%	0	0.0%	0.0%	7	5.8%	2.3
27 No. programs modified with same changes	0	0.0%	0.0%	2	100.0%	4.1%	0	0.0%	0.0%	2	1.7%	0.7
28 Programming/application duplication	0	0.0%	0.0%	1	100.0%	2.0%	0	0.0%	0.0%	1	0.8%	0.3
29 Applications fail/break frequently	0	0.0%	0.0%	2	100.0%	4.1%	0	0.0%	0.0%	2	1.7%	0.7
Dimension Total	4	28.6%	9.3%	9	64.3%	18.4%	1	7.1%	3.4%	14	11.6%	4.7
Category Total	43	35.5%		49	40.5%		29	24.0%		121		40.3
Total Sentences Coded	421	36.1%		391	33.5%		355	30.4%		1167		389.0
F. Sentences Not Coded	197	33.3%		213	36.0%		182	30.7%		592		197.3
Percent of Total Sentences	31.9%			35.3%			33.9%			33.7%		33.7%
Grand Total	618	35.1%		604	34.3%		537	30.5%		1759		586.3

APPENDIX I – SURVEY QUESTIONNAIRE

Enterprise Systems: Applications Integration Research

E.J. Ourso College of Business Administration

Information Systems and Decision Sciences Department

Only about 15 minutes is needed to fill out this survey (based on pilot testing)

Research Description

This research investigates the very essence of information technology integration. In this study, only integration of applications that make up enterprise systems is considered. Organizations devote an average of 40% of their Information Technology (IT) budget to integration. But what is integration? What does it mean? Is integration a good thing or a bad thing, and why? The value of integration is rarely defined either in abstract or practical terms. It is generally assumed that the value of integration is obvious. Your participation will help answer the above questions plus others and lead to a better understanding of integration.

Definitions

Applications — A program or set of programs that perform a set of functions (some people call these systems). Example applications are Payroll, Financial Accounting, Human Resources, Manufacturing, Sales, and Inventory.

Enterprise System — The set of related applications that an organization uses to operate and manage the organization. An organization may have more than one system — the enterprise system is typically the largest and has the greatest number of applications.

Integration — This is the concept under investigation. A very simplistic description is applications working together.

Seamless — A set of programs or applications that appear as one program or application even though we understand the "one" has multiple functions. Example: Financial accounting may consist of general ledger, accounts payable, budget, and accounts receivable, but we think of this as the accounting system rather than separate systems.

Legacy Systems — The set of applications used by an organization for several years. Typically legacy systems were developed in-house although the systems could have been purchased. Basically, legacy means older.

Instructions

It is very important that you personally complete the questionnaire for the results to have meaning. Select the answer that best reflects your view. Answer all questions as honestly as possible. There are no correct or best answers. Your answers will be part of the grand totals and used only for research purposes thereby assuring complete confidentiality.
On the last page (back) please write any comments, suggestions, or criticisms that you may have regarding this survey.

Thanks for your participation!

Important

Taking part in this survey is voluntary. By returning the completed survey you are indicating your willingness to participate. We do not know your name unless you tell us, and the results will be presented in summary form so that no participants or their companies are identified.

Lester (Les) A. Singletary, a doctoral candidate at Louisiana State University, is conducting this research. His mailing address is: Louisiana State University; 3166-B CEBA; Baton Rouge, LA 70803. You can also contact him by email at Lsingle@lsu.edu or by phone at LSU: (225) 578-9071 or Cell: (985) 507-0995.

Integration Attributes (Characteristics)

The questions in this section help define what application integration means.

A <u>defining characteristic</u> of application integration is…

	Strongly Disagree 1	2	3	Neutral 4	5	6	Strongly Agree 7
1. Using a common database or central/common shared store of information	O	O	O	O	O	O	O
2. Sharing data among applications and facilitating data sharing among people and departments	O	O	O	O	O	O	O
3. Utilizing business rules to ensure consistent definition and use of data	O	O	O	O	O	O	O
4. Reducing or eliminating data redundancy	O	O	O	O	O	O	O
5. Synchronizing data (example: accounts payable reflects latest payroll)	O	O	O	O	O	O	O
6. Providing consistent and pervasive data security	O	O	O	O	O	O	O
7. Applications working together; they "talk" and communicate	O	O	O	O	O	O	O
8. Having a set of compatible applications that fit together to form a single system	O	O	O	O	O	O	O
9. Eliminating or reducing duplication of functionality among applications	O	O	O	O	O	O	O
10. Providing industry standard external interfaces	O	O	O	O	O	O	O
11. Designing systems such that applications and data are independent	O	O	O	O	O	O	O
12. A single system	O	O	O	O	O	O	O
13. Standardized design concept for all applications ensuring consistency	O	O	O	O	O	O	O
14. Hardware and software platform compatibility	O	O	O	O	O	O	O
15. Ensuring that all or most applications are web enabled	O	O	O	O	O	O	O
16. Providing a consistent, easy, and user-friendly interface to the system	O	O	O	O	O	O	O
17. Making the system seamless: appears and functions as if one system regardless of application used	O	O	O	O	O	O	O
18. Real-time processing (little or no batch processing)	O	O	O	O	O	O	O
19. Providing response times and performance that are sufficient for the job at hand	O	O	O	O	O	O	O
20. Entering data only once into the system	O	O	O	O	O	O	O
21. Single interface to the system to access any combination of data	O	O	O	O	O	O	O

Benefits of Integration

The questions below are aimed at understanding the benefits of integration of applications.

A benefit of application integration is…

	Strongly Disagree 1	2	3	Neutral 4	5	6	Strongly Agree 7
22. Data available to everyone in the organization	O	O	O	O	O	O	O
23. Data is more meaningful	O	O	O	O	O	O	O
24. Data is more timely making it more use useful	O	O	O	O	O	O	O
25. Improved data accuracy, reliability, and consistency	O	O	O	O	O	O	O
26. Reduced data redundancy (duplication)	O	O	O	O	O	O	O
27. Increased functionality (includes more automation)	O	O	O	O	O	O	O
28. Greater efficiency, speed, and productivity	O	O	O	O	O	O	O
29. Operational improvements	O	O	O	O	O	O	O
30. Better customer service	O	O	O	O	O	O	O
31. Lower costs	O	O	O	O	O	O	O
32. Reduced hardware and software maintenance	O	O	O	O	O	O	O
33. More scalable hardware; permits maximization of hardware utilization	O	O	O	O	O	O	O
34. Use of modern technology and best practices	O	O	O	O	O	O	O
35. Replacement of legacy systems	O	O	O	O	O	O	O
36. Multi-country support (e.g. languages, currency, laws/regulations)	O	O	O	O	O	O	O
37. It permits better management decisions and analysis	O	O	O	O	O	O	O
38. Improved coordination among people and departments	O	O	O	O	O	O	O
39. It makes training and learning the system easier	O	O	O	O	O	O	O

A benefit of application integration is… (continued)	**Strongly Disagree** 1	2	3	Neutral 4	5	6	**Strongly Agree** 7
40. Improved employee morale	O	O	O	O	O	O	O
41. It leads to better overall understanding of the organization and processes by employees	O	O	O	O	O	O	O
42. A reduction in the skill set required by employees	O	O	O	O	O	O	O
43. Decreased dependence on other people or departments	O	O	O	O	O	O	O
44. Reduced paperwork	O	O	O	O	O	O	O
45. Expanded computing capacity: Total records that can be managed and number of transactions handled	O	O	O	O	O	O	O
46. Better support for legal matters	O	O	O	O	O	O	O
47. Easier software upgrades	O	O	O	O	O	O	O
48. That the system is easier to support and maintain	O	O	O	O	O	O	O
49. That organizations can standardize processes and business practices everywhere	O	O	O	O	O	O	O
50. It allows organizations to establish better processes, workflow, and business practices	O	O	O	O	O	O	O
51. The capability for organizations to achieve or increase competitive advantage	O	O	O	O	O	O	O
52. New or expanded opportunities	O	O	O	O	O	O	O
53. Improved marketing of the organization and its products and services	O	O	O	O	O	O	O
54. It empowers employees	O	O	O	O	O	O	O
55. The opportunity to increase reputation and prestige	O	O	O	O	O	O	O
56. That organizations can leverage their size to influence deal making and support	O	O	O	O	O	O	O
57. It permits for centralized control of operations and enterprise system	O	O	O	O	O	O	O
58. It makes organizational change possible or easier	O	O	O	O	O	O	O
59. The opportunity for organizations to become organizationally and geographically independent	O	O	O	O	O	O	O

Amount of Integration	**Never** 1	2	3	4	5	6	**Always** 7
60. How likely are you to recommend application integration to others?	O	O	O	O	O	O	O
	Not at All						**Very**
61. How satisfied are you with the current application integration at your organization?	O	O	O	O	O	O	O
62. How important is application integration for you to do your job well?	O	O	O	O	O	O	O
63. Please estimate the percent of applications that are integrated in your organization	☐ Percent						
64. What percent of all applications do you feel is practical to integrate?	☐ Percent						

Participant Information

1. Which category best describes your position <u>within your organization</u> during the past two years? (Choose only 1)
   - O Senior/high-level middle management
   - O IS/IT professional: Design/Programming (programmer, analyst, DB administration, management, and similar positions)
   - O IS/IT professional: Technical/Support (operator, network/communications, LAN management, user services, lab, etc.)
   - O End-user other than those listed above (professional, supervisor, lower management, secretarial/clerical, and similar)
   - O Other (explain) _____
2. Educational Level (Please indicate highest level)?
   - O Graduate (masters or doctorate)
   - O Bachelors
   - O Associate or Some College
   - O High School

	Very Little 1	2	3	4	5	6	**Expert** 7
3. How do you rate your programming abilities or database creation/management abilities?	O	O	O	O	O	O	O

4. Number of years experience using integrated enterprise systems ..... _____
5. Have you ever created a database application or written a program? ..... O Yes O No

Comments and Suggestions

Please take a couple of minutes to reply to the questions below. Then write any comments, suggestions, or criticisms that you may have regarding this questionnaire or research study.

1. What does application integration mean to you?

2. Do you think of integration any differently after completing this questionnaire?

3. Please provide any general comments, suggestions, or criticism of this questionnaire that you may have.

Thank You Very Much for Your Participation!

APPENDIX J – DESCRIPTIVE STATISTICS

Item		Min	Max	Mean	Std. Dev	Skewness		Kurtosis		Remark
Quest Num	Description					Stat	Std. Error	Stat	Std. Error	
1	Database	1	7	5.84	1.25	-1.461	.122	2.208	.244	
2	Data sharing	1	7	6.19	.94	-1.923	.122	6.000	.244	
3	Bus rules	1	7	5.38	1.42	-.863	.122	.341	.244	
4	Dup data	1	7	5.84	1.32	-1.393	.122	1.849	.244	
5	Data sync	1	7	6.06	1.07	-1.539	.122	3.281	.244	
6	Security	1	7	5.54	1.54	-.980	.122	.153	.244	Deleted
7	Apps Talk	2	7	6.37	.83	-1.644	.122	3.977	.244	
8	Comp apps	1	7	6.02	1.18	-1.418	.122	1.851	.244	
9	Dup app funct	1	7	5.86	1.17	-1.196	.122	1.557	.244	Deleted
10	Std interface	1	7	4.89	1.36	-.385	.122	-.116	.244	Deleted
11	App/data independ	1	7	4.36	1.70	-.262	.122	-.762	.244	Deleted
12	One system	1	7	4.08	1.90	-.066	.122	-1.080	.244	
13	Design stds	1	7	5.44	1.37	-1.104	.122	1.112	.244	
14	Com H/S platform	1	7	5.71	1.30	-1.227	.122	1.515	.244	
15	Apps web enabled	1	7	4.50	1.74	-.360	.122	-.718	.244	Control
16	User friendly	1	7	5.72	1.43	-1.319	.122	1.341	.244	
17	Seamless	2	7	6.05	1.08	-1.270	.122	1.621	.244	
18	Real-time	1	7	5.14	1.63	-.764	.122	-.275	.244	
19	Response time	1	7	5.57	1.41	-1.116	.122	.823	.244	
20	Enter data once	1	7	6.20	1.18	-2.032	.122	4.889	.244	
21	Single access	1	7	5.68	1.38	-1.172	.122	1.012	.244	
22	Data available	1	7	5.37	1.66	-.977	.122	.113	.244	Deleted
23	Data meaningful	1	7	5.41	1.41	-.857	.122	.314	.244	
24	Data Timely	1	7	5.98	1.13	-1.463	.122	2.808	.244	
25	Data accurate	1	7	6.03	1.18	-1.563	.122	2.696	.244	
26	Dup Data	1	7	6.16	1.06	-1.536	.122	2.599	.244	
27	New functionality	1	7	5.89	1.14	-1.288	.122	1.917	.244	
28	Efficiency	1	7	6.12	1.06	-1.635	.122	3.309	.244	
29	Op improvements	1	7	5.83	1.08	-1.038	.122	1.413	.244	
30	Cust service	1	7	5.97	1.10	-1.300	.122	1.926	.244	
31	Lower costs	1	7	5.16	1.50	-.645	.122	-.046	.244	
32	Less H/S maint	1	7	4.89	1.56	-.514	.122	-.294	.244	
33	Hardware scalable	1	7	5.09	1.32	-.462	.122	.177	.244	
34	Mod tech & pract	1	7	5.48	1.40	-1.022	.122	.733	.244	
35	Repl legacy sys	1	7	5.04	1.58	-.734	.122	-.042	.244	Deleted
36	Multi-country	1	7	4.62	1.48	-.267	.122	-.278	.244	Deleted
37	Mgt dec & analysis	1	7	5.91	1.00	-1.086	.122	2.096	.244	Deleted
38	Cord dept/people	1	7	6.09	.98	-1.649	.122	4.479	.244	Deleted
39	Easier train & learn	1	7	5.57	1.45	-1.060	.122	.498	.244	
40	Imprv wrk environ	1	7	4.77	1.45	-.363	.122	.000	.244	
41	Understand organ	1	7	5.25	1.31	-.590	.122	.123	.244	
42	Employ skill set	1	7	4.30	1.70	-.276	.122	-.802	.244	Deleted
43	Depend on others	1	7	4.97	1.64	-.721	.122	-.266	.244	Deleted

44	Reduced paper	1	7	5.35	1.48	-.841	.122	.162	.244	Deleted
45	Computing capacity	1	7	5.57	1.17	-.874	.122	.800	.244	Deleted
46	Legal support	1	7	4.71	1.27	-.190	.122	.248	.244	Deleted
47	Soft upgrade easier	1	7	4.87	1.50	-.539	.122	-.151	.244	
48	Sys easier support	1	7	5.02	1.52	-.536	.122	-.322	.244	
49	Std bus practices	1	7	5.37	1.28	-1.026	.122	1.413	.244	
50	Better processes	2	7	5.75	1.07	-.834	.122	.618	.244	
51	Competitive advant	1	7	5.45	1.17	-.477	.122	-.169	.244	
52	New opportunities	1	7	5.31	1.27	-.472	.122	-.054	.244	
53	Marketing	1	7	5.13	1.28	-.425	.122	.128	.244	
54	Empower empl	1	7	5.07	1.42	-.569	.122	.217	.244	
55	Reputation/prestige	1	7	4.60	1.43	-.435	.122	-.008	.244	
56	Leverage size	1	7	4.55	1.36	-.415	.122	.272	.244	
57	Central control	1	7	5.59	1.19	-.941	.122	.893	.244	Deleted
58	Organ change	1	7	5.07	1.37	-.590	.122	.028	.244	Deleted
59	Indep organ/geog	1	7	4.83	1.44	-.423	.122	-.220	.244	Deleted
60	Likely recom integ	1	7	5.35	1.24	-1.207	.122	2.227	.244	Deleted
61	Satisfied cur integ	1	7	4.16	1.48	-.284	.122	-.450	.244	Deleted
62	Integ import to job	1	7	5.52	1.24	-1.024	.122	1.265	.244	Deleted

Notes

1. Items were deleted because they would not load or because of validity and reliability concerns.

2. Items are numbered in this table the same as on the questionnaire. See Appendix I.

3. Item 15, “Apps web enabled”, is not a legitimate attribute and was included as a control for those who merely marked all questions the same. However, this did not work since about half of the participants considered web-enabled applications as an attribute.

APPENDIX K – FREQUENCY DISTRIBUTION

Item	1	2	3	4	5	6	7
Database	2	13	9	23	66	147	139
Data sharing	1	5	1	10	44	169	169
Bus rules	6	12	22	60	81	121	97
Dup data	5	7	14	33	58	128	154
Data sync	2	3	7	17	64	140	166
Security	6	16	23	56	49	108	141
Apps Talk	0	2	1	9	38	136	213
Comp apps	1	6	10	32	45	130	175
Dup app funct	2	4	10	36	67	142	138
Std interface	6	13	35	101	104	91	49
App/data indep	25	45	38	106	66	77	42
One system	49	48	53	85	52	61	51
Design stds	8	9	19	48	82	145	88
Com H/S platform	4	11	6	46	69	136	127
Apps web enabled	28	32	43	93	68	81	54
User friendly	6	14	15	32	63	123	146
Seamless	0	5	6	24	66	125	173
Real-time	12	23	34	59	62	120	89
Response time	5	13	21	38	72	132	118
Enter data once	5	4	4	22	40	109	215
Single access	4	12	16	40	66	128	133
Data available	14	18	27	48	58	109	125
Data meaningful	6	9	26	57	80	120	101
Data Timely	3	2	10	23	64	143	154
Data accurate	2	6	10	21	56	129	175
Dup Data	1	2	7	26	40	132	191
New functionality	2	3	12	30	62	154	136
Efficiency	1	4	8	17	48	145	176
Op improvements	2	1	5	45	67	159	120
Cust service	1	5	3	39	49	154	148
Lower costs	9	16	18	93	76	99	88

Item	1	2	3	4	5	6	7
Less H/S maint	12	26	21	103	79	89	69
Hardware scalable	6	8	17	108	99	98	63
Mod tech & pract	6	13	14	59	69	136	102
Repl legacy sys	15	20	19	89	67	114	75
Multi-countryt	12	24	30	140	69	78	46
Mgt dec & analysis	2	0	3	32	75	163	124
Cord dept/people	2	2	4	16	54	168	153
Easier train & learn	4	16	23	39	67	124	126
Imprv wrk environ	14	8	38	118	94	72	55
Understand organ	4	6	28	68	110	109	74
Employ skill set	29	42	50	88	76	78	36
Depend on others	16	24	38	52	88	111	70
Reduced paper	8	11	27	64	69	118	102
Computing capacity	2	4	14	51	89	152	87
Legal support	8	6	29	155	86	81	34
Soft upgrade easier	12	18	30	101	80	103	55
Sys easier support	9	16	37	83	80	99	75
Std bus practices	7	9	9	59	107	136	72
Better processes	0	4	8	38	90	154	105
Competitive advant	1	3	12	76	97	129	81
New opportunities	3	5	16	88	99	104	84
Marketing	5	5	17	108	97	104	63
Empower empl	10	9	21	98	100	89	72
Reputation/prestige	14	21	32	124	93	83	32
Leverage size	14	17	33	132	107	68	28
Central control	1	9	11	45	93	148	92
Organ change	5	15	26	83	100	112	58
Indep organ/geog	7	24	28	103	98	88	51
Likely recom integ	8	10	5	47	129	140	60
Satisfied cur integ	22	34	70	94	108	55	16
Integ import to job	4	7	14	46	97	145	86

VITA

Les Singletary has more than 25 years experience in the Information Technology (IT) industry. Before returning to college, he held many IT positions including computer center director, MIS manager, and project leader. He has experience working with mainframes, minicomputers, microcomputers, and several types of specialized equipment. Mr. Singletary has programmed in over a dozen languages including Visual Basic, C, COBOL, PL6, Fortran, several versions of old style Basic, Pascal, several versions of assembly, and machine language. He has extensive experience with real-time integration of applications, optical scanning, IT administration, platform conversions (hardware and software), and electronic communications. He has developed systems that have been installed in several universities including Georgia State University and The University of Vermont.

For six years, Mr. Singletary was the CEO and principal owner of a small software development company named M.I.P.S., Inc. The company developed and sold a variety of products throughout the United States and to over 30 foreign countries. He hosted and was chairman of the Board of Directors for a small international conference (Honeywell CP-6 Mainframe Computer users). He has attended and participated in many conferences. Mr. Singletary has finished his doctoral studies in the Information Systems and Decisions Sciences department at Louisiana State University. He plans to graduate in Summer 2003.

His research interests include IT/IS integration, enterprise systems, human factors, and knowledge management. For his master's thesis, he researched modeling of IT systems and developed a model to capture the integration of ERP components including data interaction/flow and events that trigger processes among the ERP applications. His dissertation research evolved around the complex problem of determining the value of information technology integration.