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A KNOWLEDGE MANAGEMENT MODEL FOR E-BUSINESS WORLD

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Abstract

Today, more than ever, organizations have to work harder to keep up with the pace of changes and increased global competition in the Internet-based environment, the e-business world. To succeed in multi-channel, high speed information processing environment, organizations need to leverage the knowledge they have at their disposal; they need to harness the knowledge inherent at both the individual and the corporate level; they also need to operate their business in real-time, making adjustments to changes in market conditions. In this thesis we demonstrate how knowledge management can and should contribute to leading and managing e-business-driven changes in business and operating processes, and indicate the rudiments of action agenda that decision makers will deploy to build a knowledge-management-based approach to transform their business processes. One accomplishment of the thesis is to build up a generic knowledge management framework – PEDS, the Online Performance Evaluation and Decision Support System, and demonstrate it, from the system architecture and development process to business modeling. We also show that PEDS can be applied to a variety of business contexts and has a great potentiality as an enhancer to the e-business world.

Key Word: Knowledge Management, Information Process, Component Based Development, Decision Making System, E-Business, PEDS
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Chapter 1

Introduction

“Knowledge, without a doubt, is the critical capital in any modern organization. The ability to collect, interpret, direct and communicate knowledge is fundamental to developing an innovation organization.”

-------- Carol Stephenson, President and CEO, Stentor Resource Centre Inc.

1.1 Background

During the past few years, the business world has undergone the emergence of interest in knowledge management (KM), which is a significant management discipline with its own body of concepts, languages, and practices. Organizations have come to realize how important it is to “know what they know” and be able to make maximum use of the knowledge. This knowledge resides in many different places such as: databases, knowledge bases, filing cabinets and people’s head and are distributed right across the enterprise.

The success in an increasingly competitive marketplace depends critically on the quality of knowledge, which organizations apply to their key business processes. Many organizations have come to use “models of KM” in order to suit the industrial epoch.
Chapter 1 – Introduction

However, despite the popularity of the buzzword, John Seely Brown [1] has reported that investment of over $1 trillion in technology over the last two decades has realized little improvement in the efficiency and effectiveness of its knowledge workers. The confusion between information and knowledge has caused people to sink billions of dollars into information technology investments that have yielded marginal results.

1.2 Motivation

The disconnection between IT expenditure and organization’s performance, on the one hand, is attributed to the economic transition, from an era of competitive advantage based on information to the one based on knowledge creation. The earlier period is characterized by relatively slow and predictable changes that could be deciphered and controlled by most information systems. While the latter one is of dynamic and discontinuous changes that require continual reassessment of organizational routines to ensure that organizational decision-making processes, as well as underlying assumptions, keep pace with the dynamically changing business environment.

On the other hand, such disconnection reflects the difference between knowledge and information: Knowledge is interpreted in terms of potential for action; Information is distinguished of its more immediate link with performance. The huge gap between investment and return is the result of out-of-date KM model, which seriously undermine organization’s information strategy.
Our basic motivation is realizing that there is great potentiality to generate much higher return on investment (ROI), so long as we could find out an appropriate business model and related knowledge-managing view to quantify, monitor and adjust performance factors throughout the entire process. Also, old information technology solutions fall in the realm of KM, which encourages us to develop a better and more accurate understanding of KM as an enabler of information strategy for the new world of business.

1.3 Research Goal

In this thesis we pursue three goals:

- One is to demonstrate how KM can and should contribute to leading and managing e-business-driven change in business or operating processes, and to indicate the rudiments of an action agenda that executives might deploy in order to build a KM-based approach to transform their business processes.

- The second is to build a genetic KM framework – Online Performance Evaluation and Decision Support System (PEDS for short). Demonstrate its great potentiality as an enhancer to the E-business world, from the system architecture, the development process, and business model to its applications.

- The third is to apply the proposed KM model to a number of examples from different industry contexts. By allowing the user to identify key factors in business and using various quantitative analysis methods, this approach allows one to correlate unstructured, discrete data into meaningful decision making
parameters in a systematic manner. Thus, providing decision makers valuable guidelines for better utilization of organization’s resources.

1.4 Organization

The organization of this thesis is as the following:

Chapter 1 presents the fact that there is an unmatched investment / return ratio nowadays in most organizations, and then briefly outlines the solution for such problem is to create an appropriate KM model. It also presents the motivations and objectives of the research.

Chapter 2 introduces concepts about KM and decision support system (DSS). More specifically, it dips into the differences between information processing and knowledge generation, and points out how dynamically updated knowledge changes the traditional information-based business process.

Chapter 3 presents the framework of a generalized KM model, the Online Performance Evaluation and Decision Support System (PEDS). It explains the use of a component-based architecture and the milestone development process to define a generic framework for business model.

Chapter 4 applies PEDS to sample application cases of academic institution performance evaluation and stock picking decision making, by using quantitative analysis and decision tree methods, explains how this model will enhance an organization’s overall
Chapter 1 – Introduction

performance based on available knowledge. And as a result, improves the return on investment.

Chapter 5 describes the implementation details of PEDS, including workflow, database, object and business logic design and deployment.

Chapter 6 concludes the thesis by summarizing the advantages of PEDS model through system architecture, development process and component reusability. Also lists future research work in the field of KM.
Chapter 2 – Knowledge Management and Decision Support System

Chapter 2

Knowledge Management and Decision Support System

“Knowledge management represents, for most organizations, a completely new and different environment in which you are attempting to bring structure and control to that which is typically without boundaries.”

-------- Thomas Koulopoulos

2.1 Knowledge Management

Knowledge Management (KM) is a newly emerging, interdisciplinary business model dealing with all aspects of knowledge within the context of the organization, including knowledge creation, codification, sharing, and how these activities promote learning and innovation. In practice, KM encompasses both technological tools and organizational routines in overlapping parts.
2.1.1 What is Knowledge?

Before addressing the definition of KM, it is probably appropriate to develop perspectives regarding just what the knowledge, which there seems to be such a desire to manage, really is. First, let’s consider this observation made by Neil Fleming [2] as a basis for thought relating to the following diagram.

- A collection of data is not information
- A collection of information is not knowledge
- A collection of knowledge is not wisdom

The idea is that information, knowledge, and wisdom are more than simply collections. Rather, the whole represents more than the sum of its parts and has a synergy of its own.

We begin with data, which is just a meaningless point in space and time, without reference to either space or time. When we encounter a piece of data, our first action is to attribute meaning, or create context to it. That a collection of data is not information, as Neil indicated, implies that a collection of data for which there is no relation between pieces of data is not information. The pieces of data may represent information, yet whether or not it is information depends on the understanding of how the one perceiving the data.
Information has a tendency to be relatively static in time and linear in nature. It is a relationship between data and with great dependence on context for its meaning and with little implication for the future.

Beyond relation there is pattern, which embodies both a consistency and completeness of relations which creates its own context. When these patterns and their implications can be understood by others, they become knowledge. A pattern which represents knowledge provides a high level of reliability or predictability as to how the pattern will evolve over time, for patterns are seldom static. Patterns which represent knowledge have the completeness to them that information simply does not contain.

Wisdom arises when one understands the foundational principles responsible for the patterns representing knowledge being what they are. These foundational principles are universal and completely context independent. Figure 2-1 illustrates the evolvement from data to wisdom.

Figure 2-1 Evolvement from data to wisdom
2.1.2 Definition of Knowledge Management

Now, let’s take a look at what is KM. KM is defined as a business activity with two primary aspects:

- Treating the knowledge component of business activities as an explicit concern of business reflected in strategy, policy, and practice at all levels of the organization.

- Making a direct connection between an organization’s intellectual assets – both explicit and tacit – and positive business results.

It is a discipline that promotes an integrated approach to identify, manage, and share all of an organization’s information assets, as well as unarticulated expertise and experienced individual workers. In practice, KM often encompasses generating new knowledge, accessing valuable knowledge from outside sources, using accessible knowledge in decision making, transferring existing knowledge into other parts of the organizations, identifying and mapping intellectual assets with the organization, generating new knowledge for competitive advantage within the organization, making vast amount of corporate information accessible, and sharing of best practices and technology.

2.1.3 A Brief History of Knowledge Management

A number of management theories have contributed to the evolution of KM, among them such notables as Peter Drucker, Paul Strassmann, and Peter Senge. Drucker and
Strassmann [3] [4] have stressed the growing importance of information and explicit knowledge as organizational resources, and Senge has focused on the “learning organization”, a cultural dimension of managing knowledge. Chris Argyris, Christopher Bartlett, and Dorothy Leonard–Barton [5] of Harvard Business School also have examined various facets of managing knowledge.

Date from the later 1970s, Everett Rogers’ work [6] at Stanford in the diffusion of innovation and Thomas Allen’s research at MIT in information and technology transfer have also contributed to our understanding of how knowledge is produced, used, and diffused within organizations. By the mid-1980s, the importance of knowledge as a competitive asset was apparent.

The 1980 also saw the development of systems for managing knowledge that relied on work done in artificial intelligence and expert systems, giving us such concepts as “knowledge acquisition”, “knowledge engineering”, “knowledge-base system”, and “computer-based ontologies” [7].

KM was introduced in the popular press in 1991, when Tom Stewart published “Brainpower” in Fortune magazine. Perhaps the most widely read work to date is Ikujiro Nonaka’s and Hirotaka Takeuchi’s The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation (1995). The phrase “KM” entered the lexicon in earnest. KM-related articles began appearing in journals like Sloan Management Review, Organizational Science, Harvard Business Review, and others.
By the mid-1990s, KM initiatives were flourishing. The International KM Network (IKMN) [8], begun in Europe in 1989, went online in 1994 and was soon joined by the U.S.-based KM Forum and other KM-related groups and publications. In 1994, the IKMN published the results of a KM survey conducted among European firms, and the European Community began offering funding for KM-related projects through the ESPRIT program in 1995.

KM, which appears to offer a highly desirable alternative and business process reengineering initiatives, has become big business for such major international consulting firms as Arthur Anderson and Booz-Allen & Hamilton [9].

2.1.4 Why is Knowledge Management Important?

KM includes many disciplines including business, economics, education, information management, psychology, and sociology among others. These areas have developed perspectives on the workings of individual and systemic knowledge. KM embraces these perspectives, but operates from the basic premise of the “sticky” nature of knowledge. That is, people acquire knowledge from established organizational routines, the entirety of which is usually impossible for any one person to know. Since routines evolve as people interact with them in response to changes in the market, this provides the impetus for KM to focus on enhancing an organization’s innovation potential to leverage it for competitive advantage.

KM enables, supports, and encourages three interrelated topics:
Chapter 2 – Knowledge Management and Decision Support System

- One is the process of discovering or creating new knowledge and refining existing knowledge – the research primary on the theory of knowledge.

- The second is the sharing of knowledge among individuals and across all organizational boundaries – the research focuses on computer-mediated collaborations.

- The third is the continued development and use of knowledge as part of individuals’ day-to-day work, and as part of decision-making process – the research work on organization’s memory to enhance decision-making, which is also the focus in this thesis.

KM extends considerably beyond design and use of the tools and technologies involved in gathering, analyzing, and transmitting data. Rather, KM centers upon individuals and groups as the creators and users of knowledge. The desire to harness knowledge is not new. Managing knowledge represents the primary opportunity for achieving substantial savings, significant improvements and competitive advantages. As resource and business medium, it is difficult and impossible to imitate or co-opt. Therefore, any technology or methods, which sustain knowledge growth and distribution, are keys to the success of today’s organizations.

2.1.5 Knowledge Management in e-Business World

E-business embodies the most pervasive, disruptive, and disconcerting form or changes: it leaves no aspect of managing organizations untouched. It challenges long accepted
business models, and organization leaders have little to draw from their past experience to manage its effects. The new technologies at the heart of e-business open up myriad possibilities not just to reconsider the re-engineering of existing processes, but also to design, develop, and deploy fundamental new ways of conceiving and executing business processes [10].

E-business constitutes the ability of a firm to electronically connect, in multiple ways, many organizations, both internal and external, for many different purposes. It allows an organization to execute electronically with any individual entity along the entire process. Increasingly, e-business allows an organization to establish real-time connections simultaneously among numerous entities for some specific purpose. It is dramatically reshaping every transactional business process: from developing new products and managing customer relationships to acquiring human resources. And by increasing traditionally largely separates processes, e-business in effect creates what might well be described as new business processes.

Through the development of e-business focused knowledge, organizations can accomplish three critical tasks:

- One is to evaluate what type of work organizations are doing in the e-business environment;
- The second is to understand how they are doing it;
The third is to determine why certain practices are likely to undergo change for the unforeseeable future.

The Internet explosion changed everything. It proved to be the catalyst for a whole new concept of how to do business and threw KM strategies and technologies into the limelight. Brian Arthur [11] had described the new world of information-enabled business organizations as a “world of re-everything”. In this view of business, success or failure for most organizations heavily depends on their ability to incessantly question and adjust the programmed logic to way things are carried out. Such reality checks of the organization’s way of doing business are necessary to keep up with the sustained dynamic and radical changes in the business environment.

Organization’s competitive survival and ongoing sustenance would depend primarily on their ability to continuously redefine and adapt organizational goals, purposes, and the organization’s way of doing things. Steve Kerr has the following description about the state of business strategy for the new world in Planning Review: “The future is moving so quickly that you can’t predict it … We have put a tremendous emphasis on quick response instead of planning. We will continue to be surprised, but we won’t be surprised that we are surprised. We will anticipate the surprise.” Figure 2-2 illustrates the transition from old world of business to the e-world of business.
The new world of business puts less premium on pre-define rules and more on understanding and adapting as the rules keep changing. The business world is now encountering not only unprecedented pace of change but also radical discontinuities in such change that make yesterday’s best practices tomorrow’s major rigidities. The new world imposes a greater need for ongoing questioning of the programmed logic and for a very high level of adaptability to incorporate dynamic changes into the business and information architecture and grow systems that can be readily adjusted for dynamic changing business environment. Organizations operating in the new business environment therefore need to be adapting at the creation and application of new knowledge as well as at an ongoing renewal of existing knowledge. Figure 2-3 illustrates the business process in the new world of business.

Figure 2-2 Transition from old world of business to E-world of business
2.1.6 From Information Processing to Knowledge Management

The information processing view has considered organizational memory of the past as a reliable predictor for the dynamically and discontinuously changing business environment. The old information model simply assumed that businesses change incrementally in a stable market, thus, the decision makers can foresee changes by examining historical data and trends. The new knowledge-based business model is marked by fundamental, not incremental, changes [12]. Businesses cannot plan for the long term; instead, they must shift to a more flexible “anticipation-of-surprise” model. Moreover, information stored within central warehouse prevent business from model innovation or existing knowledge renewal, since it is assumed the storage would ensure everyone the capability to use them. From above discussion, it is natural to account for human innovation and creativity for the application of knowledge. Figure 2-4 illustrates such evolvement from information processing to knowledge creation.
KM embodies organizational processes that seek synergistic combination of data and information processing capability of information technology, and the creative and innovative capacity of human being. Its primary focus is on outcomes in terms of performance rather than on the specification of inputs.

To understand and utilize the up-to-date KM model, we should bear in mind that knowledge in and around organizational settings is never context-free. It is always created, shared, and leveraged within a context shaped by the organization’s history, culture, mind-set, preoccupations, and its external competitive milieu. Table 2-1 lists some of the major KM principles. The breadth and depth of knowledge – both explicit and tacit – of any concept or phenomenon always varies dramatically across any sample of individuals or organizations [13].

<table>
<thead>
<tr>
<th>KM Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Need to Change as the World Changes</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Knowledge Process Requires Reasoning</td>
</tr>
</tbody>
</table>
Chapter 2 – Knowledge Management and Decision Support System

<table>
<thead>
<tr>
<th>KM is not a Technology-based Concept</th>
<th>While Technology can support KM, it is not the starting point. KM decisions should be based on who – people, what – knowledge, and why – business reason.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge cannot be Separate from People</td>
<td>We cannot separate “what we know” from “who know it”, since knowing and doing are intimately interconnected.</td>
</tr>
<tr>
<td>Knowledge is Difficult to Manage</td>
<td>We manage knowledge indirectly by managing organizations: its people, technology, system, strategy, etc.</td>
</tr>
</tbody>
</table>

Table 2-1 Principles of Knowledge Management

2.2 Decision Support System

No matter the information-processing system or KM system, the ultimate goal of using them is to provide organizations with better decision support. According to Flex U. Ubogu [14], “Researchers working on Decision Support Systems have brought together insights from the fields of cognitive sciences, management sciences, computer sciences, operations research, and system engineering in order to produce both computerized artifacts for helping knowledge workers in their performance of cognitive tasks, and to integrate such artifacts within the decision-making processes of modern organizations.”

2.2.1 Definition of Decision Support System

The traditional definition of DSS is that: A Decision Support System (DSS) is a specific class of computer-based information system that supports decision-making activities. DSS is interactive computer-based system intended to help decision maker use data, documents, knowledge and models to identify and solve problems and make decisions. Two major specific DSS are: knowledge-driven DSS and Model-Driven DSS.
Knowledge-Driven DSS can suggest or recommend actions to managers. These DSS are person-computer systems with specialized problem-solving expertise. The “expertise” consists of knowledge about a particular domain, understanding of problems within that domain, and skill at solving some of these problems. It sometimes refers to a class of analytical applications that search for hidden patterns in a database.

Model-Driven DSS includes systems that use accounting and financial models, representational models, and optimization models. Model-Driven DSS emphasize access to and manipulation of a model. Simple statistical and analytical tools provide the most elementary level of functionality. Some OLAP systems that allow complex analysis of data may be classified as hybrid DSS systems providing modeling, data retrieval and data summarization functionality. Model-Driven DSS use data and parameters provided by decision-makers to aid them in analyzing a situation.

### 2.2.2 A New Perspective of DSS

An already-in-existence DSS applies pre-defined business logic to dynamically changed data. Since the variance of data doesn’t affect the built-in business rule, decisions, to some degree, is pretty much predictable. Now, the new world of knowledge creation calls for a more sophisticated and interactive system, in which the business logic is no longer static, but is adjusted accordingly to the updated data. The decision in this model will base on both dynamic data and dynamic business rules, which makes it impossible to predict. The transition of DSS model is illustrated in Figure 2-5. By using the dynamic
model, business will improve the quality of assessment, and also the efficiency with which assessments are conducted.

![Diagram of Decision Making Process](image)

*Figure 2-5 Transition of Decision Making Process*
Chapter 3

Online Performance Evaluation and Decision Support System

“Knowledge is power, not information. Information is power only if you can take action with it.”

-------- Daniel Burris, Technotrends

3.1 Problem Overview

From the previous discussion, we are realizing that the incompatible investment and return is the result of two things:

- For one thing, to a large extend, people haven’t proceeded to the step of creating knowledge from the information collected so far. With the development of network technology and Internet, “homepage” is no longer reserved for computer gurus. Almost every organization, every department, and even every individual has come to take advantage of this powerful product of information technology industry. However, a collection of information does not equal to knowledge that can bring benefit and value to the society. Therefore, the creation of knowledge
becomes a true value enhancer that can turn seemingly unrelated information into powerful knowledge.

➢ For another, there is a lack of qualified performance analysis and control system throughout the entire business activities. Often times, when the process is not optimized, we cannot tell precisely where the problem is. Even if we can locate the problem, we have no quantitative measurement to analyze, or to find out the correlation among factors that undermine the final performance. Thus, the effective and quantified analysis is a key to the adaptive and sustainable organization’s operation.

The proposed KM model PEDS will then construct the transition from information processing to knowledge creation, and by using quantitative analysis methods to optimize system performance to best support future business decisions. The PEDS framework is presented in following sequence: system architecture, development process and business model.

### 3.2 System Architecture

In the world of e-business, competitive application is a complex, scalable, distributed, component-based, and mission critical business application. It is deployed on a variety of platforms across corporate networks, intranets, or the Internet, and is a data-centric, user-friendly, and must meet stringent requirement for security, administration, and maintenance.
3.2.1 Component-based Architecture

Effective Internet applications separate client from server components. Client components constitute the GUI front end and run in standard browser. Server components run on an application server, provide business functionality to the client, and communicate with back-end database. For distributed Web-based applications, an attractive architecture would be an n-tier model that places business functionality in components residing on the middle tiers.

Component-based development (CBD) ensures the maximum adaptability, letting components to be reused in “plug and play” fashion in different contexts. Also, CBD ensures the maximum software maintainability, for the effects of changes can be quickly localized. CBD has the potential to remove the tight coupling of an application’s parts and eases reuse of parts across different applications. The great promise of CBD is that application boundaries disappear, since the functionality and data are packaged as components, which are configured in network fashion to meet business needs.

Component-based architecture adopting a layered pattern in which reusability and stability increase downward through each layer, as illustrated in Figure 3-1, where boxes represent component specification (a description of the guaranteed behavior of the component, expressed in terms of interfaces), lollipops represent interfaces, and arrowed lines represent usage dependencies from client to server components. Table 3-1 list the functionalities of each component resides in User Interface Layer, Business Logic Layer, and Technical Infrastructure Layer.
Chapter 3 – Online Performance Evaluation and Decision Support System

Figure 3-1 Component Architecture Layer

<table>
<thead>
<tr>
<th>Reside Layer</th>
<th>Component Category</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Interface Layer</td>
<td>Application / UI Assembly</td>
<td>Supports the application’s user interface. Runs on multiple client workstations, although functionality could be distributed across multiple processors.</td>
</tr>
<tr>
<td></td>
<td>User Interface Control</td>
<td>Provides user interface graphics and associated UI event handling, which are incorporated into window design</td>
</tr>
<tr>
<td>Business Logic Layer</td>
<td>Process</td>
<td>Provides local business process function and persistence independent of the user interface.</td>
</tr>
<tr>
<td></td>
<td>Business Domain</td>
<td>Provides functionality and persistence needs across different business processes within the same domain or industry.</td>
</tr>
<tr>
<td></td>
<td>Business Infrastructure</td>
<td>Used across different domains.</td>
</tr>
<tr>
<td>Technical Infrastructure</td>
<td>Technical Infrastructure</td>
<td>Provides technical services like error message handling, access control, and</td>
</tr>
</tbody>
</table>
Table 3-1 Functionality of Each Component Reside in Different Layer

### 3.2.2 Enterprise JavaBean

Enterprise JavaBean (EJB) is a state-of-the-art architecture for developing, deploying, and managing reliable enterprise applications in production environments using the Java programming language. Figure 3-2 illustrates the EJB application programming model for Web-based applications.

![Figure 3-2 J2EE Application Model](image)

The EJB component architecture is the backbone of Java (TM) 2 Platform Enterprise Edition (J2EE). The core of a J2EE application is comprised of one or several enterprise beans that perform the application’s business operations and encapsulate the business logic from application. Other parts of the J2EE platform, such as Java SeverPages (JSP), complement the EJB architecture to provide functions such as presentation logic and client interaction control logic.

The EJB architecture provides the following benefits to the application developer:
Simplicity – It is easier to develop an enterprise application with the EJB architecture. Because the EJB architecture helps the developer access and utilize enterprise service with minimal effort and time. The developer does not have to be concerned with the system-level issues, as a result, the developer can concentrate on the business logic for the domain-specific application.

Component Reusability – An EJB application consists of enterprise bean components. Each enterprise bean is a reusable building block. An enterprise bean not yet deployed can be reused at application development time by being included in several different applications. Other applications can reuse an enterprise bean that is already deployed in a customer’s operational environment by making calls to its client-view interfaces.
Figure 3-3 Workflow between Presentation Layer and Business Logic Layer

- Separation of Business Logic from Presentation Logic – An enterprise bean typically encapsulates a business process or a business entity (an object representing enterprise business data), making it independent of the presentation logic. This separation makes it possible to develop multiple presentation logic for the same business process, or to change the presentation logic of a business process without needing to modify the code that implements the business process. Figure 3-3 illustrates the workflow between presentation layer and business logic.
3.3 Incremental Development Process

The highly dynamic and adaptable KM model requires an interactive and incrementally adaptive development process, such as the Incremental Milestone approach [14] [15].

Traditional, monolithic application development has typically followed a waterfall process model, in which approval milestones are prerequisites to the completion of one state and the start of the next. This is not well-suited to the component-based nature of distributed enterprise applications because components are best developed in parallel, rather than sequentially. In addition, the waterfall process model is not flexible and responsible enough to lend itself well to the rapid prototype development tools and iterative user interface design of GUI-driven desktop systems development. While this model provides a useful way to categorize the types of tasks that occur throughout the development life cycle, it does not recognize or leverage the characteristics of knowledge-driven development.

The major problem with the waterfall process model is that it is task-focused rather than process-oriented. It consists of distinct phases, which implies that each set of tasks must be completed before the next phase can begin. Typically, different teams handle each phase in the life cycle, and each phase must be heavily documented to allow for a different team to pick up the next phase. This makes it difficult to make the flexible decisions and meet the rapidly changing priorities that are vital to managing an enterprise
development project with its multiple components and heavy emphasis on user interface requirements.

Overcoming these drawbacks requires a more flexible, iterative, process-oriented development model. The milestone-based process model encourages thinking about work in terms of processes rather than tasks.

![Figure 3-4 Incremental Development Process Model](image)

The milestones in the Incremental Developmental Approach are depicted as points on a spiral (as illustrated in Figure 3-4) – rather than a straight line – to emphasize that the process is cyclical and iterative rather than linear. Milestones are not freeze points. Rather, they are “baseline” points at which the deliverables described by the milestone are placed under changed control. This facilitates flexibility and successive refinement.

The four major milestones are described in the following lists:
Vision/Scope Approved milestone: Once a new application gains interest and approval, a project team is assembled to define the product. A vision statement establishes scope and provides direction.

Functional Specification Approved milestone: The specification provides enough detail about the application so that the project team can begin identifying resource requirements and determining commitments. At this milestone, users and team members agree on what is to be delivered and establish priorities and expectations.

Code Complete milestone: The Code Complete milestone is an opportunity for users and team members to make a final assessment of the release and to verify that rollout and support plans and procedures are in place.

Release milestone: The Release milestone is the point when the application is formally turned over from the project team to the operations and support groups.

With this development model, we can easily adjust the project according to the new technology, further understanding toward current knowledge base, and revised business goals. Since the whole process is iterative, the changed objectives will be promptly applied, and corresponding business processes be added or removed, without affecting other already-built-up components.
3.4 Business Model

The business process in today’s e-business world can be generalized as the circulation of information, analysis, and business goal, as illustrated in Figure 3-5. The continuous interaction and adaptation of the three not only ensure organizations to correctly and timely assess their value and position in competitive environment, it is also the process of knowledge creation and utilization.

![Figure 3-5 Interaction of Information, Analysis and Business Goal](image)

The traditional business logic was based on a high level of structure and control, while the dynamics of the new business environment demand for a different model of organization design. As described by Kevin Kelly in Out of Control, this model is characterized by its relative lack of structure and lack of external control. It is based on only a few rules, some specific information, and a lot of freedom. Thus, our proposed
KM model will facilitate the organization’s “self-doing”, not only do the organization’s members define problems for themselves and generate their own solutions, they would also evaluate and revise their solution-generating processes. By explicitly encouraging experimentation and the rethinking of premise, the process promotes reflection-in-action and creation of new knowledge. The other characteristic of dynamic knowledge-creation business model is its adaptability to different business contexts with least changes, which allows maximum freedom for various purposes of knowledge users.

Based on foregoing principles, we come up with following business model for OPEDSS (as illustrated in Figure 3-6).
In this model, components are the most elementary and essential development units. Each of them is implemented with a specific functionality, encapsulated with a universal data access interface, and communicating with neighboring business logic. Since components are relatively independent entities, adding or removing can be performed in “plug and
play” fashion, without affecting remaining parts. Table 3-2 lists the functionalities of each component within client-side logic and core business logic.

<table>
<thead>
<tr>
<th>Logic Category</th>
<th>Component Name</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client-Side Logic</td>
<td>Attribute</td>
<td>Performance factor associated with each business industry. The number and context of each are determined by industry requirements.</td>
</tr>
<tr>
<td></td>
<td>Rule</td>
<td>Evaluation rule for performance assessment. To support different purpose decision making, the number of attribute involved in each rule is subject to change, the weight of attribute contributed in each rule is also different.</td>
</tr>
<tr>
<td>Core-Business Logic</td>
<td>Analysis</td>
<td>Quantitative analysis method used to calculate result of each evaluation rule.</td>
</tr>
<tr>
<td></td>
<td>Presentation</td>
<td>Tabulation or graph to show end user a vivid presentation of performance analysis result for better future strategy and decision making.</td>
</tr>
</tbody>
</table>

Table 3-2 Functionality Description for Business Model
Now let’s summarize the data flow in PEDS. Centralized relational database provide organized data set for various analyze purposes. Data from each data set may serve single analysis, or it may serve for different purposes. Function here is defined as evaluation rule, different evaluation entity requires different functions, some functions, on the other hand, may be used by multiple entities. Single entity’s performance or comparisons between different entities will ultimately lead to the final decision. As illustrated by Figure 3-7, data evaluated follows bottom-up pattern, while for different decision making purpose, data requirement is enacted as top-down fashion.
Chapter 4

Application of Knowledge Management Model

4.1 Quantitative Analysis for Evaluation

Before we put PEDS into real world application, we will first briefly introduce several quantitative analysis methods implemented as core business components in PEDS.

4.1.1 Analyze Individual Variables

Tabulation Representation

Tabulation is perhaps the most popular way of presenting the association between two or more variables. It is also a usual method to list difference about single variable. A table has the advantage that extensive data can be fitted into it and precise figures are conserved. In OPEDSS table has be widely used, either to present current Attribute information, or to present Analysis result.
Graphical Representation

A simple way of presenting a distribution of values is to present each value as a dot on a scale, called bar chart. It allows user clearly identify the changes of a particular parameter over a period of time. For example, Figure 4-1 shows the number of student under professor X’s guidance for consecutive 5 years. From the chart, we can easily compare the changes across the timeline.

![Figure 4-1 Bar Chart Presentation](image)

If the emphasis is not the absolute distribution but the proportional or percentage distribution, pie chart is a suitable choice. Still using the above example, we get corresponding pie chart as illustrated in Figure 4-2. When using pie chart, the accurate data may not be interested.
Chapter 4 – Application of Knowledge Management Model

Student Distribution Over 5 Years

Figure 4-2 Pie Chart Presentation

If the appearance of the object itself is not important and only the numerical values of this measurement are of interest, it is possible to show them as a scatter chart. Again using the student number example, the scatter chart for this case is illustrated in Figure 4-3.
Chapter 4 – Application of Knowledge Management Model

Another advantage of scatter chart is when compare relationship among two or more variables, the scattered representation is quite helpful for finding the correlations behind them. Later section will discuss Correlation method in detail.

Average

An average is a statistics, which characterizes the typical value of the data and eliminates the random scattering of values. For each of the various measurement scales there is an appropriate type of average:

- **Mode**: the mode is the most common value in the data set. In student number example, the mode is 8, since 8 have the highest frequency compared with other value.

- **Median**: the median is the value in the middle of the selection, if all the values are first arranged from the smallest to the largest. The median in student number example is also 8, since when we arrange the values, we get following list: 6, 8, 8, 9, 10, and 8 is in the right middle.

- **Arithmetic Mean**: the arithmetic mean is the sum of all the values divided by their number, or \( \bar{x} = \frac{\sum x}{n} \). The arithmetic mean for student number example is \( (6 + 8 + 8 + 9 + 10) / 5 = 8.2 \).

To better evaluate an organization’s performance, we usually choose arithmetic mean as a comparison standard. To get the arithmetic mean, we add up all Attributes, and divided
Chapter 4 – Application of Knowledge Management Model

by the total number of business entity. This number gives decision maker a clear idea how effectively and effectively an organization operates towards the general expectation.

Dispersion of Data

Once we have calculated the average value, it would sometimes be interesting to describe how far the singular values are scattered around the average. In connection with arithmetic mean, we sometimes calculate standard deviation. Since the values are measured from a population (The population is the entire group of objects from which we want to gather data), the formula is:

\[
\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}
\]

If the standard deviation concerns only a random sample, the formula would be:

\[
s = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}
\]

In both formula, n is the number of the values, and the values of each variable will be substituted for x one at a time.
4.1.2 Analyzing Relation between Variables

If two variables vary in such a way that they follow each other to some extent, it is called an association between the variables. For example, the height and weight of people are statistically associated: although nobody’s weight is caused by neither his height nor the height by the weight, it is, however, usual for a tall person to weigh more than a short person. On the other hand, the data usually include exceptions as well, which means that a statistical association is inherently stochastic.

Numerous methods are offered for revealing and presenting the associations between two and even more variables. The simplest mean is the method of tabulation. Aside from tabulation, our emphasis in this thesis is two other mostly used methods: the Correlation, and the Analysis of Variance.

Correlation

A customary way of expressing the strength of the association between two variables is the Product Moment Correlation or Pearson’s Correlation. It is usually abbreviated with the letter r. The scatter-grams below show the values of two variables and the correlation between them.
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Figure 4-4 Correlations between Two Variables

If correlation coefficient is low, the two variables have not much to do with each other. If it is high, in other words if its value approaches either +1 or -1, it means that the relation between the two variables approaches the equation

\[ Y = AX + B \]

Correlation is handy for the initial analysis of data when you have no clear idea of the mutual relations of the variables.

Analysis of Variance

ANOVA, ANalysis Of VAriance examines two or more sets of measurements, especially their variances, and tries to detect significant differences between the sets.

The ANOVA method is based on the mathematically proven fact that there is a difference between the groups only if the between-groups variance is greater than the within-group
variance. The analysis is initiated by calculating the within-group variance for each group, and the mean of all these group variances. The next step is to calculate the mean for each group, and then the variance of these means. It is the between-group variance. Then calculate the ratio of the above two figures, which is called F.

\[ F = \frac{\text{Variance of the Group Mean}}{\text{Mean of the Group Variances}} \]

### 4.2 Application to Various Business Contexts

The initiative of building up PEDS is to provide organizations in e-business world a system which enables quantified analysis to ensure prompt adjustment and adaptation to dynamic changing business environment, and as a result, facilitate organization’s decision making and resource allocation to generate higher return with fixed investment. In the following section, we’ll apply the PEDS model to two types of business enterprises, an academic institution and a financial counseling or asset management industry, to demonstrate how this model works toward each organization’s benefit.

#### 4.2.1 Academic Institution

To apply PEDS into e-business world, we need to first figure out the individualized attributes and business rules within the corresponding industry (as illustrated in Figure 3-6), we call them client side components. For example, to evaluate a university’s performance, most common factors are: strength of school’s faculty, research activity, and student performance both as they enter and leave. To evaluate how capably a
program develops its student, we can use the rate such as at which law school students pass the bar exam, or at which medical school students pass the board exam.

To arrive at a statistical result for decision-making, the general process is to first standardize the value of each performance factor about its mean. The distribution of data for each factor is then examined for significant outliers. After that, we apply user-defined weight to each factor to adjust the relative importance of various performance indicators. Thus, the final score reflects strength and efficiency of that academy institution.

Now let’s delve into the situation of how academic institution uses the PEDS- model to evaluate faculty’s performance within the organization. To evaluate faculty’s performance, we typically include the following evaluation factors: advising activity, teaching activity, publication volume, research funding, professional organization and public services, as listed in Table 4-1.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Evaluation-Related Property</th>
<th>Evaluation Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advising</td>
<td>StudentNumber, StudentDegree</td>
<td>StudentDegree x DegreeWeight</td>
</tr>
<tr>
<td>Teaching</td>
<td>ClassNumber, ClassCredit,</td>
<td>StudentNumber x NOSWeight + ProjectNumber x POSWeight + ClassCredit x CreditWeight + NewClassWeight x ClassWeight</td>
</tr>
<tr>
<td></td>
<td>StudentNumber, ProjectNumber, IsNew</td>
<td></td>
</tr>
<tr>
<td>Funding</td>
<td>FundNumber, FundAmount</td>
<td>FundAmount x AmountWeight</td>
</tr>
<tr>
<td>Publication</td>
<td>PublicationNumber,</td>
<td>PublicationType x TypeWeight</td>
</tr>
<tr>
<td></td>
<td>PublicationType</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>ServiceNumber, ServiceType</td>
<td>ServiceType x TypeWeight</td>
</tr>
<tr>
<td>Professional</td>
<td>OrganizationNumber,</td>
<td>OrganizationType x TypeWeight</td>
</tr>
<tr>
<td>Organization</td>
<td>OrganizationType</td>
<td></td>
</tr>
</tbody>
</table>
Table 4-1 Evaluation Factors for Professor Performance

The overall performance of faculty is the sum of each factor multiplies appropriate weight, while for different evaluation purposes some of the factors may be excluded (for example, if the evaluation only wants to find out the most productive faculty, the consideration in this case may only include factor Publication).

Once the performance attributes have been determined, we now need to decide on the quantified business evaluation rules. Even within the same industry, the business rules may vary drastically. By leaving this to the client side component, it gives organizations great flexibility to adjust their strategy toward dynamically changing environment.

In this sample case, based on the evaluation attributes listed in Table 4-1, we come up with the following evaluation rules:

- ClassNumber > 3 or TotalClassPoint > 10
- StudentNumber > 2 or TotalStudentPoint > 5
- PublicationNumber > 2 or TotalPublicationPoint > 5
- ServiceNumber > 4 or TotalServicePoint > 5

If any of above criteria hasn’t been fulfilled, the faculty won’t be considered as qualified. Otherwise, the performance ranking will be determined by following calculation formula:
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TotalPoint = TotalAdvisingPoint x AdvisingWeight + TotalTeachingPoint x TeachingWeight + TotalFundingPoint x FundingWeight + TotalPublicationPoint x PublicationWeight + TotalServicePoint x ServiceWeight + TotalOrganizationPoint x OrganizationWeight

The boxed parts are unspecified weight for corresponding evaluation factor. When a technique-focused department, such as Computer Science or Biochemistry, uses the rule, they will probably put more emphasis on research publication and advising activities. On the other hand, if an academic-oriented department, like English or Feminist Study, applies the rule, they may give higher weight to teaching activities or professional organizations. The total point is a quantity that can be used for multiple purposes, such as determining bonus award or position promotion.

Once performance factors and evaluation rules have been decided, we can use PEDS to make further analysis:

By applying ANOVA, we can analyze the variance of each department’s teaching load. For instance, with OPEDSS, we can calculate each department’s average teaching point, which is the total teaching point divided by the number of professor within the department. Then, we calculate standard deviation of each professor’s teaching point to average within the department, which is the within group variance. Next is to calculate the arithmetic mean of these within group variance, which is the between group variance. The ratio of the two figures reflects the relative teaching workload for each department’s professor.
Another example is we can use correlation method to figure out if there are relations between the publication number and research funding. First, we use scatter chart to get the publication-funding distribution. Then by calling build-in analysis component CorrelationAnalysis, we get the correlation coefficient in this case is equal to 0.3, which is much lower than the threshold. Thus, we come to the conclusion that a professor’s productivity has nothing to do with the amount of research fund he acquired. On the other hand, if the correlation coefficient is close to 1, we’ll certainly be sure that funding is to some degree, directly or indirectly affect the papers published by that professor.

Scalable as PEDS is, we can also apply this model to a higher level, instead of a department, we can evaluate a college or a university, in its institutional performance. The analysis and presentation methods are the same, as we encapsulate those core components into business layer; the only variance is that when applying to different business entities, we need to re-define the evaluation attributes as well as the business rules.

4.2.2 Asset Management

As a second example, we will use PEDS in financial planning and asset management applications. A typical scenario in this type of application is to support stock picking decisions. To decide the actual value of a stock, we usually consider six criteria, as listed in Table 4-2.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Evaluation Related Property</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>Debt(^A)/Equity Ratio</th>
<th>Short Term Debt, Long Term Debt, Cash, Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Margin(^B)</td>
<td>Operating Income, Revenue</td>
</tr>
<tr>
<td>EBITDA(^C)/Margin(^D)</td>
<td>Earnings, Interest Expense, Tax Expense, Depreciation Expense, Amortization Expense, Revenue</td>
</tr>
<tr>
<td>Price/Earning Ratio</td>
<td>Earnings, Price (dynamic)</td>
</tr>
<tr>
<td>EV(^E)/EBITDA Ration</td>
<td>EBITDA, Net Debt, Market Capitalization (dynamic)</td>
</tr>
<tr>
<td>Earning’s Growth Projection</td>
<td>Earnings Estimate (determined by user)</td>
</tr>
</tbody>
</table>

\(^A\) Debt = Long Term Debt + Short Term Debt – Cash  
\(^B\) Operating Margin = Operating Income / Revenue  
\(^C\) EBITDA: Earnings Before Interest, Tax, Depreciation and Amortization  
\(^D\) EBITDA Margin = EBITDA / Revenue  
\(^E\) EV: Enterprise Value = Net Debt + Market Capitalization

Table 4-2 Evaluation Factor for Stock Picking

The stock price and market capitalization in the above table are dynamic properties, which are determined by day-to-day stock market, while others can be extracted from each corporation’s balance sheet, income statement and cash flow statement. Comprehensive evaluation of a potential investment opportunity is determined by the user in terms of a rule, and the respective assigned weights to each attribute used in the rule. The calculation formula goes as following:

\[
\text{StockEvaluation} = \text{Debt/EquitRatio} \times \text{Percentage}_1 + \text{OperatingMargin} \times \text{Percentage}_2 + \text{EBITDA} \times \text{Percentage}_3 + \text{P/ERatio} \times \text{Percentage}_4 + \text{EV/EBITDA} \times \text{Percentage}_5 + \text{EarningGrowthProjection} \times \text{Percentage}_6
\]

As an example, we now compare Ford Motor and General Motor stock evaluations to demonstrate how PEDS can be applied in stock picking. The financial data of the two corporations is listed in Table 4-3.
<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Ford Motor</th>
<th>General Motor</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt/Equity Ratio</td>
<td>8.86</td>
<td>4.59</td>
<td>-25%</td>
</tr>
<tr>
<td>Operating Margin</td>
<td>10%</td>
<td>6.3%</td>
<td>5%</td>
</tr>
<tr>
<td>EBITDA Margin</td>
<td>47%</td>
<td>35.2%</td>
<td>10%</td>
</tr>
<tr>
<td>Price/Earning Ratio</td>
<td>24.58</td>
<td>314</td>
<td>-0%*</td>
</tr>
<tr>
<td>EV/EBITDA Ratio</td>
<td>9.75</td>
<td>10.4</td>
<td>40%</td>
</tr>
<tr>
<td>Earning Growth</td>
<td>5%</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Evaluation Result</td>
<td><strong>7.885</strong></td>
<td><strong>7.8475</strong></td>
<td></td>
</tr>
</tbody>
</table>

* During that year GM has extraordinary cost, therefore earnings cannot be used in the evaluation model.

Table 4-3 Comparison Financial Data for Ford and GM of Year 2000

Because these two companies operate in the same industry, the same country, many investors will consider them of the same risk profile. Evaluation therefore should be very similar, as demonstrating by our evaluation model. However, there are investors with different perceptions on riskyness of debt level, they might assign higher weight on Debt/Equity Ratio, such as –30%, in that case, evaluation result would be lower for Ford, and GM becomes a better stock to buy. There are also investors prefer higher operating margins and assign higher weighting operating margin and EBITDA margin, as a result, Ford is a better stock to buy.

We can also use ten-year historical data to calculate the evaluation and compare the resulted stock pick decision to the actual performance of the stock in the following year. Thus, users are able to adjust the model accordingly to find out the optimal weightings to each attribute.
Chapter 4 – Application of Knowledge Management Model

In summary, the data flow in the two examples follows exactly the business model we proposed in the previous chapter. To acquire interesting data, we first restrict business domain, and then we need to figure out whether the knowledgeable decision is the result of single entity or the relationships among multiple entities. This will determine individualized evaluation functions. In some cases, such as in asset management, multiple objective functions may be used before we come to the final result. Each individualized function is the arithmetic operations of evaluation-related attributes, which could be extracted from Internet or be import into the system with the changing business movement.

The reversed order is the process how interesting data been evaluated (as shown in Figure 3-7). Moreover, these two examples also demonstrate the process of knowledge management as illustrated in Figure 2-3, since the PEDS model reflects the iterative cycle of plan – act – monitor – evaluation – plan, which commendably fit the dynamic nature of KM in today’s e-business world.

4.3 The Advantages of PEDS

PEDS is a KM model that enables organizations to put the power of knowledge to work for their benefits.

First, OPEDSS starts with an architecture that enables flexibility, allowing organizations to quickly change the way they do business, without re-programming the system. It is understandable that organizations may rely on multiple system and technology models to
run business. If the systems are not flexible and interoperable enough, it is possible that organization will be locked into one way of doing things. PEDS delivers a comprehensive set of standard-based interoperability via EJB. It takes the best of enterprise application integration (EAI) and the best of inter-enterprise process workflow and melds them together in one model to enable collaborative commerce. Thus, organizations are able to integrate their own portfolio of enterprise applications, link processes with other partners, and integrate workflow engine between organizations. Not only PEDS model substantially take away the pain of internal system integration, it also enable B2B interoperability over the Internet – connecting the organization to that of its partners with relative ease.

Then PEDS integrate core business processes, enabling organizations to make the best use of assets and resources across all areas of the business. As we know, organizations have many disparate computer systems that capture various sources of raw data. However, raw data tell us little. Where is the intelligence that helps to proactively determine how organization is performing?

PEDS enables decision-maker to derive insight from raw transactional data across the organization, providing with the context and meaning. Then it expresses that information in a graphical representation to show how to drive the organization towards best in class. To achieve this functionality, PEDS first includes key performance indicators, reports and evaluates the measurements that are most critical. Then, with powerful analytical capabilities, it benchmarks the business performance against goals and objectives. By this
Chapter 4 – Application of Knowledge Management Model

way, the organization’s performance is available with easy-to-read pictures that show how the organization is performing in real time.

When the organization is under-performed, the business performance indicators, which are dynamically determined with different users across different time-span, will allow user to see where the problem occurring by drill down on the detail of data. Users can also customize the process displays and set tolerance, enabling the system to proactively warn them when problem arises. With PEDS, organizations can leverage their system because they can gain insight from and into their raw data. PEDS aggregates and homogenizes structured data from disparate sources, providing insight into business processes long before regular daily, weekly and quarterly batch-oriented sources processes are run. Using a Web-based, illustrative user interface, PEDS allows knowledge workers within the organization to view performance standard and ranking picture, and to run immediately evaluation analysis at any time. This interface also enables user to build other evaluation standard on-the-fly. The portal view allows the end user to establish a secure view of the extended understanding for at-a-glance assessment of business processes.

Finally, it links with business clients to optimize the processes that extent beyond the organizations. Maximizing value in organizations means squeezing the most from every asset. That includes the vast wealth of knowledge generated by organizations. Retrieving key information from structured sources like databases is one thing. Tapping into the knowledge hidden away in unstructured data is quite another. PEDS model allows
organizations to easily generate, manage, and distribute multi-meaning knowledge across the organization, turning unmanaged, inaccessible information into profitable knowledge assets. It puts the organization ahead of the competition in nowadays a new world of e-business.
Chapter 5

Design and Deployment Detail

The key feature of knowledge-age development is componentization, which allows maximum flexibility, reusability and the separation of business logic from presentation layer. In this chapter we’ll present how these characteristics have been carried out throughout the entire design and deployment process. In order to clearly depict the design and deployment process of PEDS model, we’ll use Academic Institution case described in Chapter 4 as our development backbone.

5.1 Workflow Design

As mentioned in Chapter 3, one major characteristic of EJB is its separation of business logic from presentation layer. We call the intermediate logic the workflow layer. Workflow layer components provide an XML interface as a wrapper around the business logic component. All methods in workflow layer components return an XML string as output. They convert record-sets received from business logic layer into an XML format string before sending the output to the presentation layer. On the other hand, they also convert user input data into XML string before sending to web server where business logic resides. Figure 5-1 shows the workflow design of PEDS, and also briefly summarizes the software and development tools and platform used in each step.
Chapter 5 – Design and Deployment Detail

User input data (to decide desired attributes and evaluation rules)

Convert user-input-data to XML format (ready to transmit)

Send XML file/stream to web server (via HTTP)

At server side, extract data from XML, load data into according analysis component in BLL

Apply QA methods to analysis user-decided evaluation attributes via corresponding rules

Send the analysis result to Graphic Component, which will send graphical result back to presentation layer

At client side call applet to show user the graphical result of performance. By changing input data value, user can get best-input-output-ratio for future decision making

Presentation layer handles Attribute Component and Evaluation Rule Component, which are input to the business logic layer.

The transformation is essential when we need to deal with large amount of data, for individual transaction, it is not necessary at all.

Web Server is Tomcat; Database is MySQL; connecting by JSP

First load user-input data, after calculation, load criteria points

Client-side applet calls Java Bean, by which when user change input data value, the performance graphic changes accordingly, which can help user making decisions.
5.2 Object Design

Another characteristic of component-based development is the maximum adaptability, letting components to be reused in “plug and play” fashion in different contexts. As illustrated in PEDS business model (Figure 3-6), there are two major types of components: client side component and core business component. The former one is rather dynamic since different business industry usually has its individualized performance attributes and evaluation rules, the only common functionality of these components are the interfaces to convert user input data into XML format string for between-layer transmission. The core business components are relatively static, since the analysis and presentation methods are generally the same even for businesses that have little similarity. They act as a platform from where the client side components can be plug in and play.

To get the overall performance of an institution, we have six criteria, which have been explained in previous sections. Each criterion could be related to a client side component. There are seven major component classes: Professor, Class, Student, Publication, Funding, Service, and Organization; thus, we get the component outlines of PEDS, as listed in Table 5-1 to Table 5-7.

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Professor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Professor.Name; Professor.Department; Professor.Email; Professor.Telephone; Professor.TotalAdvisingPoint;</td>
</tr>
</tbody>
</table>
Table 5-1 Professor Component Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Class.Name; Class.Credit; Class.NumberOfStudent; Class.IsNew; Class.SeniorProject; Class.QuarterOffered</td>
</tr>
<tr>
<td>Method</td>
<td>GetClassName(); GetClassCredit(); GetNumberOfStudent(); GetIsNew(); GetProjectNumber(); CalculateClassPoint(); CalculateHighQualityClassNumber()</td>
</tr>
</tbody>
</table>

Table 2-2 Class Component Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Student.Name; Student.Degree; Student.Advisor; Student.Thesis; Student.IsGraduate; Student.StartQuarter</td>
</tr>
<tr>
<td>Method</td>
<td>GetMasterStudentNumber(); GetPhdStudentNumber(); CalculateStudentPoint()</td>
</tr>
</tbody>
</table>

Table 5-3 Student Component Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Publication.Title; Publication.Level; Publication.Type; Publication.Year</td>
</tr>
<tr>
<td>Method</td>
<td>GetJournalNumber(); GetProposalNumber(); GetBookNumber(); CalculatePublicationPoint()</td>
</tr>
</tbody>
</table>

Table 5-4 Publication Component Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Fund</th>
</tr>
</thead>
</table>
Chapter 5 – Design and Deployment Detail

<table>
<thead>
<tr>
<th>Property</th>
<th>Fund.Name; Fund.Source; Fund.Amount; Fund.LastYear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>CalculateTotalFundAmount(); CalculateFundPoint()</td>
</tr>
</tbody>
</table>

Table 5-5 Fund Component Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Service.Type; Service.Description; Service.Quarter;</td>
</tr>
<tr>
<td>Method</td>
<td>GetThesisReviewedNumber(); GetDissertationReviewedNumber(); GetThesisDefenseNumber(); GetEvaluationVisiteNumber(); CalculateServicePoint()</td>
</tr>
</tbody>
</table>

Table 5-6 Service Component Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Organization.Name; Organization.StartQuarter; Organization.Type; Organization.PositionDescription</td>
</tr>
<tr>
<td>Method</td>
<td>GetOrganizationType(); CalculateOrganizationPoint()</td>
</tr>
</tbody>
</table>

Table 5-7 Organization Component Design

To illustrate the performance results for the presentation layer, we use several graphical representations: bar chart, pie chart, scatter chart, stack chart, etc. Each type of chart is designed as a core business component and can be reused in different scenarios. Since no matter we apply the business model to whatsoever industry context, and no matter how we change evaluation rules, the way to delineate result is the same.

These presentation components are rather independent entities, which are developed with JavaBean technology, each providing a universal interface for further application to other applications. Table 5-8 to Table 5-12 lists each of the chart components. In PEDS we primarily implemented with graphical charts, while for further analysis purposes, more
Chapter 5 – Design and Deployment Detail

sophisticated presentation methods can be added into the model, so long as they are developed with component technology.

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>GetLegend(); GetXAxisValue(); GetYAxisValue(); GetXScale(); GetYScale(); GetLabelList(); SetColor(); SetStyle(); PaintChart(); MouseMoved(); MouseDragged()</td>
</tr>
</tbody>
</table>

Table 5-8 Main Implementation of Component Chart

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Bar Chart (Inherited from Component Chart)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>GetValue(); PaintChart()</td>
</tr>
</tbody>
</table>

Table 5-9 Main Implementation of Component BarChart

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Pie Chart (Inherited from Component Chart)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>GetValue(); PaintChart()</td>
</tr>
</tbody>
</table>

Table 5-10 Main Implementation of Component PieChart

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Scatter Chart (Inherited from Component Chart)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>GetValue(); PaintChart()</td>
</tr>
</tbody>
</table>

Table 5-11 Main Implementation of Component ScatterChart

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Stack Chart (Inherited from Component Chart)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>GetValue(); PaintChart()</td>
</tr>
</tbody>
</table>

Table 5-12 Main Implementation of Component StackChart

Last but not least, there is a component called ValueWeight, since from application cases in Chapter 4 we noticed that the evaluation equation could be generalized as
TotalPoint = \sum \text{Value}_i \times \text{Weight}_i, \quad i = 1 \text{ to } n

That is, the final performance is determined by the sum of each factor times its corresponding weight. \(<\text{Value}, \text{Weight}>\) pair is thus the fundamental evaluation unit, whose function is to convert whatever your input to the desired numerical result.

### 5.3 Database Design and Deployment

By analyzing the relationships among evaluation attributes we realized that each of them is directly associated with entity Professor. The reason is obvious: they are indicators of a professor’s routine activities, and thus be solely determined by ProfessorID, which is the primary key for the Professor entity. The entity-relation diagram of central database is illustrated in Figure 5-2.

Three database design principles have been carried out throughout the process of implementation, which are: normalization, data consistency and dynamic request.

#### 5.3.1 Normalization

One of the primary benefits of normalization is to reduce anomalies or duplications by decomposing a table into multiple tables. If it is necessary to maintain consistency in the database, decomposing the offending table into two or more tables provides a means to enforce this consistency. Consider the Table Professor which contains ProfID, ProfName, DepartmentName. If we were looking at a particular professor, we might want to produce a result-set of professors within a particular department. If there are variations in the
naming of the department’s name, we will not get the complete result-set that we expect. The following record-set selection of professors classifies by Electrical and Computer Engineering and Computer Science indicates this problem. Notice how spelling variations could cause a problem when searching for all professors in a specific department.

Figure 5-2 Relations between Business Entities

<table>
<thead>
<tr>
<th>ProfID</th>
<th>ProfName</th>
<th>DepartmentName</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345</td>
<td>Dr. Smith</td>
<td>Computer Science</td>
</tr>
<tr>
<td>12346</td>
<td>Dr. Nick</td>
<td>Computer Engineering and Computer Science</td>
</tr>
<tr>
<td>12347</td>
<td>Dr. Max</td>
<td>Electrical Engineering</td>
</tr>
</tbody>
</table>
It could be time-consuming to fix data problems such as this. We can prevent this problem by decomposing the Professor table even further. If we create a Department table, we can maintain the naming of the department names separate from the remaining columns of the Professor table and enforce consistency in the naming of the department name. A foreign key must be appended in the Professor Table to refer to the appropriate record in the Department table. See this record set selection of the normalized Professor Table:

<table>
<thead>
<tr>
<th>ProfID</th>
<th>DepartmentID</th>
<th>ProfName</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345</td>
<td>100</td>
<td>Dr. Smith</td>
</tr>
<tr>
<td>12346</td>
<td>100</td>
<td>Dr. Nick</td>
</tr>
<tr>
<td>12347</td>
<td>100</td>
<td>Dr. Max</td>
</tr>
<tr>
<td>12348</td>
<td>100</td>
<td>Dr. Jason</td>
</tr>
</tbody>
</table>

Here is what the Record-set selection of the Department lookup looks like:

<table>
<thead>
<tr>
<th>DepartmentID</th>
<th>DepartmentName</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Electrical and Computer Engineering and Computer Science</td>
</tr>
</tbody>
</table>

Normalizing a database is not a trivial matter. The more normalized the database becomes, the more cumbersome and slow the joins are when we query the database. Therefore, we must be very careful when we index columns. We must define foreign key dependencies. To insure that all tables are modified correctly, Insert, Update, and Delete procedures must incorporate transaction processing. Therefore, it is necessary to balance the gain of simplified maintainable structures against possible complicated and unintuitive procedure code.
5.3.2 Data Consistency

At the time data enters database, related fields, as a result, should immediately be updated. Taken performance factor Publication as example. If a professor has published a research paper at national conference, the paper-related information, such as PaperTitle, PaperType, PublishDate, etc. will be collected. At the same time, system calculates the point for this paper, recorded as PublicationPoint in table Publication. Moreover, this point will also be added to the total publication point of that professor, recorded as TotalPublicationPoint in table Professor. The in-time updated TotalPublicationPoint allows organizational executive to promptly respond and revise their business strategy and objective, not necessarily waiting until typical evaluation date.

5.3.3 Dynamic Request

There are situations where the functions offered by an interface can be generalized in order to reuse it. For instance, to evaluate a professor’s performance, the current criteria in department ECECS includes six aspects. Despite the differences of each performance index, which means each index may have different properties, the method we evaluate them is quite similar: we first need to find, for each attribute to be considered, the relation between its value and its utility. Moreover, we’ll define the weight of all important attributes of the object. Then add together the VALUE * WEIGHT of each attribute. For example, if we want to compare two professors’ publications during ten-year span to determine which one is a better candidate for promotion with promotion. We can
construct a component called EvaluateTwoProfessor (ProfessorAID, ProfessorBID, 
Publication, StartingYear, EndingYear). The business logic can go as following:

First retrieve relevant data from MySQL database:

```sql
SELECT publicationNumber, publicationLevel, publishedYear FROM ProfessorTable WHERE ProfessorID = ProfessorAID AND publishedYear between StartingYear and EndingYear
```

Then with the dataset acquired from above transaction, calculate performance points for 
index publication:

```java
for (int i = StartYear; i < EndYear; i++)
    for (int j = 0; j < TotalPublicationNumber; j++)
    {
        SinglePublicationScore = weight * PublicationLevel;
        TotalPublicationScore = TotalPublicationScore + SinglePublicationScore;
    }
```

When we get TotalPublicationScore for ProfessorA and ProfessorB, we can display the 
comparison result either with Bar Chart or Pie Chart.

To generalize PEDS to fit various situations, we need to make our components more 
generic, which mean specific Object name or Performance Factor name are no longer 
appear here and there. Thus, the above EvaluateTwoProfessor can be revised as 
EvaluateTwoObject (ObjectAID, ObjectBID, PerformanceFactorNumber, StartingDate, 
EndingDate). If an investor wants to dip into the Net Income of K-Mart and War-Mart
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during the last five years to compare the difference of operation mechanism of the two, he can simply use the component like EvaluateTwoMart (KMartID, WartMartID, NetIncome, StartingYear, EndingYear), simply replace the ObjectID with KMartID and WarMartID, and replace the PerformanceFactorNumber with NetIncome.

By reusing components described above, we need to handle Dynamic Request. The dynamic request described here does not mean the type of request that an end user might type in, but rather one that is generated programatically. The request can be generated as a result of programmatic logic or it can be selected from a list of pre-determined requests. Either way, the exact nature of the request is not known beforehand and is generated or created at run time. For example, to use component EvaluateTwoObject, it is impossible for us to know what PerformanceFactor the client is actually interested in before the request. With SQL, which is a prime candidate for generating dynamic request in a data access layer, we can write the following query:

```
SELECT Attribute1, Attribute2, Attribute3 FROM ObjectTable WHERE ObjectID = ObjectAID AND Attribute3 between StartingDate and EndingDate
```

This statement is very easy to understand, but a security breach may occur when sensitive information needed to be supplied, such as account number, over a network. Also, when the entire statement is longer, the greater possibility that any corruption may cause an error or even causes the statement to point to another object. These types of requests can affect system performance, because not only is more information sent over the network wire, but also, in case of many SQL engine, it must be validated and compiled each time the engine receives the statement.
A better method is using Stored Procedure. Stored Procedure pre-determines what SQL statement need to be executed and store them in the SQL engine. This allows the SQL engine to pre-validate and pre-compile the statements. Then, all you need to do to execute the stored procedure is passes in the appropriate arguments. When execute above example using stored procedure, the code for selection is as follows:

EXECUTE spSelectProfessor ProfessorAID, StartingDate, EndingDate

Stored Procedure, along with workflow, which has been explained in previous section, gives us a whole picture of the working mechanism of Component-based Architecture.

5.4 Workflow Deployment

In this session we present several screenshot of the PEDS model to describe how this component-oriented, knowledge-intensive business model works towards the benefits of today’s enterprises.

As we know, even within the same business context, the attributes needed for evaluation vary with respect to different purposes. In Figure 5-3, there are altogether 8 attributes, although we only interested in 6 of them, which have been selected, it demonstrated how we can plug or remove attribute component into or from PEDS model as user requirement changes.
Figure 5-4 has similar functionality as what has been presented in Figure 5-3. It is designed for choosing evaluation rule component. Again, for different evaluation purposes, rule component can be easily added or removed.

**Please choose from following Performance Index:**

- Advising
- Funding
- Publication
- Teaching
- Professional
- Service
- Education
- Title

[Submit] [Cancel & Return]

**Figure 5-3 Selecting Evaluation Attribute**

**Please choose from following rules to evaluate professor's performance:**

- Merit-Based-Rule for Salary Promotion
- Academic-Based-Rule for Tenure Promotion
- Funding-Based-Rule for Double Bonus
- Performance-Based-Rule for Future Reference

[Show Business Rule] [Add a New Rule]

[Return to Main Menu]

**Figure 5-4 Selecting Evaluation Rule**
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One major advantage of PEDS is its quick adaptation to the changing business environment, Figure 5-5 shows how can we adjust analysis weighting dynamically to reflect the up-to-date business situation.

![Image of Figure 5-5](image.png)

**Figure 5-5 Editing Evaluation Rule for Different Purposes Analysis**

Tabulation is a widely used method to list difference among multiple evaluation candidates. A table has the advantage that extensive data can be fitted into it and precise figures are conserved. Figure 5-6 shows the tabulation presentation of evaluation result.

By clicking the hyperlink of each candidate, we get detailed and effective graphical presentation, as illustrated in Figure 5-7 and Figure 5-8. “Chart Type” is the collection of all available presentation components, while “Evaluation Method” is the set of all analysis components. These vivid and meaningful charts help decision makers to better understand and remember complex data, to increase both personal and corporate knowledge, to improve the clarity of their analysis and decisions. As a result, give organizations a competitive edge in the e-business world.
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Following are overall ranking of the professors meet previous requirement:

<table>
<thead>
<tr>
<th>Professor ID</th>
<th>Professor Name</th>
<th>Advising Point</th>
<th>Professional Point</th>
<th>Teaching Point</th>
<th>Publication Point</th>
<th>Service Point</th>
<th>Funding Point</th>
<th>Total Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECBCS002</td>
<td>Nick Clinton</td>
<td>54</td>
<td>74</td>
<td>86</td>
<td>47</td>
<td>82</td>
<td>14</td>
<td>1256</td>
</tr>
<tr>
<td>ECBCS005</td>
<td>Bill Wang</td>
<td>35</td>
<td>58</td>
<td>56</td>
<td>72</td>
<td>82</td>
<td>42</td>
<td>1194</td>
</tr>
<tr>
<td>ECBCS003</td>
<td>Richard Lee</td>
<td>86</td>
<td>16</td>
<td>24</td>
<td>56</td>
<td>74</td>
<td>34</td>
<td>1010</td>
</tr>
<tr>
<td>ECBCS008</td>
<td>NiuEr Chen</td>
<td>12</td>
<td>54</td>
<td>74</td>
<td>63</td>
<td>23</td>
<td>98</td>
<td>1003</td>
</tr>
<tr>
<td>ECBCS009</td>
<td>Jesse Gruber</td>
<td>12</td>
<td>73</td>
<td>32</td>
<td>72</td>
<td>70</td>
<td>47</td>
<td>946</td>
</tr>
<tr>
<td>ECBCS007</td>
<td>Jacky Cheng</td>
<td>2</td>
<td>57</td>
<td>32</td>
<td>75</td>
<td>70</td>
<td>22</td>
<td>874</td>
</tr>
<tr>
<td>ECBCS004</td>
<td>Curtis Zhang</td>
<td>31</td>
<td>12</td>
<td>32</td>
<td>54</td>
<td>34</td>
<td>12</td>
<td>650</td>
</tr>
<tr>
<td>ECBCS001</td>
<td>Jade Winn</td>
<td>12</td>
<td>45</td>
<td>56</td>
<td>18</td>
<td>43</td>
<td>69</td>
<td>607</td>
</tr>
</tbody>
</table>

The highlighted professors are rank top using Merit-Based Performance Evaluation Rule.

Choose Another Evaluation Rule  Edit Merit Base Rule

Figure 5-6 Tabulation Presentation of Evaluation Result

This the performance chart for Professor Nick Clinton

Figure 5-7 Bar Chart Presentation of Evaluation Result
This is the performance chart for Professor Nick Clinton.

**Nick Clinton**

**Chart Type**
- Scatter chart

**Evaluation Method**
- Personal vs. Average

**Chart Style**
- Informal

---

**Figure 5-8 Scatter Chart Presentation of Evaluation Result**
Chapter 6

Conclusion and Future Work

Knowledge is power. It can become an organization’s most valuable and greatest asset. One analyst firm estimates that Fortune 500 companies will accumulate knowledge deficit – i.e., inefficiencies and costs associated with intellectual rework, below-standard performance, and an inability to access knowledge resources – of $31.5 billion by 2003 [16]. Creating a competitive edge in the business to business (B2B) world means making informed decision quickly [17]. Yet specific information technology solutions failed in the field of “KM” rather than within the realm of former “information management” or “data management”. This ambiguity has encourages us to figure out what is the underline requirement and differences of KM that actually count.

In this thesis, we first introduced differences among data, information, and knowledge, developing a better and more accurate understanding of KM as enabler of information strategy for the e-business world. Then, we briefly reviewed the transformation from traditional information process to nowadays knowledge creation, and emphasized the importance of the dynamic and unpredictable nature of knowledge. Following that, we created a knowledge-based decision support system – PEDS.

➢ We first explained from system architecture, development process and business model why component-based technology is essential in e-business world.
Chapter 6 – Conclusion and Future Work

- Then through two examples – Professor Performance Evaluation and Stock Picking Decision – illustrated how such model is applied to e-business scenarios and help to improve the organization’s decision-making and resource allocation.

- By implementing the case of Professor Performance Evaluation pointed out step-by-step how component-based and knowledge-oriented ideology are carried out through the design and deploy process.

Finally, we generalize PEDS as an up-to-date KM model that organizations can put the power of knowledge to work for their benefits.

With PEDS KM model, organizations can harness their pool of knowledge into information that everyone can use to build or maintain a competitive advantage. Access to real-time information – both internal and external – helps organizations stay abreast of the key metrics needed to track and make informed decisions. In addition, planned functionality includes the ability to facilitate the capture, creation, organization, access, distribution, and use of data by aligning key business processes, technology, and information management principles, giving organizations freedom to search against multiple data sources and create profiles.

It is obvious that to handle KM well, contributions from diversified areas such as decision science, artificial intelligence (AI), knowledge modeling and data mining are needed [18]. For practical purposes, KM is a discipline that encompasses processes and techniques for collection, organization, distribution, access to and evaluation of institutional knowledge for improvement of performance. Currently, most KM system
Chapter 6 – Conclusion and Future Work

has already embedded some kind of AI technology, such as Bayesian Reasoning, Ontology, Intelligent Agent, and so on [19] [20]. Due to advances in Web-based technology and component-based development, there are plenty of opportunities for well-development AI techniques to be used in various parts of core business process [21].

Future Intelligent System for KM system will include following aspects:

- Human – computer interaction
- Automatic categorization and indexing of documents
- Link Data Mining and Knowledge Discovery to KM

Information and communications between technologies are important components for the success of KM system. As further research work contribute, more sophisticated and more powerful KM system will be generated and serve the new e-business world’s benefits.
Bibliography


Bibliography


Bibliography


