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Development of a Web-Based System for Supporting Sales in a Mineral Water Manufacturing Firm: A Case Study

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Abstract

In this paper, we present the findings of a case study of the development of a Web-based workflow system in a mineral water manufacturing firm for supporting sales management. The system aims at providing assistance in i) performing efficient dissemination and management of information and sales documents, ii) ordering and delivering mineral water, and iii) improving the control processes. A framework for the development of Web-based workflow systems is proposed. The framework is examined and explained in the context of the case study. Finally, the case study illustrates and highlights the benefits and advantages of the system, which provides better support to teamwork as a result of better communication and monitoring, and which reduces sales cycle times.

1. Introduction

The Internet, a global web of interconnected networks, is accelerating the information revolution. Many businesses are using the Internet as a new technology platform upon which to build all sorts of new products and services, and even to redesign the workflows, products and services in their companies. With great advances in Internet and World Wide Web (WWW) technologies, various attempts have been made to implement Web-based supporting systems for different applications in the areas of sales, design and manufacturing [1-3]. Information Technology (IT) is identified as a significant enabler in effecting the changes and achieving the productivity gains conceptualized through business process re-engineering (BPR) techniques [4]. Web-based workflow management systems are being increasingly exploited as enablers of many BPR projects, mainly due to their ability to automate processes involving combinations of human activities and IT [5-6]. It is this dual nature of IT that it is considered as a powerful tool for BPR. Through the control of the core work process by means of proceduralization of the component tasks, and through the empowerment of employees via "connectivity" with the necessary resources, IT successful integrates these two aspects of BPR into a single workflow management system [7]. However, very little has been reported on how small manufacturing firms are using Web-based technologies to support sales and on how to develop a Web-based workflow system for small-medium enterprises.

This paper describes the research and development of a Web-based system for supporting sales in a mineral water manufacturing firm. A framework for the development of Web-based workflow systems is first proposed. The framework is then examined and explained in the context of a case study. Finally, the case study is used to illustrate and highlight the issues of system development and the benefits and advantages

of the system, which provides better support to teamwork as a result of better communication and monitoring, and which reduces sales cycle times. Other industries can use a similar approach to develop Web-based workflow systems that can support the sales of their products or services. An understanding of the Web-based system development life cycle is essential for today's manufacturing practitioners, because most organizations need Web-based information systems to survive and prosper. We will see from this study that innovative use of IT can help manufacturers gain competitive advantages through achieving better quality, greater flexibility, lower cost and higher speed over their competitors.

2. Literature Review

A number of experts in the field of BPR highlight that IT plays a pivotal role in BPR. Dennis *et al.* [8] describe a methodology and the supporting group software tool for modeling and analyzing business processes. The supporting group software tool extends the capabilities of the existing electronic meeting system technology to help groups build complex representations of an organization. Walczuch *et al.* [9] describe a case study using multiple group support systems and manual methods to support the reengineering process in a university housing department. Grover *et al.* [10] provide preliminary empirical results that indicate that IT-enabled BPR projects are more likely perceived to be successful, and that this success can be explained by the integration of IT endeavors with corporate strategy. Gunasekaran and Nath [11] discuss the role of IT in BPR and present a design of an effective BPR system with the help of advanced IT.

Workflow is a network of activities, also commonly known as a business process, defined for a specific business objective [12]. A working definition of workflow

management stems from an industrial consortium called Workflow Management Coalition (WfMc) [13]: “A workflow management system is one which provides procedural automation of a business process by management of the sequence of work activities and the invocation of appropriate human and / or IT resources associated with the various activity steps”. Nurcan and Rolland [14] show how workflow management systems can be instrumental in satisfying quality requirements defined in the ISO 9000 standard. Thoresen [15] explores computer-supported cooperative work in a workflow oriented material administration system in a large company. A good introduction and theoretical treatment of workflow systems are given in the *Workflow Handbook* [16] created by WfMc, which is an organization of more than 170 members located in 24 countries around the world aiming at the advancement of the workflow management technology and its use in industry.

In detail, a framework proposing the logical phases involved in the development of a Web-based workflow management system is presented in Section 3. Then, details of a case study are presented in a subsequent section as an application example. Finally, concluding remarks about results, lessons learned, future work and benefits of the approach are drawn in Section 5. The Appendix illustrates a sample session of running the system developed and implemented in the case study firm.

3. Development of the Web-based Workflow Management System

The main objectives of the project are to design and develop a prototype Web-based workflow system

- to perform efficient dissemination and management of information and sales documents to customers, and vice versa,
- to order and deliver mineral water in a user-friendly way, and

- to improve the control processes so that a request order can be dealt with within 24 hours.

A six-stage structured development methodology (Figure 1) for developing Web-based workflow management systems – business systems planning, business process analysis, system architecture development, system analysis and design, system building and system observation and evaluation – is described below.

[Insert Figure 1 about here]

1) Business Systems Planning

Business systems planning can help identify the key entities and attributes of an organization's data [17]. To implement any chosen strategy, senior management must have a clear vision of the company strategy needed to deliver the value expected by the customers and desired by the company. Vision is necessary to ensure consistency of strategic purposes within the firm. In this phase, managers are asked how they use information, where they get their information, what their environments are like, what their objectives are, how they make decisions and what their data needs are. The outcomes of this phase are identifying the relevant goals, objectives and business areas, and strategies for the company under study.

2) Business Process Analysis

Automating business processes requires careful analysis and planning. Business processes refer to how a particular business is conducted and how it is related to the business rules, strategies and unique ways in which an organization coordinates work, information, and knowledge, and to the ways in which management chooses to

coordinate work [17]. The choice of the business process to improve or redesign is critical. Our first task is to select the right set of business processes to improve or redesign, and identify the areas of improvement that require automation. The acquisition of business process knowledge is typically done by conducting interviews or questionnaire survey [18]. One of the most time-consuming activities for process engineers is the acquisition of the necessary business process knowledge for process analysis and redesign.

3) System Architecture Development

A good system architecture provides a road map for the system building process. It puts the system components into perspective, defines the functionalities of the system components and delineates how they interact with one another.

4) System Analysis and Design

In system analysis data are collected about the present system. The focus is on determining the requirements for a new system. In the system design phase, a new or alternative information system is crafted. Software and hardware is acquired and tested. Design involves the understanding of the domain being studied. Design specifications will be used as a blueprint for the implementation of the system [19].

5) System (Prototype) Building

By building a prototype system, various issues that have arisen can be addressed. For instance, new concepts of user interface design can be evaluated. The prototype can be used to clear up a variety of problems, learn about the concepts, framework and design through the system building process.

6) System Observation and Evaluation

The use of the prototype system can be observed through case studies. Once the prototype system is built, testing and evaluation can be performed. It is checked to see if the system works correctly and meets the requirements. Researchers can capture information on what users like and dislike, and what the system does or does not do to meet those users need. Its impact on individuals and the organization can be observed through detailed documented case studies.

4. Application Example: The Case Study

According to Nunamaker *et al*., [19], an ideal research problem cannot be verified mathematically and tested empirically; its validity must be demonstrated by developing a system. Once the system has been built, its performance and the phenomena related to its use can be studied in order to gain insights into the research problem.

This section reports the findings of a case study of the application of the above framework in a mineral water manufacturing firm, highlighting issues pertaining to the development of a Web-based workflow management system and demonstrating the benefits and advantages of the proposed approach. In particular, the development is illustrated by going through the different phases of the proposed framework in a step-by-step manner.

4.1 The Company

The case study company is a Hong Kong manufacturer of mineral water, which supplies the markets in Hong Kong/Shenzhen, a contiguous region to the New

Territories of Hong Kong in the south of the Chinese mainland. The company relying on a traditional manual system to process order requests for mineral water suffers from two major disadvantages:

i) The process is time-consuming and expensive as it usually takes between two and three days to process a customer request. Complaints are often received by customers about the long time it takes to process their orders.

ii) The monitoring and tracking systems are inadequate, so management finds it difficult to keep track of the request process.

4.2 Research Questions

A research question evidently arises from these disadvantages. Can IT be used to improve this situation? What kinds of technologies would be most appropriately employed to tackle the problem? With these questions in mind, we propose a solution to the existing manual system. The proposed solution takes the form of a workflow system operating on the Web. The use of a workflow system is motivated by the following three factors [20]:

i) Improved efficiency, leading to lower costs or higher workload capacity,

ii) Improved control, resulting from standardization of procedures,

iii) Improved ability to manage processes: performance problems are made explicit and understood.

1) Business Systems Planning

The senior management recognizes that they need to develop a broad strategic vision –"provides customer with the best Price, Service, Products and most of all Quality for your bottled water needs" – that calls for redesigned business processes. In

this study, management looks for breakthroughs to lower costs and accelerate product development and sales that would enable the firm to regain regional market leadership in the sales of mineral water. The company takes the measure to redesign its entire sales and ordering process to replace expensive, labor-intensive tasks.

2) Business Process Analysis

A business area is characterized by a descriptive model – a business process that specifies how a particular business is conducted. We identify a few core business processes to be redesigned, focusing on those with the greatest potential payback. One of the principal methods used in business process analysis is interviewing. Interviewing users and managers offers the best insight into their work environment and identifies weak areas and areas of possible collapse of current business processes. In this study, most of the interviews are conducted with middle and supervisory managers. Moreover, the questions mainly focus on what existing information is used. The result is to understand how business is conducted and to redesign the process with a tendency to automate the processes.

Figure 2 depicts the manual processing of mineral water request orders before the implementation of the Web-based workflow system. It is a time-consuming and expensive process as it is a “desk-to-desk assembly line” approach, which might take up to two/three days for processing an order, and sometimes even longer if there is a hold-up during the process. Moreover, what is even more troubling is that there is little communication between the departments involved, such as the accounts, vending service and production departments.

[Insert Figure 2 about here]

The sequential desk-to-desk approach as shown in Figure 2 has been redesigned and replaced by a Web-based workflow system. Figure 3 depicts a flow chart of the system, starting with an order request by a customer to deliver a mineral water product. First, we create a new customer account and input the customer's information into the workflow system. After verifying the customer information, approval needs to be granted by the department sales manager so that a new sales contract and a request for deposit payment can be generated. A request for a debit note is sent to the accounts department. Furthermore, the acquisition of actual sales figures is conducted by the Loading Service Department. Daily sales reports are then generated. Finally, the vending service and production departments arrange for dispenser sterilization and water production via the system, respectively.

[Insert Figure 3 about here]

3) System Architecture Development

System Architecture

The architecture of the system comprises three main components: the clients, the sales Web server, and the sales database server (see Figure 4). All of them are linked up with the Internet but may be located in different geographical places. In practical situations with distributed functions, these components can also be distributed; for example, the sales Web server may be located in Hong Kong (logistics center). The Sales database server is located in a manufacturing plant in Shenzhen. Clients can be anywhere, as long as they have access to Web browsers on the Internet.

[Insert Figure 4 about here]

Sales Web Clients

When a user loads the Internet page with the applet, it activates the server part of the system and starts communication with it through a socket connection. This approach allows combining high user interactivity and dynamic data displays on the client side [21]. The user can execute at any host connected to the Internet, using different Web browsers, such as Netscape's Navigator or Microsoft's Internet Explorer. The screen has two main areas: one is a hierarchical item tree structure on the left-hand side, and the other is the multiple buttons on the top of the screen showing various departments. The screen design is simple and considered to be user-friendly.

Sales Database Server

A database server machine may be physically different from the sales Web server that maintains the sales database. We use the Microsoft structured query language (SQL) server, which is a relational database management system with a client/server architecture. This remote sales database is accessed through the Open Database Connectivity (ODBC) gateway to insert, delete or update information in the database.

Sales Web Server

The sales Web server is a computer that serves requested sales Web pages. The Web server interacts with the individual user's Web browser and accepts external HTTP requests from the browser. An Application Programmer's Interface (API) is distributed, along with most of the commercially available browsers, such as Netscape's Navigator or Microsoft's Internet Explorer. Application programs can be

written using these APIs to enhance the capabilities of a browser. Rezayat [22] points out that servers must have secure and reliable access to data stored in a wide variety of persistent data engines (e.g. object databases, file systems, dynamic Websites), which may be scattered throughout an enterprise. Java DataBase Connectivity (JDBC) API to access databases is used in this study.

4) *System Analysis and Design*

The workflow system automates processes and streamlines business procedures so that documents can be moved easily and efficiently from one location to another. This Web-based workflow system transforms customer service support into an effective and efficient activity that meets users' requirements and satisfaction. Basically, it provides three levels of sales management support service. The first is an electronic platform for the company's salesperson to record customer orders. The second generates a customer contract and sends it to the Accounts and Vending Services Department for preparing a deposit invoice and sterilizing water dispensers. The third arranges the production of mineral water and generates reports, providing statistics of the workflow progress.

The design of the system follows a three-tier structure, namely the client-server-server architecture. In such a system, the first tier is the Internet browser, through which the user gains access to the system and is connected to the Object-Web server (tier two). This, in turn, is connected to the data servers, where all the information regarding the documents and sales data is stored (tier three), with access to and control over all types of information scattered throughout the company.

5) System (Prototype) Building

Building a prototype system is an engineering concept [23]. It has been widely used in software engineering research [19]. The developers gain insights into the application area and into the users' work tasks and the problems they face. The Web-based workflow system has no specific computer hardware requirements, although faster machines will provide quicker results. Since it is a Web-based system with standard Web-based interfaces, no special client software is required other than a Web browser such as Netscape's Navigator or Microsoft's Internet Explorer.

After evaluating a number of tools for development of the system, we choose Java as it is a promising language for developing the Web-based system because it has the following characteristics:

- it is platform independent: Windows, Unix and Macintosh all support Java,
- it supports embedded applets and allows users to remotely access embedded applications,
- its built-in TCP/IP, HTTP and FTP make it suitable for Internet deployment, and
- it contains libraries for developing GIU.

The salesperson uses the point-and-click interface along with some Java applets that perform simple tasks. The approach consists in the use of Java applets. Java is a programming language that can be interpreted by most Internet browsers on various hardware platforms. Java applets embedded in WWW pages are loaded by a browser from an Internet server computer and then executed on a client computer without requiring any installation [21]. It provides secure software that can run on literally any computer connected to the Web. However, this approach also has certain

shortcomings. First, a critical issue is the size of the Java applet: downloading of a big applet may require quite a long time. This may seriously inhibit augmentation of the functionality. Second, applets may run rather slowly on some hardware and software platforms. Third, data security is not guaranteed: any other software can access database files accessed by the applet [21]. In this project, the applet used is considered not big, so that long downloading time is not a concern.

Security of data on the Internet is a major issue. Some special features have been included for the safe handling of customers' details. The system uses an authentication system to restrict access to customers' records. Security is achieved through password authentication and verification.

6) System Observation and Evaluation

Once the prototype system is built, testing and evaluation can be performed. It is checked to see if the system works correctly and meets the requirements. Researchers can capture information on what users like and dislike, and what the system does or does not do to meet those users need. In this way it can be verified that whether the desired requirements are fully met. We use a formal approach, employing a user questionnaire to document responses to system testing. In order to obtain comprehensive feedback, a mix of users and managers were invited to evaluate the system. Most respondents were positive about the potential of the system, particularly indicating that it was helpful in improving the dissemination and management of information and sales documents to customers.

5. Conclusions and Recommendations for Further Study

This paper describes the research and development of a Web-based system that has been used to effectively support sales management for a mineral water manufacturing firm. A framework for the development of Web-based workflow systems is proposed. The framework is examined and explained in the context of a case study.

The case company in this study, a mineral water manufacturer, has reengineered its business. The Web-based workflow system, which changes the way in which the company runs its business and makes decisions, was developed in response to changes in competitive pressures from the business environment. People usually order mineral water when they need it, giving very short notice. So efficiency in delivering mineral water to customers is one of the most important criteria when the customer is evaluating a mineral product or service.

At present, the Web-based workflow system reported in this study yields a number of advantages:

i) The Web-based workflow system supports different computing platforms. Since it is a Web-based system, it does not need expertise to maintain clients with different computing platforms. Only standard Web browsers, such as Netscape's Navigator or Microsoft's Internet Explorer, are required.

ii) Users are increasingly familiar with Web technology. Web browsers are widely used for finding information from the Internet. Most potential workflow users know it, therefore no further training on using the Web is required.

iii) The system enables consistent handling of work and more efficient handling of paperwork and the documents needed to invoice.

iv) Faster response times to customers' requests and shorter service times are possible under the system. In fact, customers are experiencing a more than 100% improvement in response time.

v) The system facilitates improvement in monitoring work progress. Statistics of work progress in the workflow system can be generated for management control purposes.

The lessons learned from carrying out this project are summarized as follows:

i) There is a need to understand the whole process of the existing service thoroughly. It is virtually impossible to create a successful workflow system without a thorough understanding of the whole process.

ii) There is a need for a detailed survey of existing state-of-the art technology and an understanding of what is possible, so that it can be harnessed to yield satisfactory results.

iii) There is a need for user cooperation in the planning and implementation of a new workflow system. We believe that without user involvement, learning and using the new workflow system, the project can never succeed.

We are interested in the following areas and propose them as subjects for future research.

i) A comprehensive study is currently being planned, with the aim of introducing and evaluating the effectiveness and impact of this new Web-based technology in terms of improved operational mineral water delivery time, reduced operational cost, and improved customer services.

ii) A Web site integrated with the existing workflow system is under construction, so that customers can place a request order directly onto the Web site and access customer sales information with the online database via Web browsers such as Netscape's Navigator or Microsoft's Internet Explorer.

Appendix: An Illustrative Example of Using the System

The illustrations in this section are intended to provide a better understanding of the system. We demonstrate the primary capabilities of the system and show how the system can help in supporting sales management in the mineral water manufacturing firm. Registered users are provided with a unique username and password that allow them access to the system. After activating the system, the system main screen is displayed. On the left-hand side of the main screen, there is a window with the list of available Web-enabled process programs, namely "New Carboy Customer Process", "New Contract Process", "Financial Process", "Report Process" and "Other Features" (Figure 5). Running the enabled application process is simple: a user has to point and click on the selected application areas. Authorized people in different departments (Accounts, Vending Services, Production and Loading Services) can login to the system using the corresponding button on the top of the main screen (see Figures 5 and 5a).

[Insert Figure 5 about here]

[Insert Figure 5a about here]

To create a new customer account, the user clicks the “Fill Carboy Customer Information Sheet” under the “New Carboy Customer Process” (Figures 5 and 5a) of the main screen. When the user (a manager) clicks on the “Manager’s Approval” button, the screen “Manager’s Approval Processing” is displayed (Figure 6). There are three buttons under the heading of “Manager’s Approval Processing”: “Awaiting Approval” for a list of customers who have an order stored in the system and waiting for approval by the manager, “Recently Approved” for a list of customers that have been approved to open a new account in the last two days, and “Approval History” for a list of customers that have been approved by the manager for more than two days, but still have not proceeded to the next stage of the process.

[Insert Figure 6 about here]

After the “Manager’s Approval”, the input data will be passed to the next stages. For customers needing the hire of a water dispenser, “Record Deposit Debit Note Details” should be activated. Detailed figures related to the delivery of a water dispenser and mineral water is displayed for confirmation, while the user clicks on “Sterilization & Production Report”. The user can click on “View Work Process” to display the time used in each stage of the workflow process (see Figure 7). The user can click on “Statistics” to generate a bar chart for displaying the overall percentage of time that is spent on each stage of the workflow process. A sample output is shown in Figure 8.

[Insert Figure 7 about here]

[Insert Figure 8 about here]

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