
Application of the workflow management system in electronic commerce: a case study

Eric W.T. Ngai* and C.H. Leung

Department of Management and Marketing
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong, China
E-mail: mswtngai@polyu.edu.hk
E-mail: msleung@polyu.edu.hk
*Corresponding author

Y.C. Wong

Department of Computing
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong, China
E-mail: CSYCWong@comp.Polyu.edu.HK

Abstract: Electronic commerce (e-commerce) applications are developed to allow companies to communicate with their partners, suppliers, and consumers on the internet. The migration from traditional business to e-commerce requires fundamental changes in business operational systems. It is not sufficient to focus on the development of web-based interfaces only. The front-end of a system for e-commerce should be supported by the back-end infrastructure. A Workflow Management System (WFMS) is important for linking front-end and back-end applications to automate business processes. In this paper, a generic model of a WFMS in e-commerce is proposed. Based on the proposed model, a specific WFMS model was developed and implemented in a company for a case study. The case study illustrates and highlights the benefits and advantages of the system. The user survey results from the case study showed that the users responded positively to the WFMS.

Keywords: Workflow Management System (WMS); e-commerce; case study; garment manufacturing company.

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Biographical notes: Dr. Eric W.T. Ngai is currently Associate Professor in the Department of Management and Marketing at the Hong Kong Polytechnic University. His research interests are in the areas of e-commerce, decision support systems, supply chain systems, and knowledge management systems. He has published in a number of journals including *IEEE Transactions on Systems, Man and Cybernetics*, *Information and Management*, *Decision Support Systems*, *International Journal of Operations and Production Management*, *Omega*, and *European Journal of Operational Research*. Dr. Ngai serves on the Editorial Board of *International Journal of Production Research*. Dr. Ngai has received the Faculty Award for Outstanding Performance/Achievement in Teaching (2003–04).

Dr. C.H. Leung received his PhD in Computer Science from the Chinese University of Hong Kong. He was a Project Fellow in the Department of Management and Marketing at the Hong Kong Polytechnic University. He worked as a tutor in the Chinese University of Hong Kong and Senior Research Assistant in Hong Kong University. His research interests are in the areas of e-commerce and information systems.

Y.C. Wong received his bachelor's degree in computing from the Department of Computing at the Hong Kong Polytechnic University. His current research areas are business information systems and ERP implementation.

1 Introduction

Corporations, markets, and the global economy are being transformed by e-commerce. E-commerce affects how business transactions are performed. On the internet, customers can easily find products and services, and compare prices and qualities. At the same time, companies can easily find customers and suppliers, and arrange to trade with them. User-friendly interfaces, targeted advertisements, up-to-date product catalogs and personalised stores are common features of e-commerce. Nevertheless, the front part of the web might conceal inefficient and inflexible operations that are slow and complex. With the web, companies can communicate with their customers, suppliers, and partners to carry out e-commerce transactions. However, the transformation from traditional ways of doing business to e-commerce requires a fundamental re-implementation of back-end operational systems. Simply developing web-based interfaces to the legacy application is not enough. Human interventions would be involved in different processes such as repeated data entry, the monitoring of processes, the handling of exceptions, and the scheduling of different activities. Inefficient e-commerce processes lead to high operating costs and affect the profits of the companies using them. Most e-commerce applications have the front-end of the web powered by an application server supporting the dynamic generation of web content and linking the front-end to business applications. There should be a back-end system managing inventory, procurement, billing, payments, shipments, and other functions required to perform the transaction.

In fact, workflow management is necessary to connect front-end and back-end applications. The Workflow Management System (WFMS) is a key technology for integrating, automating, and monitoring business and e-commerce processes; and for providing the online delivery of services (Cichocki *et al.*, 1998; Georgakopoulos *et al.*, 1995; Leymann and Roller, 2000). When processes span many systems and departments in a company, it is often difficult to monitor them. Without tracking capabilities, it is not easy to locate which process has problems and needs to be modified. It is often necessary to interfere with the running processes to manage unexpected situations and carry out corrective actions.

The paper is organised as follows. In Section 2, we present a brief review of the literature on the WFMS and its applications. A generic WFMS model is proposed in Section 3. Based on this model, a specific WFMS model was designed and implemented in a company as a case study which is presented in Section 4. Finally, we discuss the evaluation of the WFMS in the company.

2 Workflow management system and its applications

According to Marshak (1994), essential workflow characteristics are tasks/activities to be performed by (role-playing) persons using supporting tools that give access to various shared information resources. In the past, there was no agreed way on how to categorise workflows or WFMS. There were several attempts to classify current workflow products. Alsop (1994) divided workflow into *ad hoc* workgroup support, task automation, document flow, and process automation; Frye (1994) divided workflow into three categories: mail-centric, document-centric and process-centric. Georgakopoulos *et al.* (1995) characterised workflow along a continuum from human-oriented to system-oriented. Ader (1997) categorised workflow into production workflow, administrative workflow, *ad hoc* workflow, and collaborative workflow.

A WFMS is a technological system in which workflow processes are defined, performed, managed, and monitored through the execution of computer software; and in which the order of events is driven by processes. A business process is a set of one or more procedures or activities that realise business objectives or policy goals such as insurance claims process, an order process, or a loan process (Ould, 1995; Chang *et al.*, 2000). An ideal WFMS should support the model-driven design, analysis, and simulation of business processes; and provide features for monitoring the execution of processes and reacting automatically to exceptional situations. Successful e-commerce companies should develop their e-commerce applications on top of WFMS tools that can help companies to drastically reduce costs, improve the quality of services and time to market, and respond to an ever-changing business environment.

The most fundamental requirement for success in the domain of e-commerce is the ability to faultlessly integrate and interoperate diverse operations provided by different business processes. The integrated workflow should be easily accessed by processes using the network infrastructure. There are three basic components in a system of e-commerce: data management, workflow processes, and commercial functions. Data management deals with how data are stored, retrieved, searched, and presented to users of different applications such as product catalogs. Data management should also include logical-level functions (*e.g.*, data modelling) and physical-level functions (*e.g.*, indexing). These functions have been under continuous development and can be implemented in typical database management. Workflow processes are collaborative actions in which workers follow business procedures and regulations to achieve business objectives efficiently and effectively. A WFMS should be capable of handling modelling, of routing and monitoring workflows, automating tasks, formalising communications, and integrating systems (Zhao *et al.*, 1998).

Commercial functions are the core activities in commercial transactions such as payment and cataloging. These activities are often contained in the business processes and management of data. Thus, some commercial activities are supported by database management systems and some are supported by WFMS. The business processes in e-commerce are mainly of the production type, and data transactions are often well defined (Becker and Muehlen, 2002).

A working definition of workflow management stems from an industrial consortium called Workflow Management Coalition (WfMC, 1993; Fischer, 2004):

“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.”

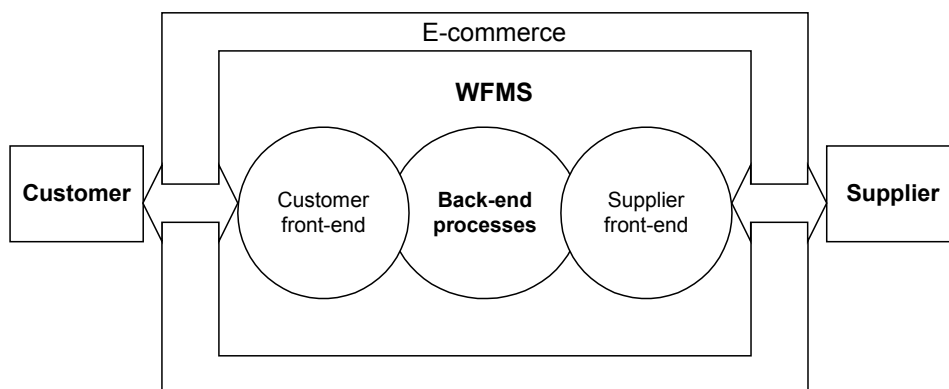
Hu and Grefen (2003) proposed a three-layer workflow concept framework to realise workflow enactment flexibility by dynamically binding activities to their implementations at run time. Rouibah and Caskey (2003) described an engineering workflow approach to control early phases of product design that is suitable for concurrent engineering’s dynamic and iterative processes. Narendra (2004) developed a three-tier architecture that supports adaptive workflow and demonstrate it on a real-life example in insurance claims processing. Yang *et al.* (2004) presented a web-based network management system architecture that is built around a data storage and management module that is responsible for collecting data from managed objects via SNMP/CMIP. Liu *et al.* (2005) presented the system design and implementation of a workflow-supported inner supply chain system and an integrated interface for a large motorcycle corporation in China.

3 A generic model of a workflow management system in e-commerce

A WFMS delivers work items to the defined users, and supports work performance by invoking appropriate applications and utilities (Kobielus, 1997). Towards this direction, a company’s technology infrastructure can build on web-based workflow management. This is the evolution of the traditional WFMS that supports the automation of e-commerce processes within a company. The following generic model consists of:

- internal back-end processes
- a customer front-end process
- a supplier front-end process (see Figure 1).

Figure 1 A generic model of a workflow management system in e-commerce



The customer front-end process entails supporting, developing, and retaining profitable customers. It uses the concept of customer self-service. This allows a company to analyse past customer behaviour so as to personalise its offerings and anticipate the wants and needs of customers. The long-term goal is to transform single-transaction customers into lifetime customers. The benefits to companies include:

- fine-tuned target market segmentation
- improved customer retention by building loyalty
- improved customer satisfaction
- increased customer mind share (*i.e.*, the first company that comes to the customer's mind when a particular industry/product is mentioned) and spend share (*i.e.*, the company from which the customer would prefer to buy the product)
- established competitive advantage
- increased profitability.

A supplier front-end process works with the suppliers to ensure that there are sufficient products to sell. Giving suppliers access to the internal resource planning applications of an enterprise will help them to better anticipate the company's needs. Manufacturers and vendors can share sales forecasts, manage inventories, schedule labour, optimise deliveries, and improve productivity. The benefits to companies include:

- lower operating costs from reduced inventory requirements
- improved customer satisfaction resulting from maintaining adequate stock (this will ensure that the company's offerings are fresh and attuned to trends and changes in the marketplace)
- fewer order entry errors, less reworking, faster communications and, ultimately, improvements in productivity resulting from better data integrity. This will improve the company's competitive position.

The back-end processes enable customers to purchase the company's offerings over the web. The e-commerce processes manage the electronic presentation of goods and services, online order-taking and the presentation of bills, automated customer account inquires, and the handling of online payments and transactions. By offering e-commerce solutions, a company will benefit in the following ways:

- improved margins by using a lower-cost online channel
- reduced costs associated with eliminating paper-based processes such as postage, printing, and handling
- a reduction in float through the use of electronic transfers or just-in-time payments
- the provision of a faster, more responsive service to customers.

The above model shows customer and supplier front-ends connecting to a company's internal business process. The front-ends are an external interface to allow customers and business partners to access the company's internal business processes. The networked systems improve efficiency by giving business partners, suppliers, and

distributors access to the company's internal business processes. E-commerce systems that enable web-based payment and other secure transactions are the key to both the business-to-consumer and business-to-business sides of the model.

4 The company

The case study company is a leading garment manufacturing company that makes and supplies casual wear under a range of fashion labels. The company has factories in six countries that produce knitwear and woven wear. The company has about 450 retail shops in Chinese Mainland and Australia. In order to maintain the current level of profits in a competitive environment, the business objectives of the organisation include:

- expanding the number of store outlets to achieve sales growth
- keeping up with fashion trends
- offering high-quality products
- providing value-added services.

Because of the rapid growth of the internet in recent years, the company has begun using the internet as an information and communication platform. The worldwide platform can provide global competitiveness in the market through e-commerce. All e-commerce services are enabled through the implementation of some back-end processes in the WFMS. For instance, after an order is received from an online store, some activities such as searching through the stock to send the product, selecting a delivery agent, communicating with the stock department and the agent, and monitoring delivery have to be performed.

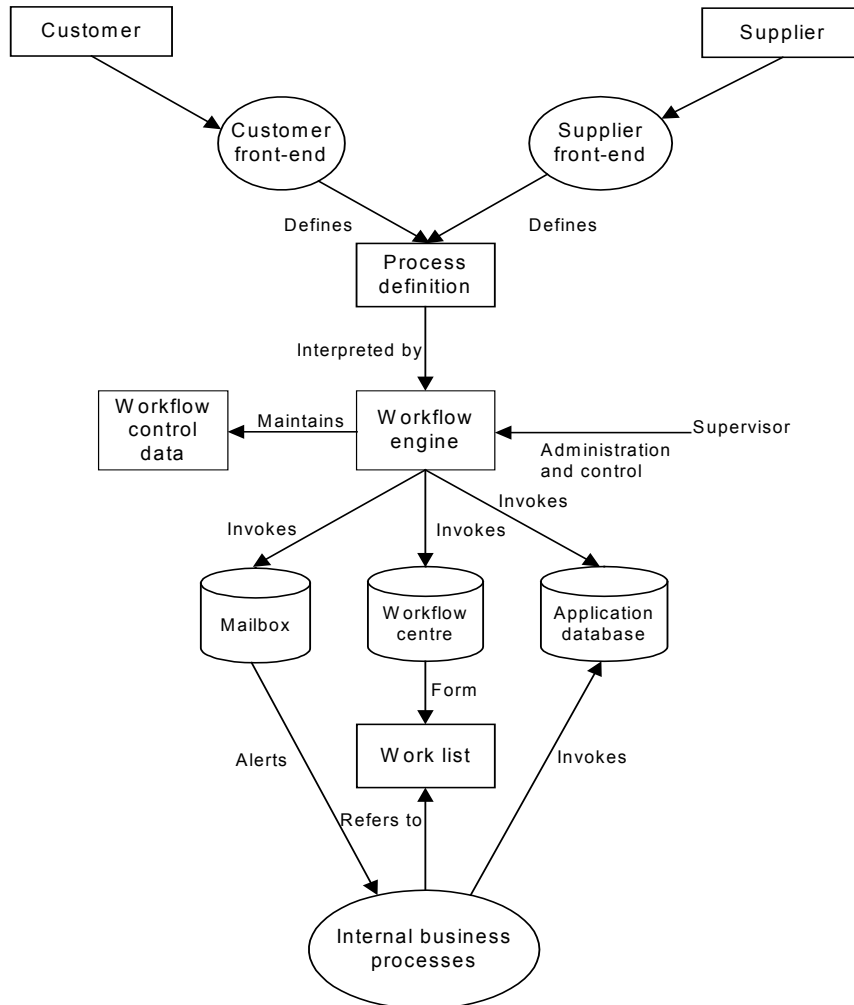
4.1 A generic workflow management model and the specific model in the case study

Although workflow management has its roots in different fields of computer science and systems engineering, it has been recognised as the key to optimising manufacturing processes. A WFMS provides procedural automation of a business process, organising the sequence of work activities in the manufacturing environment (Jablonski and Bussler, 1996).

A specific model was developed and used in the case study (see Figure 2). A WFMS can use a push model in which the system *pushes* work to the user. Users can only pay attention to tasks routed to them. Users have no idea how their work fits into the overall process because they have no visibility of upstream or downstream tasks. This is particularly suitable for users who are responsible for a very small number of tasks in the overall process in the case study. The push model was implemented in this research. The users are informed that they have a task to perform, and the information required to perform the task is presented to them.

There are several important components in the specific workflow model. A workflow engine manages the execution of individual instances of the various processes. The workflow engine maintains the internal workflow control data, which includes information on the internal state associated with the process. The workflow engine is also a part of the user interface, allowing users to invoke it to execute particular activities (*e.g.*, 'Approve', 'Reject', 'Send', *etc.*).

Figure 2 The specific workflow management model used in the case study



In this model, there are three kinds of databases: the user's mailbox, the application database, and the workflow centre database. The applications database contains different applications invoked at different activity points within the workflow process. The applications can be developed by the company itself, using the programming tools, or purchased from third parties to provide the required functions in the workflow process.

The user's mailbox acts as the message centre in this mode. The participants will receive electronic mail, which will contain information about the status of the process. The individual participants can either click 'doclink' from the main menu or open the work list to invoke the process. The mail contains the location of the document, the title of the document, and the deadline for approval. A 'doclink' is provided for the user's quick reference. The workflow centre is a shared database that keeps the documents or records available for others within the workflow process. Moreover, this database has a view, which presents the work list to the corresponding participants.

4.2 Implementation with Lotus Notes

Conversely, collaborative, administrative, and *ad hoc* workflow applications need flexible management environments and rely on built-in databases and communication infrastructure such as e-mail systems. The people involved in the process use the e-mail system to route forms and messages to each other. The forms are usually created with a standalone tool, and these forms are sent between people, allowing them to change and update fields. When a form has reached its end-point, where the process is finished with it, it is written into the database.

This kind of workflow management functionality can be provided by groupware systems like Lotus Notes™ (Rayl, 1994; Marshak, 1995). Lotus Notes™ was chosen to implement the specific workflow model in the case study. Because messaging is based on an existing e-mail system, products of this category are usually low-cost. Groupware systems like Lotus Notes™ mostly bundle some basic workflow capabilities that can be used to process workflows. There is an integrated database and communication architecture in Lotus Notes. The Lotus Notes™ client serves as a desktop user interface for different end-user applications. In addition, the basic infrastructure for coordinating, tracking and managing business processes, and sharing data in a distributed environment is provided by Lotus Notes™. Lotus Notes™ can support the end user in receiving work in the form of a document, and acting on it. It can automate the steps in a work process and perform the routing to the next step. Notes is suitable for a variety of workflow applications. Typical workflow applications include inquiry tracking at help desks, bug tracking, and travel authorisation request applications (Pyle, 1994).

The workflow engine is the most important component in the workflow model. The major processes in the workflow engine subsystem can be illustrated by the following algorithmic description. As Lotus Notes™ is an event-driven system, the major purpose of the workflow engine is to handle the events that are triggered by the users. For an easier description, the whole system is divided into different parts according to the events that are handled:

- the 'PostOpen' event, which will be triggered when the document is opened
- the 'Send' event, which will be triggered when the user clicks the 'Send' button
- the 'Approve' event, which will be triggered when the user clicks the 'Approve' button
- the 'Reject' event, which will be triggered when the user clicks the 'Reject' button
- the 'Handle Finish Action' event, which will be triggered when the workflow is finished.

The first event is the 'PostOpen,' which will be triggered when the document is opened (see Algorithm 1 in Figure 3). The goal of this action is to find the workflow setting record and fill in the workflow setting parameters into the current workflow document.

Figure 3 PostOpen algorithm

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Algorithm 1:
Begin
Step 1: Find the corresponding workflow setting record
      find the user's workflow setting record associated with this document
      find the default workflow setting record associated with this document
      If the user's workflow setting record is found,
        compare the modified date of the record
        If the user's setting is more up-to-date than the default setting record
          WFDoc: = user's setting record
        Else
          WFDoc: = default setting record
      Else
        WFDoc: = default setting record

Step 2: Fill in the workflow setting in the corresponding field
      For each approver in the WFDoc
        fill in the parameters in the corresponding field
End

```

The second event is 'Send,' which will be triggered when the user clicks the 'Send' button (see Algorithm 2 in Figure 4). After the user has finished the current work step, the workflow document will be sent to the approvers in the order defined in the corresponding workflow setting record.

Figure 4 Send algorithm

```

Algorithm 2:
Begin
Step 1: Check if the required approver's name is already filled in
      For each approver
        If the approver's name is not defined
          display a warning message
          break the action
Step 2: Determine the next approver
      If the routing path is sequential
        determine the next approver name
        IF the approver name is a group name
          Send a reminder to all of the group members
          record the group members' user name on the list of approvers
        Else
          send a reminder to the approver
          record the approver's user name on the list of approvers
        Else
          For each approver
            If the approver name is a group name
              send a reminder to all of the group members
              add the group members' user name to the list of approvers
            Else
              send a reminder to the approver
              add the approver's user name to the list of approvers
Step 3: Save the user's workflow setting
      If the user's workflow setting record is found
        update the existing user workflow setting record
      Else
        create a new user workflow setting record
        save the current workflow setting to the user workflow setting record
End

```

The third event is 'Approve', which will be triggered when the user selects the 'Approve' functionality (see Algorithm 3 in Figure 5).

Figure 5 Approve algorithm

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Algorithm 3:
Begin
Step 1: Fill in the approving information
    record the approving time
    inset the approver's signature image into the corresponding field
    send an approving message to the applicant
Step 2: Handle the next approver
    If the routing path is sequential
        determine the next approver
        If the approver's name is a group name
            send a remind message to the group members
            record the group members' user name on the list of approvers
        Else
            send a reminder to the approver
            record the approver's user name on the list of approvers
    Else
        remove the current approver's user name from the list of approvers
Step 3: Handle the workflow finish action
    If the flow is finished
        send an approved message to the applicant
        set the status of the workflow document to finished
        trigger the "Handle Finish Action" event
End
    
```

The fourth event is 'Reject', which will be triggered when the user selects the 'Reject' functionality (see Algorithm 4 in Figure 6).

Figure 6 Reject algorithm

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Algorithm 4:
Begin
    set the status of the current workflow document to "rejected"
    record the reject time
    restore all of the approvers' approving status to initial
    remove all of the approvers' user names from the list of approvers
    send a reject message to the applicant
End
    
```

The final event is the 'Handle Finish Action,' which will be triggered when the workflow is finished (see Algorithm 5 in Figure 7). The goal of this action is to trigger another work step that is defined in the workflow setting record.

Figure 7 Handling the Finish Action algorithm

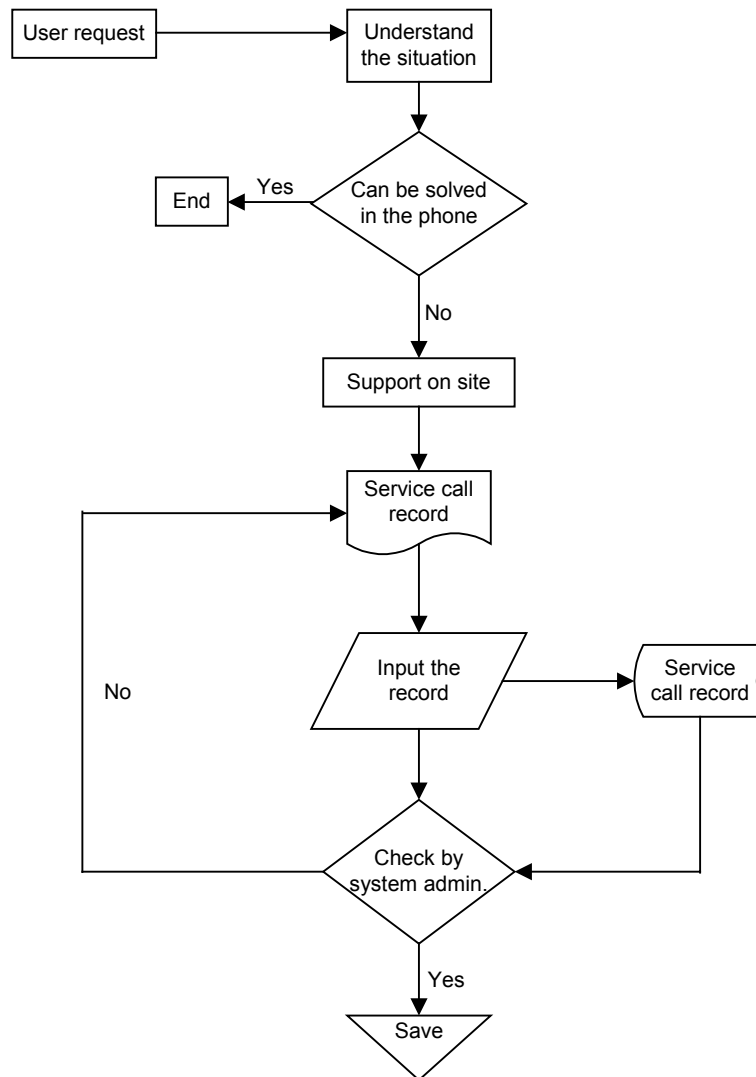
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Algorithm 5:
Begin
    get the definition from the default workflow setting record
    If another work step needs to be triggered
        If it is the condition routing
            If the field value in the current workflow document meets the condition
                create the workflow document defined in the "True" statement
                send a reminder to the users defined in the "True" statement
                record the user names in the list of participants
                initial the workflow parameters
            Else
                create the workflow document defined in the "false" statement
                send the reminder to the users defined in the "false" statement
                record the user names on the list of participants
                initial the workflow parameters
        Else
            create the workflow document defined in the "True" statement
            send the reminder to the users defined in the "True" statement
            record the user names on the list of participants
            initial the workflow parameters
End
    
```

4.3 An example of using WFMS in the case study

In this section, a real-life workflow process, ‘System Maintaining and User Support Workflow’, will be discussed. It is a kind of back-end process mentioned in Figure 1. Before using the workflow automation process, the conventional workflow process is shown in Figure 8.

Figure 8 System maintenance and user support workflow



This conventional workflow process has some drawbacks. One of the disadvantages is that there must be someone to pick up the phone to receive the user’s request. Another disadvantage is that when the system support team member finishes the job on site, he must return to the EDP department in order to serve another request. This is

time-consuming because there are more than 400 users residing in 12 floors inside the building. After the system support team member has finished the job, he/she also needs to record the service details into the computer for further reference. After the implementation of WFMS, the performance of the process is changed as follows.

Step 1

When the users need help, they can open the shared workflow centre database and create the service request record. The view of the system support application acts as the work list that shows all of the jobs in ascending order according to the time they were created. Users can type in their request with a short description of the problem they are facing or simply leave a voice message using the microphone. After saving and closing the document, the document appears in the work list.

Step 2

As this work list can be seen from all of the computers, everyone is clear about his/her request status, such as how long it will be before they will be served. Moreover, the system support team member does not need to go back to the EDP department. He/she only needs to open the first request record from one of the computers when he/she is ready for another job.

When the system support team member has finished the job, he/she needs to fill in some additional information in the user's request record about the service and then send it to the system administrator to be checked. After the job has been finished and its status sent to the system administrator, the request record will disappear from the list of support work. The system support team member can begin another job by opening the next record in the work list.

Step 3

The system administrator will receive a message to inform him/her that there is a request record that needs to be checked. The mail contains the location of the service call record, and also a 'doalink' to the record. The system administrator can click the doalink to open the record for checking. Dependent on the correctness of the support's service details, the system administrator can end this process or enter the comments to inform the support team member about the problems with the service. While there are mistakes in the service call, the system support team member can review the administrator's comments and then resend the record to the administrator for a reexamination.

By using the WFMS, the efficiency of this process can be improved. The number of phone calls will be greatly reduced and the users will be more satisfied because they know the status of their request. Another significant advantage is that the related information can be accessed with the touch of a button. The user's information and the system's configuration record can be a great help to members of the system support team in determining the problems.

4.4 Evaluation of the workflow automation application

In this study, 352 people in the organisation had Lotus Notes™ in their desktops. In order to understand the implications of implementing Lotus Notes™ as the WFMS, the respondents were asked to complete scales on the degree of collaboration and the impact of Lotus Notes™ to both individuals and organisations. The survey was to understand the nature and extent of collaboration as well as such outcome variables as efficiency, effectiveness, and satisfaction.

Out of 100 questionnaires issued, 68 were completed and returned, representing a response rate of 68%. Of the 68 respondents, 36.8% had more than six years of experience in using computer, 17.6% between three and six years, 33.8% between one and three years, and the remainder (11.8%) less than one year. Most (58.8%) had worked in the company for more than six years. Of these, 58.8% were clerical workers and 29.4% were supervisors. Most (55.9%) were between 31 and 40 years of age.

There are several ways to determine the level of collaboration in the organisation. The degree of interdependence and information exchange can be combined to determine the degree and nature of collaboration. More than half of the respondents gave a positive answer in this section: 40 of them (58.8%) needed assistance from other people and 48 (70.6%) needed information from other departments. That means that there is a high degree of collaboration in the organisation.

From the information summarised in Table 1, it can be seen that more than 45 respondents (66.2%) agreed or even strongly agreed (7.4%) that Lotus Notes™ could enhance communications with others. Fifty-eight (85.2%) felt that they were accomplishing tasks more quickly. Fifty-five (80.9%) agreed that using Lotus Notes™ could improve their job performance. Forty-seven (69.1%) agreed that using Lotus Notes™ could enhance the quality of the job result. Fifty-four (79.4%) of the respondents agreed that it was useful for the job, and the average rating was 3.85.

Table 1 The summary of the responses

	Number of respondents					Mean	S.D.
	5	4	3	2	1		
Degree of collaboration							
Need assistance from people in other departments	5	35	22	3	3	3.53	0.87
Need information from other departments	5	43	18	0	2	3.72	0.73
Need to provide information to people in other departments	0	38	28	0	2	3.50	0.66
Need to assist people in other departments	0	38	28	0	2	3.50	0.66
A lot of documents are exchanged with other departments	0	30	32	3	3	3.31	0.76
Individual impact							
Enhances communication with others	5	45	15	0	3	3.72	0.79
Accomplishes tasks more quickly	3	55	8	2	0	3.87	0.52
Improves the performance of the job	3	52	13	0	0	3.85	0.47
Enhances the quality of the job result	0	47	20	0	1	3.66	0.56
Overall, is useful for the job	4	50	14	0	0	3.85	0.50

Table 1 The summary of the responses (continued)

	<i>Number of respondents</i>					<i>Mean</i>	<i>S.D.</i>
	<i>5</i>	<i>4</i>	<i>3</i>	<i>2</i>	<i>1</i>		
Organisational impact							
Enhances the management of the organization	5	37	25	1	0	3.68	0.63
Improves the organisation's efficiency	8	52	8	0	0	4.00	0.49
Enhances the ability to make decisions	3	37	20	5	3	3.47	0.87
Enables the organisation to be more competitive	10	40	17	0	1	3.85	0.72
Enables the organisation to react more quickly to changes in the market	8	45	12	0	3	3.81	0.82
Overall, is useful for the organisation	13	42	13	0	0	4.00	0.61
Usability of Lotus Notes TM							
Very easy to use	0	28	40	0	0	3.61	0.50
Very easy to learn	0	30	38	0	0	3.64	0.50
The online help provided is adequate	0	30	35	3	0	3.60	0.58
Has a friendly user interface	5	28	32	3	0	3.71	0.70

Notes: 5 – strongly agree; 4 – agree; 3 – natural; 2 – disagree; 1 – strongly disagree

For the use of a WFMS in the organisation, the users gave an average rating of 4.0. This shows that most believed that the implementation of WFMS technologies in an organisation is useful for the organisation. Sixty (88.2%) of them believed that the WFMS could improve the organisation's efficiency and none of them claimed that the WFMS was useless for the organisation overall.

The survey shows that more than half claimed that the system was easy to use. This survey study was limited by time and resource constraints. The size of the sample for each sector was relatively small. Therefore, the generalisations of the result might not be applicable to another sector. However, based on the above analyses of the data, it was found that most people were very supportive of the WFMS technology and believed it would improve the overall performance of both individuals and the organisation.

The survey shows that users have trouble with the sharing of information. As WFMS is an efficient way of managing and exchanging information, communication will be more effective. By implementing a WFMS, a paperless office can perhaps be achieved one day. Paper will no longer act as the carrier of information, and all of the information and workflow processes will be managed by the WFMS in a much more effective and efficient way. However, the WFMS is still a relatively 'new' technology. There is a long way to go in terms of understanding the power of these tools and how to use them.

5 Conclusion and recommendation

The WFMS is a technology that can automate workflows and manage information across organisational boundaries and dramatically improve the productivity of organisations. This is essential to the implementation of e-commerce processes. A thorough understanding of the work process within an organisation is essential before

implementing the WFMS. It is necessary to consider issues such as the way business is organised, the skills of the staff, the existing computer hardware, software, and network infrastructure. WFMS is not an end itself. It is not as simple as installing a spreadsheet software package. Rather, its adoption may involve significant changes in working practices and organisational structures. It also needs to be associated with business process reengineering, which can provide a solid understanding of business services to determine workflow automation needs (Abbott and Sarin, 1994).

In order to achieve success, people can use the new technology in an appropriate manner to support their working environment and work relationships. A training session should be provided to all levels of staff in the organisation. A WFMS is quite different from other software tools with which members of an organisation are familiar. Instructing new users in the operation of the workflow automation application will not be adequate. WFMS technology represents a new way of performing tasks in a business organisation. With a WFMS, the ways in which people do their jobs in an office are changed. The training should develop a new framework for understanding the technology and its potential.

The WFMS will, no doubt, develop to be an important technology for office automation. WFMS technology presents the opportunity to fundamentally change the way business is done, especially e-commerce. However, without an appropriate framework for understanding the technology and for fitting the premise of the technology into the organisation's structure, culture, and policies, the impact of WFMSs will be quite limited. Business processes are at the centre of every e-commerce operation. Thus, the WFMS should be at the heart of any e-commerce solution. They are designed to provide the required performance and to be scalable, reliable, and highly available to maintain the requirements of e-commerce applications. WFMSs allow for incremental and controlled processes for automation. Typically, when they are first introduced to the business world, they are only used to schedule and monitor the working steps, but the process is still carried out using the same, old technology (*e.g.*, e-mail). Consequently, the different steps in the process can be gradually automated, possibly by implementing the interaction with external systems. Once a process has been designed and automated, it can be measured and incrementally improved.

There is still room to enhance the workflow model developed in this research. Most of the WFMSs, such as Lotus NotesTM and ExchangeTM, lack the mechanism to separate the predefined process flow from the application tasks. Because processes evolve, business rules change, and the role assignments may also change, an essential requirement of WFMS is to allow flexibility in configuring process logic without having to modify the application tasks, which are complex and expensive to change. One of the enhancements is to develop a graphical workflow map interface. Although the model developed in this project provides the mechanism for separating the process flow definition from the application tasks, users should feel that it is more convenient to use the workflow map to specify the business roles, rules, and routings that are essential for the automation of a business process. Another direction can focus on providing the functions to take the cost statistics for each process, and provide a way of measuring the workload and throughput of a business process that is not present in the workflow model. With those capabilities, the subsequent changes can be incorporated into the procedural rules that define the business process, allowing for better management and planning of the workflow.

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