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EXPERIENCES WITH IMPLEMENTING WORKFLOW ENGINE IN THE PUBLIC SECTOR: AN EXPLORATORY STUDY

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Abstract

This paper examines the development and implementation process of workflow engine in the context of Government e-business system (GeBIZ), an electronic procurement system. This study does not represent the overall picture of building a workflow engine, but it helps to highlight the issues and problems both of technical and organizational nature encountered during the development and after the implementation of workflow engine. Based on lessons learned, we have found that implementation of workflow system in a Government context is rather complex and different from that of a private organization. In particular, five challenges were identified from this study: (1) workflow engine failure problems (2) workflow performance monitoring (3) work process variation (4) user resistance to work processes (5) enhancements in workflow system.

Keywords: E-government; workflow engine implementation in e-procurement system; case study

Introduction

In a recent paper, which focuses on BPR in public sector, Thong et al. (2000) argue that the public administration literature recognizes that private and public organizations are not homogenous. Between them, there are critical environmental and organizational differences (Bozeman 1988; Bozeman et. 1986; Bretschneider, 1990; Bretschneider et. 1993; Coursey et. 1990; Rainey, 1976: 247). According to Robertson et al., (1995: 247), there are some unique factors which play important role in public sector, "Unique characteristics include the absence of market incentives; the existence of multiple conflicting goals; and a political context with a broader range of constituent groups, higher levels of accountability, and more rules, regulations and constraints". In order to shed some lights into the development and implementation of e-business initiatives in the public sector, this study examines a workflow engine developed by System Computer Organization (SCO), I.T arm of Ministry of Defense (MINDEF) in alliance with Anderson Consultants. The workflow was applied as part of the Government Electronic Business (GeBIZ) e-procurement system implemented by SCO. Thus, this study will assist project managers in public sector on problems they may face in the deployment of workflow engine in the context of government based an e-procurement system. Further this study does not represent the overall picture of building a workflow engine, but it helps to bring out a number of complex issues and problems both technical and non-technical in nature. This article reports a case study of a workflow engine developed and implemented in the context of GeBIZ e-procurement system by Singapore government.

Literature Review

Ames et al. (1997) define workflow as being about making a plan and putting into motion. One of the objectives of workflow engine's design is to improve an organization's performance in doing planned work. Further it minimizes errors and delay in the progress of a plan instance, enabling users to know the current status of any instance of any plan at any time and allowing users to analyze plan completion history to aid in improving the plans. The aim of a "plan" is to define a guideline describing how certain work is to be done in an organization. "Processes" are models of these plans, and a "procedure" is a template of a process-ready to run in workflow system. The engine is designed to facilitate process participation, process management and process engineering (p.215). The importance and purpose of workflow system has been well established in workflow literature. Abbott et al. (1994) noted the importance of workflow as workflow management is a technology that is considered strategically important

by many businesses, and its market growth shows no signs of abating. It is however, often viewed with skepticism by the research community, conjuring up visions of oppressed workers performing rigidly defined tasks on an assembly line. In the earlier studies writers have focused on different nature of workflow problems and issues. Aalst et al. (1999) and Casati (1998) reported that, "Today's workflow management systems also have problems dealing with both ad-hoc changes and evolutionary changes". Likewise, Wil M.P et al. (1999, Pg. 669) found, "Workflow management systems are not used to support dynamically changing workflow processes or the workflow process is supported in the rigid manner, i.e. changes are not allowed or handled outside of the workflow management system." In the same way Wil M.P et al. (1999, Pg. 669) identified another workflow problem: "Today's workflow management systems are able to support workflows inside one organization but have problems dealing with workflow crossing organizational boundaries". In addition, some of the workflow challenges have been reflected in a variety of studies. Abbott et al. (1994, Pg. 116) reported that a major challenge for workflow management systems is to make use of process descriptions during enactment of a process. This requires that the runtime workflow "engine" be capable of accommodating the variety of behaviors that occur when performing the task. Another issue discussed by Abbot et al. (1994, Pg.113) in his article is that, "Workflow management can instead be used to help individuals manage their work and provide a clear context for performing that work. A key challenge in the realization of this ideal is the reconciliation of workflow process models and software's with the rich variety of activities and behaviors that comprise 'real' work". Furthermore, Weiske et al. (1999) reported some of the issues and problems encountered in real workflow projects, such as development of interface between workflow management system and applications, performance problems (in case of large number of users & workflow cases), integration problems and selection of workflow system at a very early project state. Correspondingly, some of the previous studies on workflow discussed workflow processes architectures (such as case transfer architecture & loosely coupled architecture) for supporting inter-organizational workflows and identified criteria to select a suitable architecture (Wil M.P et al. 1999). Moreover, Weiske et al. (1999) in their article "A Reference Model For Workflow Application Development Processes" reported a reference model for workflow application development processes that provides a guidance to project managers and developers to develop a reliable workflow application. Some studies have been conducted to explore the issues faced in the deployment of commercial workflow systems in the private sector, but no studies have been conducted to explore the workflow implementation issues and challenges in the government sector. The contribution of this study is to highlight challenges and issues encountered in developing and implementing a workflow engine in the context of a government based e-procurement system.

Methodology

We have adopted single case study methodology. Our research is qualitative in orientation, exploratory in approach and interpretative in nature. Qualitative research, as portrayed by a range of diverse mini-cases, is very appropriate to acquire the contextual richness and complexities of the investigated systems (Bensbat et al., 1987; Yin, 1994). We have used qualitative and retrospective approach to analyze the data (Eisenhardt 1989; Miles and Huberman, 1984, Pettigrew, 1990; Staruss and Corbin, 1990, Yin 1989) because of the exploratory nature of the study and small number of interviewees (only ten managers) responsible for providing responses. Qualitative approaches are useful for contextual or descriptive research, in which basic questions relate to "What's going on here?" (Weingand, 1993).

Data Collection

The data collection began in the spring of 2000. For the purpose of this investigation data collection was performed through a series of in-depth semi-structured interviews with open-ended questions based on a when, what, how and why approach. Primary research entailed a total of some fifteen hours of interviews. The interviews ranged in duration from approximately one hour to two hours. Interviews were taped and tapes transcribed for analysis. The main fieldwork was conducted on-site at the GeBIZ Center and interviews were carried out with knowledgeable managers, [Huber and Power, 1985] software engineers and database administrators. Informants were encouraged to express their opinions in their own terminology and experiences. The study reported here sought answers to the following research questions:

- (1) What technical and non-technical challenges did the GeBIZ team face during the development phase of the workflow engine?
- (2) What problems did the GeBIZ team experience during the post-implementation phase of the workflow engine?
- (3) How did the GeBIZ team tackle challenges and problems relevant to the workflow engine?

Data Analysis

In the case of our study, the data collection is performed through interviews, on-site observation and documentation. Data analysis is performed systematically based on concepts of open coding, axial coding and selective coding (Strauss and Corbin, 1990). The iteration between data and concepts helped the researchers not only generate categories and sub-categories, but also identify

potential links between categories. The five constructs (workflow engine failure problems, workflow performance monitoring, work process variation, user resistance to work processes and enhancements in workflow system) emerged from open coding, a technique of categorizing data; the processes emerged from axial coding, a technique that links the constructs. Analysis continued until no further concepts emerged. Drawing on the analytical technique proposed by Miles and Huberman (1984), patterns that were unique to the case study were identified through matrix displays. Such pattern-matching processes enabled the researchers to enhance the internal validity of the research findings (Yin 1989). The qualitative approach facilitated an analysis of different informants' interpretations of organizational practices and their activities around it. In particular, data was first separated into groups depending on whether they reflected statements or the actions of management, users and software engineers. Then, for each of these groups, interview transcripts and field notes were examined to identify statements or actions that reflected assumptions, knowledge of the system and its implications for work and the organization's operations as a whole.

The Development and Implementation of Workflow Engine in the Context of GeBIZ, an E-Procurement System: A Case Study

The System computer organization (SCO), I.T arm of Ministry of Defense (MINDEF), in alliance with Anderson Consultants started development of workflow engine in November 1999 and implemented it in April 2000. During the development of GeBIZ system, the GeBIZ team started to search for a workflow engine, in order to achieve the concept of procurement based inter-organizational workflow within GeBIZ system (e-procurement system). In this regard, the GeBIZ team contacted a few vendors to judge the appropriateness of the workflow engine. According to one of the project managers, "In June 1999 we began our search for commercial workflow engines. We looked at a few products. The most promising one was Fujitsu (J-flow). It's a workflow engine which can route documents to different mailing systems including Lotus notes, Microsoft exchange mail etc, for the approval of procurement based documents. This workflow engine was offering both parallel and sequential routing features. But Fujitsu was charging us very high and was not ready to deliver us the source code of the workflow engine, which was one of our major requirements. Finally the GeBIZ team contacted IBM for another workflow engine (IBM MQSeries) that was unfortunately more expensive than Fujitsu". Keeping in view the high cost factor of workflow engines (Fujitsu and IBM), Project manager GeBIZ administration proposed in-house development of the workflow engine in alliance with Anderson Consultants. Before development of the workflow engine, workflow requirement study began. During the workflow requirement study, the GeBIZ team made a series of decisions pertaining to streamlining the methods of approving procurement-based documents. As one of the informants commented, "In the current practice, the required number of approval by officers is different from one ministry to another. This has implications for how an approval process is designed and managed within the system. In particular, traditional methods of approving procurement-based documents must be streamlined. More process innovation is needed so that all institutions could adopt one single approach for approving (procurement) documents in order to provide efficiency to the procurement process." Considering workflow requirements of procuring institution's users, the GeBIZ team decided to adopt sequential routing approach and re-routing feature, allowing procuring users to send procurement-based document to other approving officers in the absence of any one of the approving officers. Furthermore, the GeBIZ team also introduced web based approval feature for the users of procuring institutions, to make the procurement process more user friendly. As such, it gives procuring institution's users more freedom to exchange their procurement-based documents without restricting them to the specific e-mail applications (Lotus Notes or Microsoft Exchange Mail). Another decision was to acquire a product (Lotus Enterprise Integrator), which allows storage of approved and rejected procurement-based documents in workflow databases. This will allow higher authorities to view the status of the approved and rejected procurement based documents with reasons, in the form of a report.

Workflow Engine Post Implementation Phase

After the implementation of the workflow engine, several technical and non-technical problems surfaced. One of the problems was relevant to the very success or failure of the workflow engine. As described by the project manger GeBIZ administration, "In one instance the workflow engine failed. As a result, the whole procurement process was stopped and users were unable to route procurement-based documents. Our web logic server got unstable and it ran out of the memory and caused the problem. We re-started the server to resume the workflow process again." As a result of the workflow engine failures, users of procuring institutions complained to the GeBIZ team about the unsuccessful delivery of procurement-based documents. One informant recalled, "On one occasion a user complained to us that, he had submitted a particular purchase request sometime ago and that it was still pending and his approving officer didn't receive the purchase request/P.O/ITQ etc yet. Then we studied that problem, resolving it successfully by un-suspending the suspended case." Moreover, the cases (workflow instances) are mostly suspended due to human errors and technical problems but there are several other factors that are responsible for the suspension of cases. As project manger GeBIZ administration elaborated, "There are a few reasons due to which cases are suspended, one of the common reasons being that user types recipient's e-mail address incorrectly or the e-mail application is configured incorrectly at the user's end. Another reason is, sometimes the server runs out of memory and third reason is oracle replication problem.

Sometimes replication fails terribly and that causes data loss.” Therefore, to overcome workflow problems and to deal with suspended cases, one of the challenges for the GeBIZ team was to introduce a diagnostic feature in the form of a web page, which enables the help desk monitor the workflow related problems (suspended cases). Further, in order to rectify problems related to workflow, the helpdesk had to re-trigger the suspended cases. Finally, the GeBIZ team also introduced work re-assignment module to prevent “knowledge loss” in case any procuring officer/user resigns from the procuring agency. According to one of the Project Managers, “At each ministry, the procuring users have ownership of particular procurement based documents. For example, if the procuring user or officer ‘A’ raised purchase requests and then he decides to leave the organization, the superior of that user has the authority to change the ownership of the documents to another person. So the concerned superior goes into the work re-assignment module and changes the ownership of the documents and assigns ownership of documents to the other individual.”

Case Analysis

Based on our findings, we have highlighted some of the problems and challenges, which are extracted from the experiences of the GeBIZ team in implementing workflow engine in the public sector.

Workflow Engine Failure Problem

After the implementation of the workflow engine, several problems were encountered. When the workflow engine stops, the procurement flow will be affected and the users cannot exchange procurement-based documents, such as purchase request/ITQ/purchase order etc. As a result of this failure, the GeBIZ team often face angry suppliers and depressed procuring users (Wil et al., 1999: 659). A number of causes have been found responsible for the failure of the workflow engine. One of the simpler reasons being that sometimes the web server would “hang”. This problem is normally resolved by restarting the web server. The second cause of this failure could be inappropriate interfaces between the workflow system and the GeBIZ system. We concluded that this particular problem was probably due to the GeBIZ teams relative inexperience in using application program interface (API) for providing the interface for the GeBIZ system with the workflow engine. The third possible cause of workflow engine failure is due to the Oracle replication (which allows to transfer data from partner to enterprise databases and vice versa) problem. One of the reasons we have found responsible for the replication failure is the network problem, because two components (enterprise and partner) of e-procurement system reside on two different networks because of security reasons. Therefore, if replication fails half way due to network failure then data integrity will be lost. If data integrity is lost then workflow process is affected seriously. As a result, users and suppliers will be unable to access procurement based documents (workflow depends upon the integrity of data). In order to overcome replication problem the GeBIZ team normally re-runs the replication job to resume the workflow process. If any complicated workflow problem arises, the GeBIZ team troubleshoots such problems themselves or with the help of consultants. To overcome network related problems and to avoid replication failure, the GeBIZ team in alliance with Infocomm Development Authority (IDA), who are the network infrastructure providers, must streamline their networks. Furthermore, the GeBIZ team introduced a workflow diagnostic web page in order to improve the workflow process.

Workflow Performance Monitoring

The techniques the GeBIZ team used in administration and monitoring the workflow and in dealing with suspended cases (Wil et al., 1999) are also worth discussing here. As indicated, the GeBIZ team has introduced a workflow diagnostic web page that keeps helpdesk informed about workflow related problems. One of the most frequent problems noticed is when a recipient’s (approving officer) e-mail address is keyed in wrongly by the sender (procuring user), it results in case (workflow instances) suspension. The workflow diagnostic feature will allow helpdesk view the suspended cases and re-trigger the suspended cases by referring the workflow diagnostic web page. In this regard, we have discovered that the diagnostic feature provides the GeBIZ team an opportunity to learn from the problems and such an approach could also help them improve the workflow processes by adopting more advanced techniques to avoid future workflow related problems.

Work Processes Variation

In addition, to technical challenges we have also discovered some non-technical challenges in the context of workflow processes. One of the problems is related to the different methods of approving procurement-based documents at each ministry. This problem is a major hindrance to the successful deployment of GeBIZ in all (150) ministries and statutory boards. In this regard we suggest that policy makers must streamline the procurement process of all ministries or procuring institutions by allowing them to adopt one single approach for approving procurement based documents. Our findings are similar to Swenson et al., (1995, Pg. 27). According to them “there is a built in assumption that the optimal process for one organization is not necessarily optimal for a

different organization. Workflow engine that incorporated into their design, the assumption is that different groups may have slightly different processes to reach the same goal will allow greater organizational performance". Consequently, after the implementation of workflow engine, procuring users offered some resistance to the change.

User Resistance to Work Processes

One of the reasons for this resistance we have found is that users of different ministries were comparing their existing in-house procurement-based systems workflow processes with the workflow processes offered by the GeBIZ system. In fact, normal practice is that, if any department raises a purchase request, the ministry's in-house procurement system would automatically route the purchase request to the concerned approving officer for the approval. Therefore, it is not necessary to tell the system to which approving officer purchase request must be routed. On the contrary, workflow process offered by GeBIZ system is different in a way that, the procuring user is restricted in selecting the approving officer as to whom he wants to route the purchase request etc for the approval. In this case, we observed that users feel such a practice as an additional task and a waste of time. One of the reasons for this restriction, we have discovered, is that the GeBIZ is not meant for only one single ministry, as compared to previous individual in-house procurement systems. Instead, it's an integrated web based e-procurement system that will fulfill the procurement needs of all (150) ministries.

According to our observation, this problem may be due to the user resistance and lack of coordination among policy makers, users and the project team. In order to overcome the differences between the two systems, we suggest that policy makers must coordinate closely with the project team and users of procuring institutions in order to formulate the effective workflow process relevant to the flow of procurement based documents among the participants of workflow. Moreover, we also suggest that to overcome user resistance, workflow-authoring tools may be used. Those tools will allow procuring users to graphically compose a workflow according to their needs, which can then be given to the workflow system for storage and activation (Ames et al. 1997).

Enhancements in Workflow System

Finally, we found that in order to improve the workflow system, the GeBIZ team introduced Lotus Enterprise Integrator (LEI) to facilitate the storage of approved/rejected procurement based documents by different approving officers along with the reasons of approval and rejection in workflow databases. Moreover, we found that by realizing the importance of procurement based documents' ownership problems at different ministries, the GeBIZ team handled the task of introducing work re-assignment module, allowing change of ownership of the procurement-based documents. For example, if a concerned procuring user resigns or leaves the organization, the system lets the senior officer reassign the responsibilities of the leaving user to a new user, who is taking charge, by using GeBIZ work re-assignment module. We have found this feature to be useful in keeping the procurement process flow in motion without causing any disruption, even if any concerned user responsible for procurement based activities resigns. This finding is similar to what Abbott et al., (1994, Pg. 117) had reported. According to them, "non-procedural behaviors typically represent action taken when handling 'exceptions' to the structured process representation. For example, reassigning work from one person (who is unexpectedly unable or unavailable to complete the work) to another person". Another challenge faced by the GeBIZ team was to introduce web based approval method for procuring users. This proved problematic as only a few procuring institutions were using Lotus Notes mail to route their procurement-based documents. Most of the other ministries were using Microsoft mail to route procurement-based documents. As a result, those not using Lotus Notes mail cannot use GeBIZ system to perform their procurement activities. Keeping in view this problem, the GeBIZ team introduced a web based approval feature, allowing approving officers to do approvals/rejections of procurement based documents without the restriction of a particular e-mail application. We observed that web based approval is a user-friendly method and a cheaper solution for ministries. Further, those are not using Lotus Notes mail will not need to replace their mailing system with Lotus Notes and they can save money from investing extra capital in the implementation of Lotus Notes system. Although most governments seem to have accepted the importance of Internet use in their daily activities, governments must understand that e-government goes further than that (automating some processes, especially in terms of information retrieval) and impacts every aspect of their organization, from workflows to technology to staffing. Therefore, in building a seamless on-line e-government, a common understanding and coordinating mechanism should be established. Particularly, it is important to consider developing policies to address issues such as the privacy of users, free speech and censorship, ownership of on-line information leading to procurement transactions, copyright, intellectual property, information pricing, and many other issues (Rose, 1995).

Conclusion

This paper examines the development and implementation process of a workflow engine in the context of Government e-business system (GeBIZ), an electronic procurement system. Based on lessons learned, we have found that implementation of workflow

system in a Government context is rather complex and different from that of private organizations. In particular, five challenges were identified from this study: (1) workflow engine failure problems (2) workflow performance monitoring (3) work process variation (4) user resistance to work processes (5) enhancements in workflow system. Finally, this study does not represent the overall picture of building a workflow engine, but it helps to highlight the issues and problems both technical and organizational nature, which were encountered during the development and after the implementation of workflow engine.

References

- Abbott R. Kenneth and Sarin K. Sunil; "Experiences with Workflow Management: Issues for the Next Generation", *Proceedings of the Conference on Computer Supported Cooperative Work*, 1994, Pages 113 -120
- Aalst van der W.M.P and Bansten T., H.M.V Verbeek, P.A.C Verkoulen, and M. Voorhoeve. "Adaptive workflow: an approach based on inheritance." In M.Ibrahim and B. Drabble, eds, *Proceedings of the IJCAI'99 Workshop on Intelligent Workflow and Process Management: The New Frontier for AI in business*, (1999), pp. 36-45, Stockholm, Sweden.
- Ames K. Charles, Burleigh C. Scott, Mitchell J, Stephen (1997), "A Web Based Enterprise Workflow System", *Proceedings of the International ACM SIGgroup Conference on Supporting Group Work: The Integration Challenge* , pp. 214-220.
- Benbasat, I., Goldstein, DK, and Mead, M. The Case Study Research Strategy in Studies of Information Systems, *MIS Quarterly*, (1987), 11.3
- Bozeman, B., and Bretschneider, S. "Public management information systems: theory and prescription," *Public Administration Review*, 46 (November 1986), 475-487.
- Bozeman, B., "Exploring the limits of public and private sectors: Sector boundaries as Maginot line." *Public Administration Review*, 48, 2 (1988), 672-674.
- Bretschneider, S. "Management information systems in public and private organizations: an empirical test." *Public Administration Review*, 50,5 (1990), 536-545.
- Bretschneider, S., and Wittmer, D. "Organizational adoption of microcomputer technology: the role of sector." *Information Systems Research*, 4, 1 (1993), 88-108.
- Cousey, D., and Bozeman, B. "Decision making in public and private organizations: a test of alternative concepts of "publicness." *Public Administration Review*, 50, 5 (1990), 525-535.
- Casati F. Ceri S, B. Pernici, and G. Pozzi. Workflow evolution. *Data and Knowledge Engineering*, 24(3): (1998), pp.211-238.
- Eisenhardt, K.M. "Building Theories from Case Study Research", *Academic Management Review*, 14, (1989), pp. 532-550
- Huber G. and D.J. Power. "Retrospective Reports of Strategic-level Managers: Guidelines for Increasing Theory Accuracy," *Strategic Management Journal*, 6 (2), (1985), pp.171-180.
- Miles M. and A.M. Huberman (1984). *Qualitative Data Analysis: A Sourcebook of New Methods* . Sage Thousand Oaks, CA.
- Pettigrew A.M., 'Longitudinal Field Research on Change: Theory and practice'. *Organization Science*, 1(3), 1990.
- Rainey, H.G.; Back off, R.W.; and Levine, C.H. "Comparing public and private organizations." *Public Administration Review*, 36, 2 (1976), pp.233-244.
- Robertson, P.J., and Seneviratene, S.J. "Outcomes of planned organizational change in the public sector: a meta-analytic comparison to the private sector." *Public Administration Review*, 55, 6 (1995), pp.547-558.
- Rose, L. "Netflow: Your Rights in the On-line World (Berkeley, CA: Osborne McGraw-Hill, 1995).
- Strauss A. and J. Corbin (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publication, London
- Swenson D. Keith, Irvin Kent, "Workflow Technology: Tradeoffs for Business Process Re-engineering," *Proceedings of the Conference on Organizational Computing Systems*, ACM press, Milpitas California, (1995), pp. 22-29.
- Thong Y.L. James, Yap Sing-Chee, and Seah Lee-Kin (2000). "Business Process Reengineering in the Public Sector: The Case of the Housing Development Board in Singapore." *Journal of Management Information Systems/Summer 2000*, Vol. 17, No. 1, pp. 245-270
- Weingand, D.E. (1993). Grounded theory and qualitative methodology, *IFLA Journal*, 19 (1), 17-26.
- Weske Mathias, Goesmann Thomas, Holten Roland, Streimer Rudiger (1999), "A Reference Model for Workflow Application Development Processes," *Proceedings of the International Joint Conference on Work Activities Coordination and Collaboration*, Pages 1 - 10
- Wil M.P. Vandlee Aalst. "Process-Oriented Architectures For Electronic Commerce & Interorganizational Workflow", *Information Systems* Vol.24, No. 8, (1999), pp. 639-671.
- Yin, R. *Case study research: Design and methods* (2nd ed.). Beverly Hills, CA: Sage Publishing., (1994).
- Yin, R. *Case Study Research: Design and Methods*. Sage. Beverly Hills, CA. (1989).