Towards the integration of enterprise software: The business manufacturing intelligence

Consoli, Domenico and Musso, Fabio

University of Urbino "Carlo Bo"

2010

TOWARDS THE INTEGRATION OF ENTERPRISE SOFTWARE: THE BUSINESS MANUFACTURING INTELLIGENCE*

Domenico Consoli, Fabio Musso

Department of Business Studies and Law , University of Urbino, 61029 Urbino, Italy

E-mail: domenico.consoli@uniurb.it, fabio.musso@uniurb.it

Abstract

Nowadays, the Information Communication Technology has pervaded literally the companies. In the company circulates an huge amount of information but too much information doesn't provide any added value. The overload of information exceeds individual processing capacity and slowdowns decision making operations. We must transform the enormous quantity of information in useful knowledge taking in consideration that information becomes obsolete quickly in condition of dynamic market. Companies process this information by specific software for managing, efficiently and effectively, the business processes. In this paper we analyse the myriad of acronyms of software that is used in enterprises with the changes that occurred over the time, from production to decision making until to convergence in an intelligent modular enterprise software, that we named Business Manufacturing Intelligence (BMI), that will manage and support the enterprise in the future.

Keywords: *business manufacturing intelligence, enterprise resource planning, business intelligence, management software, automation software, decision making software*

1. INTRODUCTION

To process business information, in different years, many software were used to support single activity of enterprise: management, production and decision making. With the advent of Enterprise Resource Planning (ERP) the application software crossed different business functions working for processes and leaving space for vertical applications like Business Intelligence (BI), Customer Relationship Management (CRM) and Computer Integrated Management (CIM). In the future there will be a modular software that will integrate and support the management of all enterprise area of business. We name this software Business Manufacturing Intelligence (BMI).

This paper is organized as follows: in the next section we describe information as an enterprise strategic asset. In the section 3 we illustrate, in detail, the myriad of acronyms of enterprise software. In section 4 we talk about Business Intelligence. The section 5 shows the utilization of a modular software, named BMI, that will manage, in the future, all enterpise processes. Finally some conclusions are drawn.

2. INFORMATION: ENTERPRISE STRATEGIC ASSET.

In the enterprise, information is a strategic resource (Caudle, 1996) like economic and financial assets. Information, like an other product, follows its assembly line: capture, classification, selection, summary, distribution. The value of information increases while we proceed in subsequent stages. Exchange value of information is linked to the form, space and time. This value increases and becomes a factor of success when satisfies the form (text, image, audio, video ...), the requirements demanded by users and when it is available everywhere (place) at any time. More the information is exclusive and higher is its value.

* This article is the result of a common research activity of the authors. Nevertheless, single sections can be attributed as follows: sections 3.1,3.2,5,6 are attributed to Domenico Consoli, sections 1,2,3.3,4 to Fabio Musso.

Nowadays we live in a society where people who want to have success must continually compete with its competitors, meet customer demand and gather, before the others, useful information for market opportunities.

The environment in which companies operate is complex and turbulent: instability of markets, global market, consumers increasingly demanding, more sophisticated products, dynamic and aggressive competition, dynamic costs and prices, technological innovation.

The information that circulates in company reduces uncertainty, costs and enriches products. Products and services are increasingly information-intensive. Nowadays, inside the enterprise, intangibles resources (brand, logo, reputation,..) are important. Even physical products is dematerializing and incorporating an high informative content. People don't have more interest in the physical phone but in all value-added services that revolve around it (ringtones, logos, wap). The after-sale, online assistance and various updates make more attractive the extended product (Kotler, 1988). This immaterial content is well integrated with the flow of business information and it is processed by intelligent techiniques of Knowledge Management (KM) that support strategic decisions (Choi and Lee, 2002). The system of Knowledge Management is integrated with the culture and business strategy and in particular with business processes (Alavi and Leider, 1999). KM manages all type of information: structured and unstructured. Enterprise Information System (EIS) currently processes only structured information that correspond to 20% of the information that circulate in the company; the remaining 80% is unstructured information (Tan, 1999). From the annual survey Teradata 2006, on a sample of about 1200 managers from 23 countries (56% from the Americas, 23% from Asia-Pacific and 21% from Europe, Middle East and Africa –EMEA-), 70% of interviewees who work in America and Asia-Pacific and 36% of interviewees of EMEA said that the use of unstructured data, can be an high competitive advantage to support decision and enterprise business.

3. ENTERPRISE SOFTWARE AND LITERATURE.

Nowadays the companies use many application software: Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Customer Relationship Management (CRM), Material Requirements Planning (MRP), Computer Integrated Manufacturing (CIM), Decision Support System (DSS), Business Intelligence (BI) (Hendricks et al., 2007). The enterprise software has evolved over time, from individual independent applications to a modular integrated structure. There are software that manage business processes or the productive line (manufacturing scheduling, logistic planning, distribution) and others focused in the area of decision support and decision making. In next sections we present a list of acronyms relative to specific software circulating, for several decades, in manufacturing and service companies.

3.1. Acronyms of Automation Software

The automation of the physical processes in the plant started with numerical control machines and subsequently with Flexible Manufacturing Systems (FMS) (Shafiee and Sundaram, 2004). In the field of automation there are many acronyms. We divide these acronyms in these three sectors: design, planning, production (Fig.1).

Design	
Computer Aided Design CAD	Computer Aided Manufacturing CAM
Computer Aided Inspection and Testing CAI e CAT	Computer Aided Engineering CAE
Automatically Programmed Tools APT	Cutter Location File CLF
Planning	
Bill Of Material BOM	Master Production Schedule MPS
Computer Aided Process Planning CAPP	Capacity Requirements Planning CRP
Manufacturing Planning and Control System MP&CS	Material Requirement Planning MRP
Manufacturing Resources Planning MRPII (II to distinguish from MRP).	Money Resource Planning MRP III
Enterprise Resource Planning ERP	Inventory Control IC
Make-to-stock/ Make-to-order MTS/MTO	Customer Order Decoupling Point CODP
Human Resource Management HRM	Value Chain Resource Planning VCRP / ERP II
Business Operations Management BOM	
Production	
Production Planning PP	Automated Materials Handling AMN
Open System Interconnection OSI	Manufacturing Message Specification MMS
Manufacturing Automation Protocol MAP	Business Process Redesign BPR
Standard for Exchange of Product Data STEP	Open Distributed Processing ODP
Product Data Management PDM	Open Distributed Processing ODP
Computer Numerical Control CNC	Numerical Control NC
Direct Numerical Control DNC	Cell Control System CCS
Flexible Manufacturing Systems FMS	Flexible Manifacturing Cell FMC
Modular Integrated Robotized System MIRS	Computer Integrated Manifacturing and Engineering CIM/CIME
Emerging Knowledge Processes EKP	Construction Management Process Reengineering CMPR
Team-based Human Resource Planning THRP	Automated Guided Vehicle AGV

Fig.1 Acronyms of Automation Software.

The first applications of computers in mechanical design was in the 60s in General Motors Corporation. The drastic reduction of the cost of microelectronics has enabled the rapid spread of this technology and the evolution to three-dimensional Computer Aided Design (CAD).

The diffusion of microprocessors (mid-70s) has facilitated the development of digital Computer Numerical Control (CNC) machines, Programmable Logic Controller (PLC) and Robot Control. All this has encouraged the development of technology Computer Aided Manufacturing (CAM) and Computer Aided Engineering (CAE). The CAE software supports the engineering aspect like design calculations, definition of methods, timing, cycles and business tools. All sequences in the processing cycle of a piece was recorded in a file by software Automatically Programmed Tools (APT) and then transmitted to CNC machines for processing and cutting (Zhao et al., 2002).

The master schedule was defined by Master Production Schedule (MPS) and supported by Computer Aided Process Planning (CAPP). The CAPP (Zhang et al., 2002) defined the specific production and represented a link between CAD and the productive process.

The software Material Requirement Planning (MRP) planned material requirements while the software Manufacturing Resource Planning (MRPII), in addition to the supply of materials, planned the use of resources involved in the production scheduling. Software Computer Aided Inspection and Testing (CAI & T) makes testing and computer checking. Using special sensors and instruments it is possible to collect feedback data on the product at any stage of the processing cycle or during the functional tests.

To fully automate the production chain many tools, hardware and software, are used: Robots, Flexible Manufacturing System (FMS), Computer Integrated Manufacturing and Engineering (CIM/CIME), Modular Integrated Robotized System (MIRS).

The flexible manufacturing system FMS has the ability to automatically create different products. It includes various elements like a central computer to manage the system, CNC machines, automated and programmable systems for storage, for management and movement of Automatically Guided Vehicle (AGV).

With the Computer Integrated Manufacturing (CIM) (Maw, 1995) (Nagalingam and Lin, 2008) the automation of the company, that combines all the business activities of planning, design, production, warehousing and sales, is realized. The information flow is automated from the arrival of an order and product design to the shipping of the finished product.

The automated factories Modular Integrated Robotized System (MIRS) (Pirelli, 2010) has revolutionized the technology and traditional methods of production. The new robotic process is based on the concept of mini-factories. In a robotized space of hundred square meters, the work of the robot, without interruption, covers the production cycle. With this technique we have the integrated management of online enterprise lifecycle, from purchasing to marketing, from research to design, from production to logistics. The program manages all stages of production: engineering, initial design, instructions generation of the production cycle, movements of robots, automatic supply of materials, quality control, handling of the finished product. All this allows to reduce the average time of transit of materials from some days of the traditional process to few hours of MIRS. The first automated factories that implemented the technique MIRS in Italy was Pirelli company. With this technology the company has managed the production of a tire every three minutes.

3.2 Acronyms of Management Software

The Fig. 2 shows acronyms of software that elaborate contents that circulate in enterprise.

Office Automation OA	Office Productivity Tools OPT
Business Application Tools BAT	Technical Scientific Application Tools TSAT
Job Specification Application Tools JSAT	Document Management DM
Integrated Information System IIS	Human Capital Management HM
Enterprise Wide System EWS	Corporate Information System CIS
Transaction Processing System TPS	Enterprise Application Integration EAI
Knowledge Management KM	Search Engine Marketing SEM
Strategic Enterprise Management SEM	Enterprise Content Management ECM
Business Process Reengineering BPR	Enterprise Performance Management EPM
Computer Supported Cooperative Work CSCW	Distribution Resource Planning DRP
Enterprise Resource Planning ERP	WorkFlow Management System WFMS
System Development Life Cycle SDLC	Direct Access Storage Device DASD
Collaborative Planning Forecasting CPFR	Enterprise Information Portal EIP
Supply Chain Management SCM	Customer Relationship Management CRM
Extended Enterprise Resource Planning EERP	

Fig. 2 – Acronyms of Management Software.

In the enterprises, there are different types of business content, from a generic document to complex report, that could reside in Internet, intranet or stand alone computer. The management of content, inside the companies, is named Enterprise Content Management (ECM).

In the management of the procedures of Office Automation, from simple spreadsheets as Visicalc we passed in advanced programs of Office Productivity Tools (OPT). The monomedia static document of past were overcome from a dynamic multimedia document, intelligent documents of second generation. We don't process a sequential text but a text that we can browse in a random way where spreadsheets, database, presentation slides are linked to websites. The text becomes hypermedia and allows the navigation and generation of personalized reading paths. The text becomes a document-centric multiplayer where everyone can express their reviews and make a cooperative workgroup. From single job we have passed to cooperative work where more people can work together during design and creation of documents.

The CSCW (Computer Supported Cooperative Work) (Liu et al., 2008) exploits the use of technologies to support teamwork. Nowadays the world is interconnected, people work in teams, collaborate on projects distributed around the globe. Groupware is a flexible and customizable software that supports and encourages teamwork, exploits the network infrastructure and facilitates the automation of document flows.

The Workflow Management System (WFMS) (Combi and Pozzi, 2004), were born in the 80s as trend of office systems and are integrated into processes that manage the entire production cycle of business documents, from creation to tracking revisions and dissemination through different units. Any event that happens within an administrative or productive process, it is recorded in a administered database. Through a system of roles assigning, we may assign the responsibilities of each part of work to people that live in different towns of worldwide. The different software modules are wedged like in an ordered assembly line and information distribution (R-Moreno et al., 2006).

The birth of ERP, in the 90s, allowed to organization to manage, synchronize and integrate business functions optimizing available resources. The ERP is primarily an organizational and managerial methods to optimize operational activities of a manufacturing company. ERP manages customized orders and integrates business cycle and all aspects of the business: planning, manufacturing, sales, finance, procurement, logistics and marketing. ERP working for processes has led organizations to re-engineering deeply business processes by Business Process Redesign (BPR) methodology (Cheng et al.,2006). The ERP allows the reduction of the cycle time and delivery and improves the response to customer needs (Celeste et al., 2001).

The software can be parameterized for adapting the company to enterprise business (Yongjean and Ki-Heung, 2001). The suite centralizes data management into a single database and creates a unique tool to monitor all business activities.

The first version of ERP connected directly the areas of management accounting with the area of logistics (warehouse and supply), subsequently other functions were implemented.

Since the 2000s, the major ERP vendors are beginning to create vertical and specialized software for different market sectors. The Extended ERP (EERP) controls the whole cycle from the provider (SCM) to end customer (CRM) (Plikynas, 2008).

3.3. Acronyms for decision making software

In the Fig. 3 we show a list of acronyms of software useful for decision making.

Management Information System MIS	Executive Information System EIS
Decision Support System DSS	Knowledge Based Export System KBES
Business Intelligence BI	Business Process Intelligence BPI
On-Line Analytical Processing OLAP	Business Activity Monitoring BAM
Process Performance Monitor BPM	Strategic Management Process SMB
DataMining DM	Text Mining TM

Fig. 3 – Acronyms of Decision Making Software.

In the 60s, the IT revolved around the creation of individual applications that perform specific operational tasks. In the mid-70s appeared on the market the first forms of Online Transaction Processing. In the 80s, the first Management Information System (MIS) is developed. In these years a software Extract Processing became popular to scan the entire database to satisfy operational transaction and informative requirements.

The Decision Support System (DSS) was born with the perspective to implement tools that can be used in decision making. On Line Analytical Processing (OLAP), term coined by Codd E.F. and associates (Codd et al., 1993) were based on dimensional analysis for decision-making policies and on concept of hypercube. Once the decision-making powers were confined to the upper levels of organizational hierarchy, but with the lean and networking organization, it have affected all levels of company.

In 1989 a new concept of Business Intelligence, introduced by Howard Dresner of Gartner Group, affirms in the enterprise context to describe a set methodologies useful for taking strategic decisions.

The Business Intelligence predict market trends and uses monitoring tools (dashboards) that measure business performance in terms of Key Performance Indicator (KPI) and Balanced Score Card (BSC) (Kaplan and Norton, 1992). The company is controlled and monitored in all its processes: from purchasing to sales, from production to warehouse, from suppliers to customers.

4. BUSINESS INTELLIGENCE

Business intelligence is a set of models, methods to gather, aggregate and analyse information to support enterprise strategic decisions. It is a process that transforms data and information in useful knowledge. The information can be analysed, in different level of detail, for any business function: marketing, production, finance, administration,...

Implementing a Business Intelligence project means to manage different business processes, create a common approach in the communication and share actions aligned with the corporate mission.

We can refer to business intelligence systems with the term Decision Support Systems (DSS) or with the term Business Performance Management (BPM) that represents a new generation of Business Intelligence (van der Aalst et al., 2007).

The data collected are properly prepared and are used to support the decisions of manager to generate estimates, hypothesize future scenarios and future strategies. The system of decision support is data-driven and the whole process feeds the data warehouse, special enterprise database where information, without redundancy, are aligned.

The Business Intelligence allows to users to exploit powerful features for reporting, monitoring and data analysis (KPI). Generally to monitor business performance we focus on key indicators such Key Performance Indicator, tables, graphs, trend lines, gauges, heat maps, etc.. The indicators for business performance can be controlled by appropriate business dashboards. The dashboard, or summary report, is the intuitive visualization of data to control certain parameters and monitor the performance. Executives, managers and business users can immediately have the health of organization through a variety of options for displaying data like to key indicators, metrics to reflect the critical success factors of an organization.

The software of Business Intelligence includes specific tools of Data and Text Mining. Data mining, also known as Knowledge Discovery in Databases (KDD), for extracting useful knowledge from a large amount of structured data, uses computational techniques derived from statistics and pattern recognition.

With the techniques of Text Mining (TM) (Berry and Castellanos, 2007), we can transform a large amount of textual documents into structured knowledge. From data apparently isolated and without meaning we can extract all the most relevant information and quickly identify significant correlations between specific entities. We can identify relationships between documents, independently of the format. The Text Mining (TM) uses techniques of statistics, natural language processing and semantic intelligence (SI) to index, categorize, extract, correlate the information asset.

Business Performance Management (BPM) (Wang and Liu, 2009) can be considered a new generation of Business Intelligence. BPM is a set of processes that helps organizations to optimize the performance of the business (Hendricks et al., 2007) with feedback loops. BPM involves consolidation of data from various sources, queries and data analysis in a context of planning and forecasting. BPM provides KPIs that help companies to measure the effectiveness of projects and resources comparing them with operational objectives.

5. FUTURE CHALLENGE: THE BMI SOFTWARE

We can classify business software (Fig. 4) in three main areas: Enterprise Management –EM- (accounting, employees, finance,..), Manufacturing Management –MM- (assembly line, robotics,

computer integrated management), Decision Support –DS- (decision making).

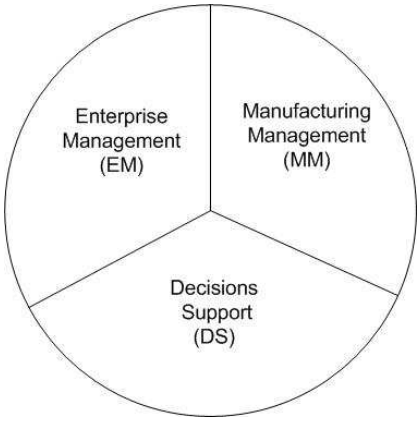

Fig. 4. Software classification

Currently, the evolution of the software (Fig. 5), allows us to group Enterprise Management (EM) and Decision Support (DS) in Business Intelligence (BI)

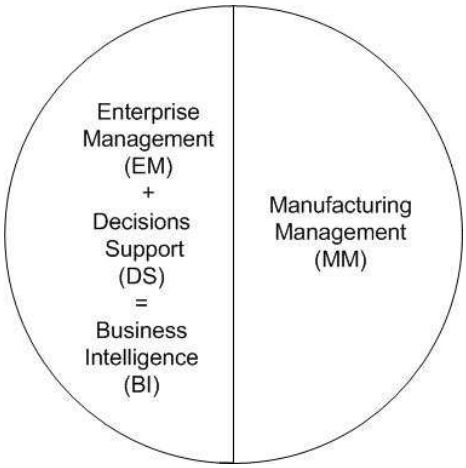

Fig. 5. Software aggregation

The next step is to incorporate different modules into a single software that we name BMI (Business Manufacturing Intelligence) (Fig. 6)

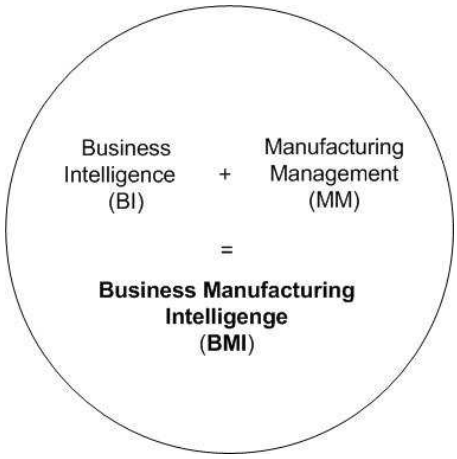

Fig. 6. Business Manufacturing Intelligence

The software Business Manufacturing Intelligence (BMI) takes the data from a single corporate database and provides valuable tools to manage the company and move working cells through numerical controls. It is a software that with a specific customizations (parameter setting) automates different manufacturing companies. This software fully integrate strategies for Knowledge Management, Business Process Reengineering, Business Intelligence and Control Manufacturing Management.

Therefore, we can consider the following classification of enterprise software (Tab. 1):

Period	**Software modules**
80s-90s	Management (ERP), Automation (CIM), Decisions Support (DSS, BI)
2000	Management/Decision Support (ERP/BI), Automation (CIM)
trend	Management/Automation /Decision (Business Manufacturing Intelligence -BMI-)

Tab.1. Enterprise software classification.

The BMI is a software that automate all business processes: administrative, manufacturing and decision making. The software will also include modules for Analysis and Business Intelligence to meet the growing need of information to monitor and govern business processes. BMI monitors the company and its performance and provide high scalability and flexibility in the management of new resources and processes.

6. CONCLUSIONS

About fifth years have passed from the first rudiments of computer information systems. Still now we are invaded by acronyms indicating a software with particular functions. The acronyms have been continuously multiplied until to combination in three big frameworks: ERP - CIM - DSS. The Business Intelligence (BI) can incorporate ERP and DSS modules and manage the business processes. Since everything must be calibrated to business it is clear that ERP modules are tailored and aligned to corporate strategic goals. The future step is the development of a software, in this paper, named BMI (Business Manufacturing Intelligence) that includes, in a modular structure, the three major areas (management-automation-decision). The software must collect data inside and outside of enterprise and merge, unify them into one big repository that feeds a framework for management-production-decision making and strategic plans. From this repository information, appropriately classified, sorted and filtered is ready to control production lines, manage and support decision making of all offices and enterprise departments.

REFERENCES

1. Alavi M., Leider D. (1999) Knowledge management systems: emerging views and practices from the field, System Sciences, HICSS-32 Proceedings of the 32nd Annual Hawaii

2. Berry, M. W., Castellanos, M., editors (2007). Survey of Text Mining II: Clustering, Classification, and Retrieval. Springer

3. Caudle S. L. (1996) Strategic information resources management: Fundamental practices. Government Information Quarterly, Volume: 13, Issue: 1, pp. 83-97

4. Celeste S. P.N., Gable G.G. & Chan T. (2001) A Client-Benefits Oriented Taxonomy Of ERP Maintenance, In Proceedings of the IEEE international Conference on Software Maintenance Icsm'01, November 2001 ICSM. IEEE Computer Society, Washington, DC, 528.

5. Cheng M-Y, Tsai M-H & Xiao Z-W (2006) Construction management process reengineering: Organizational human resource planning for multiple projects, Automation in Construction Volume: 15, Issue: 6, November, pp. 785-799

6. Choi B., Lee H. (2002) Knowledge management strategy and its link to knowledge creation process, Expert Systems with Applications Vol. 23, Issue 3, 1 October 2002, pp. 173-187

7. Codd E.F., Codd S.B., and Salley C.T. (1993), Providing OLAP (On-line Analytical Processing) to User-Analysts: An IT Mandate, Codd & Date Inc, San Jose

8. Combi, C. and Pozzi, G. 2004. Architectures for a temporal workflow management system. In Proceedings of the 2004 ACM Symposium on Applied Computing (Nicosia, Cyprus, March 14 - 17, 2004). SAC '04. ACM, New York, NY, 659-666

9. Hendricks K., Singhal V., Stratman J. (2007) The impact of enterprise systems on corporate performance: A study of ERP, SCM, and CRM system implementations, Journal of Operations Management, Volume: 25, Issue: 1, January, 2007, pp. 65-82

10. Kaplan R.S., Norton D.P. (1992) The Balanced Scorecard – Measures That Drive Performance, Harvard Business Review

11. Kotler P.(1998) Marketing Management: Analysis, Planning, Implementation and Control, Prentice-Hall, Englewood Cliffs, NJ

12. Liu, P., Laffey, J. M., and Cox, K. R. (2008) Operationalization of technology use and cooperation in CSCW. In Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work (San Diego, CA, USA, November 08 - 12, 2008). CSCW '08. ACM, New York, NY, 505-514

13. Maw Aardal (1995) A model of CIM, IEEWSEMI Advanced Semiconductor Manufacturing Conference

14. Nagalingam S. V., Lin G. C. (2008) CIM-still the solution for manufacturing industry. Robot. Comput.-Integr. Manuf. 24, 3 (Jun. 2008), 332-344

14. Pirelli web site, Pirelli Tire North America, 20/03/2010, http://www.us.pirelli.com/web/company/about-pirelli-tyre/pirelli-usa/default.page

15. Plikynas, D. 2008. Extended enterprise resource planning: conceptual approach using multiagent systems. In Proceedings of the 10th WSEAS international Conference on Automatic Control, Modelling & Simulation, World Scientific and Engineering Academy and Society (WSEAS), Stevens Point, Wisconsin, pp. 380-387

16. R-Moreno M.D., Borrajo D., Cesta A. & Oddi A. (2007) Integrating planning and scheduling in workflow domains, Expert Systems With Applications Volume: 33, Issue: 2, August 2007, pp. 389-406

17. Shafiei F., Sundaram D. (2004) Multi-enterprise collaborative enterprise resource planning and decision support systems, System Sciences, Proceedings of the 37th Annual Hawaii International

18. Tan A.H. (1999) Text mining: The State of the art and the challenges, Proceedings of the PAKDD 1999

19.Teradata (2006), Insights from the Fifth Annual Teradata Survey Validate a Global Phenomenon, Enterprise Decision-Making survey, 2006 Report, Teradata

20. van der Aalst W.M.P., Reijers H.A., Weijters A.J.M.M., van Dongen B.F., Alves de Medeiros A.K., Song M., Verbeek H.M.W. (2007) Business process mining: An industrial application, Information Systems Vol. 32, Issue: 5, July, 2007, pp. 713-732

21. Wang Y., Liu, Z. 2009. Study on Port Business Intelligence System Combined with Business Performance Management. In *Proceedings of the 2009 Second international Conference on Future information Technology and Management Engineering* (December 13 - 14, 2009). FITME. IEEE Computer Society, Washington, DC, 258-260

22. Yongjean J., Ki-Heung Y. (2001) A study on an environment of ERP introduction, Info-tech and Info-net, Proceedings ICII, vol. 6, pp. 84- 89

23. Zhang X.Q., Peng Y.H., Ruan X.Y. & Yamazaki K. (2006) Feature based integrated intelligent sequence design for cold extrusion, Journal of Materials Processing Technology, Volume: 174, Issue: 1-3, May 25, pp. 74-81

24. Zhao Y., Ridgway K., Al-Ahmari, A.M.A. (2002) Integration of CAD and a cutting tool selection system, Computers and Industrial Engineering, Volume: 42, Issue: 1, April, pp. 17-34