SIMULATION MODELLING TOWARDS E-BUSINESS MODELS DEVELOPMENT

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Abstract: In order to survive in competitive economic environments, many organisations need to continuously improve their business processes. The Internet enables companies of all sizes to develop new online business models, which means improving and altering the ways in which companies operate and interact with business partners, customers and suppliers. It is apparent that developing dynamic models of business processes prior to their radical change could increase the success of BPR projects. Simulation has an important role in modelling and analysing the activities in introducing BPR since it enables quantitative estimations of influence of the redesigned process on system performance.

This paper presents a methodology that addresses some of the problems enterprises are faced with in their BPR projects. An example of "business to business" electronic commerce process modelling using simulation tool iGrafx Process is presented. The main objective of the paper is to investigate some potential benefits and outcomes of introducing new processes that could be assessed in advance by using simulation modelling.

Keywords: simulation modelling, business process reengineering (BPR), e-business, iGrafx Process

1. INTRODUCTION

The business model enables a firm to gain a competitive advantage while an Internet business model generally means the adoption of company's current business model to the Internet economy [Afuah and Tucci, 2001]. Electronic business (e-business) dramatically and strategically changes traditional business models. Companies are now pursuing more intensive and interactive relationships with their business partners: suppliers and customers. Competitive conditions and pressures on global market are forcing companies to search for strategies of streamlining the entire value chain.

The value chain could be described as the set of activities an organization performs in order to create and distribute its goods and services, including direct activities such as procurement and production, and indirect activities such as human resources and finance [Porter, 1980]. Each of these activities adds some value to the product. Increasing the effectiveness of the value chain will increase the competitiveness of the company. To compete effectively, organizations must structurally transform their internal and external processes. These goals could be reached by simultaneous renovation of business processes and implementation of electronic business models.

Business Process Reengineering (BPR) is an organizational method, which demands radical redesign of business processes in order to achieve higher efficiency, better quality and more competitive production [Hammer and Champy, 1993]. BPR has become one of the most popular topics in the organisational management creating new ways of doing business [Tumay, 1995]. Many leading organisations have conducted BPR in order to improve productivity and gain competitive advantage. However, regardless of the number of companies involved in re-engineering, the rate of success of re-engineering projects is less than 50% [Hammer and Champy, 1993]. Some of the frequently mentioned problems related to BPR include an inability to accurately predict the outcome of a radical change, difficulty in capturing existing processes in a

structured way, shortage of creativity in process redesign, the level of costs incurred by implementing the new process, or an inability to recognize the dynamic nature of the processes.

It is well known that e-business might bring several advantages to a company. However, existing practical business applications have not always been able to deliver the benefits they promise in theory. Prior to adopting e-business, companies need to assess the costs needed for setting up and maintaining the necessary infrastructure and applications, and they need to compare it with the expected benefits. Although the evaluation of alternative solutions might be difficult, it is essential because it reduces some risks associated with BPR projects.

The main objective of this paper was to develop a simple simulation model of business-to-business (B2B) electronic commerce process that could be used to evaluate the potential benefits and constraints of a BPR project. The paper is structured as follows. Following a discussion on influence of information technology and BPR on e-business implementation (Section 2), a brief overview of electronic business models and strategies is presented (Section 3). In Section 4 information systems modelling and simulation modelling are presented. Simulation modelling tool iGrafx Process is described in Section 5. An example of modelling B2B processes is provided in Section 6. Here the applicability of simulation modelling and evaluating alternative business process strategies is investigated. Finally, Section 7 outlines the main findings of this research and provides concluding remarks.

2. BPR AND INORMATION TECHNOLOGY IN ADOPTING E-BUSINESS

In the 90-s, BPR focused on internal benefits such as cost reduction, downsizing of a company and operational efficiency which are more tactical than strategically focused. Nowadays, e-business renovation strategies focus on the processes between business partners and the applications supporting these processes. These strategies are designed to address different types of processes with the emphasis on different aspects [Phipps, 2000], [Kalakota et al, 2000]: customer relationship management (CRM), supply chain management (SCM), selling-chain management and enterprise resource planning (ERP).

2.1. Information Technology as BPR Enabler

Information technology (IT) has been developing very quickly, and nowadays it offers very good solutions for executing and implementing BPR, such as: database, expert systems, simulation, telecommunication networks and extremely powerful computers. In addition to IT, BPR requires consideration of organizational and managerial issues and structures, because re-engineering projects involve cross-functional processes. The application of a new IT often enables reengineering projects to be successful [Davenport and Short, 1990], [Morris and Brandon, 1993], [Parker, 1996], [Hammer and Champy, 1993] [Teng et al, 1998].

Recent BPR research papers demonstrated the critical role of information technology in business process restructuring [Broadbent et al., 1999], [Teng et al., 1998]. There is a strong correlation between the quality of information systems within an organization, and the improvement of an overall corporate culture and the organizations' strategies [Lederer and Sethi, 1996]. The contributions of IT in BPR could be categorized in two different ways [Chang, 2000]. Firstly, IT contributes heavily as a **facilitator** to the process of reengineering. Secondly, IT contributes in the reengineering process as an **enabler** to master the new process in the most effective way [Davenport and Short, 1990]. IT should be the enabler, but not the initiator of BPR projects [Hammer and Stanton, 1994].

It must be stressed that the application of IT has the strongest impact on standardization or elimination of process variations. But it cannot be introduced before the workflow process improvement has been successfully implemented. For that reason, BPR and IT infrastructure strategies, which both derive from an organizational strategy, need an effective alignment to ensure the success of the BPR initiative [Al-Mashari and Zairi, 1999].

2.2. BPR Transitioning Toward E-business

The Internet enables new possibilities for the implementation of business processes (e.g. order entry, distribution, on-line payment) as well as for solving some technical issues (e.g. integration of ERP with e-commerce, SCM, CRM, etc.). Internet technology is also easily available and low-cost strategy for BPR implementation. There are many reasons for organizations to use the Internet during BPR implementation including availability and cost; return on investment; types of information storage; and platform independence [Wells, 2000]. The biggest challenge most companies are faced with is how to quickly leverage their traditional information systems and business processes, such as an enterprise resource planning system or a physical goods distribution network, as e-business building blocks, not barriers.

E-business is about improving and transforming key business processes by using the Internet and other contemporary technologies. It refers to all aspects of business that take place over computer networks [Kalakota and Whinston, 1999], [McEachern and O'Keefe, 1997], [Minoli and Minoli, 1997], and radically changes the way organizations do business. Electronic business is expanding, and is constantly being transformed through innovative processes. It pushes fundamental changes throughout the company and demands quick and flexible adoption of businesses.

By strictly pursuing a process perspective, businesses are restructured across functional and hierarchical boundaries. To accommodate these changes, organizations may need to be restructured around these new business processes [Grover and Malortha, 1997]. BPR driven by e-business could not be based only on radical redesign of intra-organisational processes, but should be extended to the entire business network (internal and external). An enhancement geared to include also inter-organisational processes is called Business Network Redesign [Alt et al, 2000].

Business Network Redesign (BNR) is driven by global information connectivity and e-commerce. It identifies the inter-organisational processes to redesign and extend the strengths of BPR to the networking among business partners. An online partnership must extend far beyond presenting promotional and pre-sales activities on companies' Web sites. It has to drill deep into a company's processes in order to create totally different business models. Therefore, most companies need to re-evaluate and Web-enable core processes to strengthen customer service operations, streamline supply chains and reach new customers. Traditional companies are forced to change their current business models and create new ones.

3. E-BUSINESS MODELS AND STRATEGIES

There are three critical factors that determine business performance: business models, business environment and change [Afuah and Tucci, 2000]. A competitive environment (powerful suppliers and competitors) and change (demand and supply, government regulations and deregulations, technologies and demographics) impact business models. Some basic questions global business leaders faced with are: Has the classical business model invented in a 19th-century outlived its usefulness? Is it capable of successfully handling the complexity of IT and today's “New economy”? Parallel to the development of Internet technologies, new business models have emerged on the Internet. Technology has enabled business models to become flatter and more flexible, but there is still a need to work with higher levels of complexity, with networking and virtual organizations which compete in a variety of sectors and along a number of dimensions like speed, quality and service. In today's complex and dynamic business environment, there is a claim to build new business models around a full array of capabilities, which keep a corporation to bring to function in an efficient way.

3.1. Overview of Electronic Business Models

There were a number of attempts, which formally described and classified a business model for e-business era. Venkatraman and Henderson [1998] define a business model as a coordinated plan to design strategy along three vectors: customer interaction, asset configuration and knowledge leverage. Hamel [1999] relates the high capitalization of Internet companies to new business models.

Other definitions rely on business models revenue and value potential. Timmers [1998] defines a business model as "an architecture for the product, service and information flows, including a description of the various business actors, their roles, potential benefits and sources of revenues for the model". The author identifies eleven business models (e-shop, e-procurement, e-mall, e-auction, trust services, info brokerage, value chain service provider, virtual community, collaboration platform, third party marketplace and value chain integrator) that are currently used or being experimented with, and then classifies them along two dimensions: degree of innovation and functional innovation.

Rappa [2000] offers nine business models: brokerage, advertising, infomediary, merchant, manufacturer, affiliate, community, subscription and utility with a number of revenue models: transaction fees, percentage of sale, set-up fee, fee per transaction, advertising fees and others. Mahadevan [2000] brings logistic streams into consideration and defines business model around three dimensions that are critical to business: value stream, revenue stream and logistic stream. The value stream identifies value proposition for business partners, buyers, sellers, market makers and portal. The revenue stream is a plan for assuring revenue generation and the logical stream is related to the supply chain design for business. The author sees the overall market space broader and divides it into three structures: portals, market makers, and product/service providers; all of them are separated into business to business (B2B) or business to customer (B2C) segments.

Many companies are struggling with a basic problem: What is the best e-business model? Different business models and their combinations are usually incorporated very deeply into companies' business strategies. Recently there has been a big increase of patent licensing revenue, because business models are defined within the context of patent law. The patent licensing revenues showed the growth from about $10 billion in 1990 to approximately $100 billion in 2000 " [Rivette and Kline, 2000]. The truth is that the effects of the patent system on the innovation activity and economic growth are actually widely studied subjects in the field of economics. The study results available from the National Bureau of Economic Research (USA) suggest that strong patent protection may actually be one of the most effective means of promoting innovation, knowledge sharing, and economic growth yet devised. Patent could be a critical success factor determining winners and losers in business competition.

3.2. Business-to-business Strategies

Within the overall electronic commerce industry, there are two major branches: business-to-consumer and business-to-business. Because of the early success of business-to-consumer Internet companies that provided new ways for consumers to purchase goods, several entrepreneurs developed Internet solutions to long-standing business purchasing problems. Business-to-business electronic commerce has experienced explosive growth in the marketplace, beginning in the early 1999. The market for B2B has continued to expand with predictions that the B2B commerce will far exceed B2C commerce in the future. Forrester research estimates that over $1.5 trillion in goods and services will be purchased over the B2B e-commerce by the year 2003, while this number could be about $108 billion for B2C e-commerce [Forrester Research, 2000].

Several fundamental forces are driving the rapid growth of business-to-business e-commerce: pressure for global free trade, global competition, demand for the increase of customer service and value-added relationships. The advantages of IT and the Internet (faster connections, speed of delivery, collaboration capabilities, and information collected across all commerce channels) yield the unprecedented opportunities to suppliers and buyers; these advantages will help them to connect and establish mutually profitable relationships.

Business-to-business model could be defined as the use of electronic interactions to conduct business among enterprises [Turban et al, 2000]. B2B includes purchasing and procurement, sales activities, payment management, inventory management, channel management, supplier management, and service support. B2B functions must be carefully managed because they include:

- sophisticated Web authorization and control for delivery of sensitive price;
- contract and content information for business partners;
- catalogues that provide custom views based on access control and buyers' personalisation;
- mechanisms for order fulfilment status control;
- and standardized order entry functions (e.g. destination locations and payment options).

The roots of B2B are in the Electronic Data Interchange (EDI) and Enterprise Resource Planning. Businesses with well defined trustworthy relationships link together through EDI and ERP. In order to establish B2B e-commerce, companies have to provide a secure and reliable interchange. Electronic Data Interchange (EDI) was developed in the early 70-s to facilitate transactions between established trading communities. However traditional EDI is no longer an effective means to carry out electronic transactions in the new e-commerce economy [Deitel et. al, 2001], [Turban et al, 2000]. The EDI/ERP model is expensive and limited. This is due to the following reasons: difficulties in establishing communication, lack of standards in EDI transactions between different industries, EDI systems are prohibitively expensive for small and medium-sized companies, EDI systems are not flexible, they do not permit real-time interactivity, and it is difficult to add new business partners and new transaction types.

Modern B2B models should go beyond this. Therefore, companies should extend their solutions through new and emerging Internet standards utilizing Extensible Markup Language (XML). As Handfield and Nichols [1999] suggest, B2B applications should offer companies an access to the broad range of information about products, business partners, transportation, inventory, supply chain alliance, sales and marketing. There are a number of producers providing a comprehensive suite of software solutions that enable other organizations to create their own B2B models, such as Ariba, Oracle, I2 Technologies, FreeMarkets and SAP.

In the recent literature, several B2B models were described [Kalakota and Robinson, 2000], [Turban et al, 2000], [Afuah and Tucci, 2000], [Deitel et al, 2001], but the most common way of their classification depends on who controls the marketplace: a supplier, customer, or an intermediary:

- **Seller-oriented model** is the primary model used in business-to-consumer scenarios. The simplest seller-push models were companies' websites to distribute product information, and later on, websites that could accept orders online. In this model, both individual consumers and business buyers use the same supplier-provided electronic store. An application can be considered "seller-push" if one or a small subset of suppliers is featured on the site. A group of sponsoring suppliers aims to achieve higher prices or volumes as a result of the site.
- **Buyer-oriented model** is intended to help buyers purchase products on more favourable terms than might be found from traditional sales channels. Therefore, big buyers open their own marketplace and invite potential suppliers to bid on the announced purchase orders. A model can be considered "buyer-oriented" if many suppliers are allowed to compete, and the application creates a competitive level playing field among these suppliers. This model is linked to the back end office ERP or accounting system, cutting time and expense.
- **Intermediary-oriented marketplace:** in this model, businesses use the Internet to buy and sell services from and to each other. This model seeks to emulate the structure of stock or commodity exchanges where the website becomes the meeting point for many buyers and sellers. The current strategy is using B2B hubs - also called intermediaries or exchanges or e-Business brokers. Hubs provide a central point where buyers and sellers find each other. The strategy helps companies to concentrate on managing the business-to-business relationship, but, on the other hand, leaves the management of the technical infrastructure to the intermediaries.

4. BUSINESS PROCESS MODELLING

The growing interest among academic and industrial communities in organizational change and business process re-engineering has resulted in a multitude of approaches, methodologies, and techniques to support these design efforts [Wastell et al, 1994], [Harrison and Pratt, 1993]. Many different techniques can be used for modelling business processes in order to give an understanding of possible scenarios for improvement [Ould, 1995]. Flowcharting, IDEF0, IDEF3, Petri Nets, System Dynamics, Knowledge-based Techniques, Activity Based Costing and Discrete-Event Simulation are only some examples of business process modelling techniques widely used [Eatock et al, 2000]. There are also many software tools on the market that use these modelling techniques.

In [Kettinger et al, 1997] the empirical review of existing methodologies, tools, and techniques for business process change was conducted. The authors also developed a reference framework to assist positioning of tools and techniques that help in re-engineering strategy, people, management, structure, and technology dimensions of business processes. According to [Curtis at al, 1992], a modelling technique should be capable of representing one or more of the following modelling perspectives: *functional* (represents what activities are being performed), *behavioural* (represents when and how activities are performed), *organizational* (represents where and by whom activities are performed) and *informational* (represents the informational entities – data). A deeper analysis of simulation modelling techniques suggests that these techniques are suitable to address at least the functional, behavioural and organizational perspectives [Banks et al, 1997].

4.1. Information System Modelling and BPR

Business processes can be defined as a series of logically connected activities that use the company's resources. Davenport and Short [1990] define a process as "a structured, measured set of activities designed to produce a specified output for a particular customer or market". It gives a strong emphasis on how work is done within an organization. Some common elements can be identified in a majority of definitions. These elements relate to the process itself (usually described as transformation of input, work flow, or a set of activities), process input and process output, usually related to creating value for a customer, or achieving a specific goal [Paul et al, 1998].

The awareness of IT capabilities should influence the design of business processes. In addition to the investment in information technology, a new type of information systems models should be designed. The structure of information system model could be divided into the static and the dynamic part. The static structure of the model consists of functions, human and other resources, while the dynamic part consists of data, processes and events. The dynamic structure of information systems demands the implementation of process-oriented methods and tools.

Process models are often developed by using graphical software tools that show business processes, activities and participants with flow diagrams and process charts. A disadvantage of these tools is that they are

unable to perform process analysis. Process modelling tools must be able to show interconnections between the processes and to conduct a decomposition of the processes. These tools must help users to conduct "what-if" analysis and to identify and map no value steps, costs, and process performance (bottleneck analysis). They should be able to develop "AS-IS" and "TO-BE" models of business processes.

Important initial activities for BPR projects are the acquisition of descriptions of the concerned business systems and the development of "AS-IS" model of the company's processes. "AS-IS" model (model of current business processes) provides BPR participants with the information needed to decide what to change, how to change and what will be the result of the change. The next phase is the development of "TO-BE" models which represent both existing and alternative processes. It must be validated and tested before the implementation. It can be used to predict characteristics that cannot be directly measured, and it can also predict economic and performance data that would otherwise be too expensive or impossible to acquire.

4.2. Simulation Modelling and BPR

Simulation has an important role in modelling and analysing the activities in introducing BPR since it enables quantitative estimations on influence of the redesigned process on system performances [Bhaskar et al, 1994]. The simulation of business processes represents one of the most widely used applications of operational research as it allows understanding the essence of business systems, identifying opportunities for change, and evaluating the impact of proposed changes on key performance indicators. The design of business simulation models is proposed as a suitable tool for BPR projects; it will incorporate the costs and effects of e-business implementation and will allow for experimentation and analysis of alternative investments.

Some of the benefits can be directly evaluated and predicted, but the others are difficult to measure (intangible benefits). Some intangible benefits might be (as observed in several case studies in Slovenian companies that have introduced e-sales): improved image of a company as a whole, increased market share, better relationships with partners, and increased customer satisfaction. This research investigates some of the benefits and outcomes of introducing new processes (time and cost savings, workload reduction and increased throughput) that could be measured in advance, by simulation modelling.

Recent development in simulation software made simulation particularly suitable to use in BPR [Van Ackere et al, 1993]. A re-engineering business process involves changes in people, processes and technology over time. As these changes happen over time, simulation appears to be a suitable process modelling method. Simulation is often called a technique of last resort because it is used when the system to be modelled is too complex for analytical models [Oakshot, 1997]. The interaction between people with processes and technology results in an infinite number of possible scenarios and outcomes that are not possible to predict and evaluate using widely popular static process modelling methods. Kettinger et al [1997] mention simulation as one of the modelling methods in their survey on business process modelling methods.

The reasons for the introduction of simulation modelling into process modelling can be summarized as follows:

- simulation enables modelling of process dynamics,
- influence of random variables on process development can be investigated,
- anticipation of reengineering effects can be specified in a quantitative way,
- process visualization and animation are provided,
- communication between clients and an analyst is facilitated by simulation models.

Modern simulation software tools are able to model dynamics of the processes and show it visually, which then can enhance generating the creative ideas on how to redesign the existing business processes.

5. BUSINESS PROCESS MODELLING AND SIMULATION USING IGRAFX PROCESS

This study presents iGrafx Process [Micrographix] software as a suitable tool for process mapping and simulation modelling in BPR projects. One of the main advantages of this modelling technique is its simplicity; even the people who have never seen the models of business processes before can easily understand this technique. IGrafx Process is very powerful in simulations. It can generate many useful reports regarding the duration of each transaction, costs, resource utilization, etc at the end of the simulation.

Figure 1 shows basic modelling elements of the process maps technique that is used by iGrafx Process. An activity is an individual step of a process map presented as a symbol in a flowchart. Each activity can set or determine the following information:

- Inputs: an activity can have one or many inputs that arrive by way of incoming connection lines.
- Resources: a resource is a person, machine, or other asset that may perform the activity. An activity can use several resources or more than one kind of resource simultaneously.
- Task: the task information covers the duration that the activity takes to complete, its associated costs, activity base, and schedule.
- Outputs: the outgoing connection lines from an activity attach to other activities for further processing.

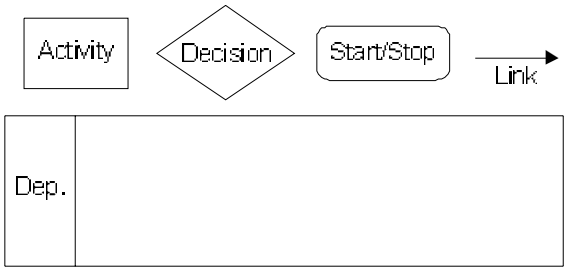

Figure 1. Basic modelling elements of the process map technique

Modelling elements are connected with links, which describe the process flow. Each activity is placed in one or more departments that represent an organizational unit, which performs these activities. IGrafx Process also offers a wide range of possibilities for describing a process: different possible splits of the process flow, many possible settings for events generation, schedules may be customized, it is possible to use custom attributes etc.

6. SIMULATION MODELLING OF "BUSINESS TO BUSINESS" PROCESS

Many business processes relate to business-to-business processes [May, 2000] Therefore, a large potential lies in introduction of e-business in the inside part of the value chain. One of the reasons why this type of e-business could be easier to implement is that a large proportion of transactions in this case are repeating orders. On the other hand, several problems and obstacles occur during the introductory phase of the business-to business model. The investments into information technology can be significant, industry common standards are yet to emerge and to be adopted and the way that the company operates has to be (sometimes radically) changed. But the results can be rewarding for both sides in the form of savings through reduced costs, process efficiencies, and compliance [Deise and Nowikow, 2000].

This study refers to a business change effort undertaken by a virtual company. The process itself is adapted from a case of a real Slovene company. The study emphasises the assessment of savings in terms of time and cost for one purchase transaction execution.

During the first phase of the research, "AS-IS" model has been developed (Figure 2). The procurement process is performed in four departments: Purchasing, Warehouse, Finance, and Accounting. There are six employees working on this process; the detailed list can be found in Table 3. The details about activities are presented in Table 1.

The simulation of a two-year performance was carried out and the report has shown that an average procurement process lasts for about 10 days and the average cost is 54.8 EUR. However the simulation report, no matter how precise and deep it is, is not the only way of using the business process modelling for the analysis of problems of such a process execution. Very frequently business process maps themselves show many problems that have not been observed before. In our case two main (and very common) problems have been discovered:

- The communication within the company, and between the company and its suppliers is slow and ineffective; consequently many time gaps occur in the process execution.
- Very often the same data are inserted and therefore there are good chances to have low data quality [Redman, 1995].

In the second phase of this research, the results of the analysis were used as the basis for the introduction of new business model of the procurement process, "TO-BE" model (Figure 3). The workflow management system and electronic data interchange with the suppliers via the Internet were introduced. From the process map itself not many differences can be observed between the AS-IS and TO-BE model. However, the most important differences are evident in the way of performing these activities. On the other hand, this is usually the most difficult part of introducing new or reengineering existing business processes. The details about activities are presented in Table 2.

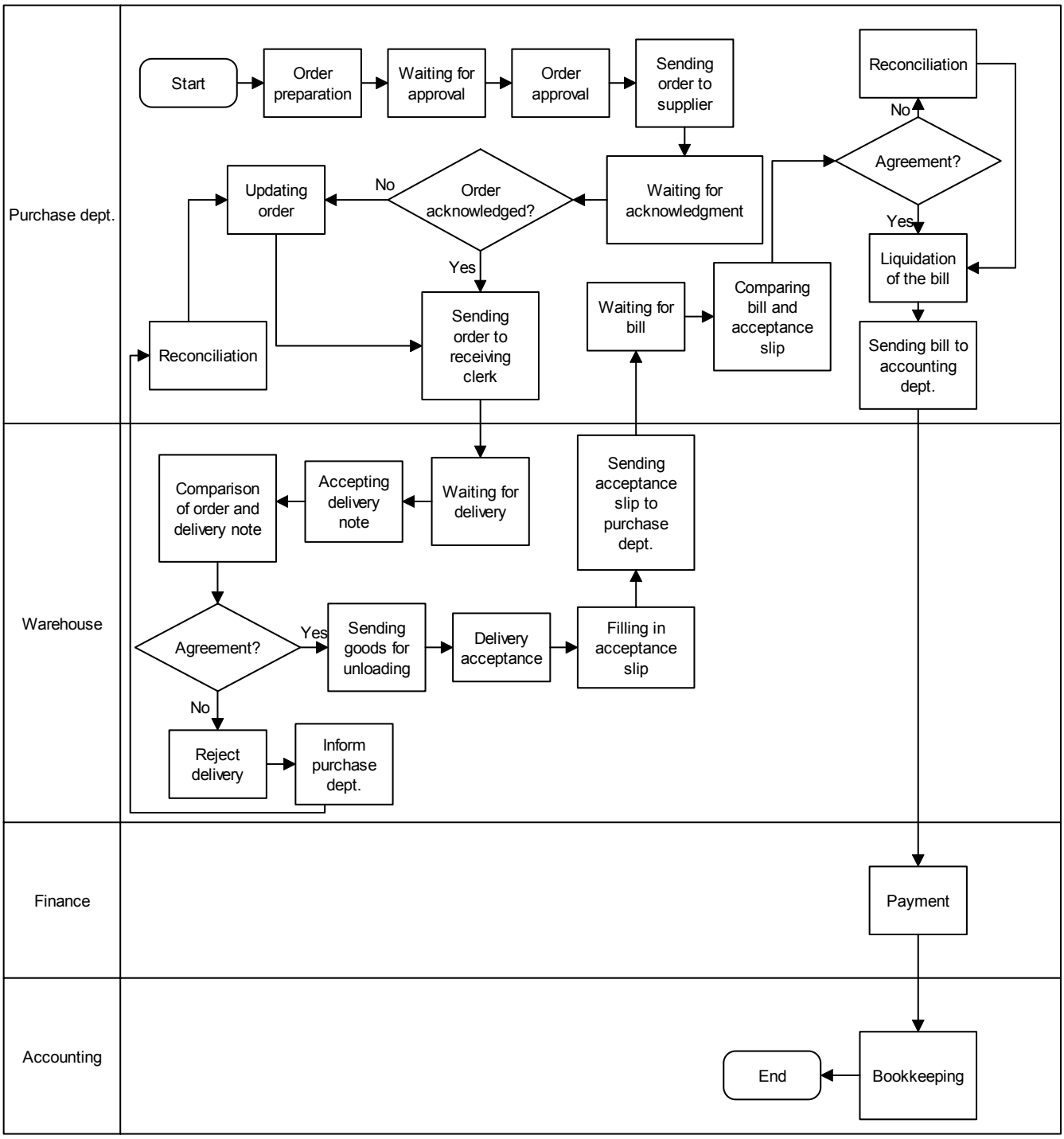

Figure 2: Existing process ("AS-IS" model)

Activity	Resources	Time	Outputs
Order preparation	Purchasing officer	1 - 3 hrs	
Waiting for approval		0 - 24 hrs	
Order approval	Purchasing director	10 min	
Sending order to supplier	Purchasing officer	10 min	
Waiting for order acknowledgment		1 - 48 hrs	
Order acknowledged (availability, prices etc.)?			Yes - 80%, No - 20%
Updating order	Purchasing officer	10 - 20 min	
Sending order to receiving clerk	Purchasing officer	10 min	
Waiting for delivery		1 - 7 days	
Accepting delivery note	Receiving clerk	1 min	
Comparison of order and delivery note	Receiving clerk	5 - 20 min	
Agreement?	Receiving clerk		Yes - 90%, No - 10%
Reject delivery	Receiving clerk	20 min	
Reconciliation with the supplier	Purchasing officer	30 - 120 min	
Informing purchase dept.	Receiving clerk	20 min	
Sending goods for unloading	Receiving clerk	5 min	
Delivery acceptance	Warehouseman	15 - 120 min	
Filling in the acceptance slip	Warehouseman	10 - 30 min	
Sending acceptance slip to purchase dept.	Warehouseman	10 min	
Waiting for bill		1 - 3 days	
Comparing bill and acceptance slip	Purchasing officer	5 - 20 min	
Agreement?			Yes - 95%, No - 5%
Reconciliation with the supplier	Purchasing officer	30 - 120 min	
Liquidation of the bill	Purchasing officer	10 min	
Sending the bill to accounting dept.	Purchasing officer	10 min	
Payment	Financier	20 min	
Bookkeeping	Accountant	20 min	

Table 1: Activities in "AS-IS" model

In this case the models were analysed and compared according to the time and cost of an average process execution (Table 3). The results of the comparison showed that the time could be halved if the proposed solutions are used. Also the costs can be significantly cut from (on average) 54.8 EUR to 30.7 EUR for one process execution.

There are, of course, other important benefits that are more difficult to be measured or evaluated in advance. For example, the data quality was already mentioned; the others could be: better working relationships with the suppliers, suppliers have better and more accurate evidence of company's needs and they can react more promptly to partners' demands. On the other hand, several problems can occur in the introduction of e-business solution, especially in the B2B model; high costs and risk are always associated with such a project.

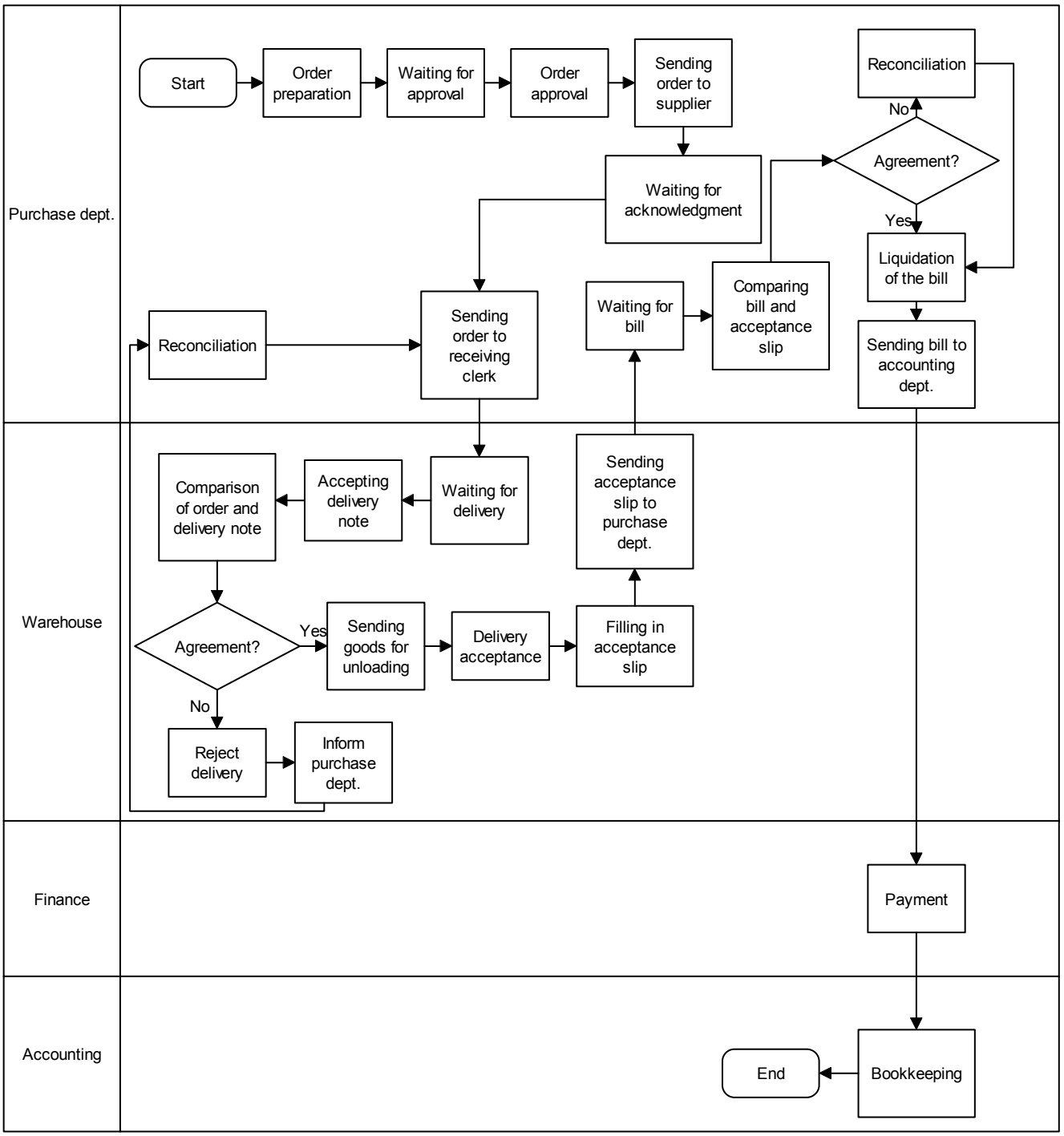

Figure 3: Renewed process ("TO-BE" model)

Activity	Resources	Time	Outputs
Order preparation	Purchasing officer	0.5 - 2 hrs	
Waiting for approval		0 - 3 hrs	
Order approval	Purchasing director	10 min	
Sending order to supplier	Purchasing officer	1 min	
Waiting for order acknowledgment		1 - 30 min	
Sending order to receiving clerk	Purchasing officer	1 min	
Waiting for delivery		1 - 7 days	
Accepting delivery note	Receiving clerk	1 min	
Comparison of order and delivery note	Receiving clerk	1 min	
Agreement?	Receiving clerk		Yes - 99%, No - 1%
Reject delivery	Receiving clerk	20 min	
Reconciliation with the supplier	Purchasing officer	30 - 120 min	
Informing purchase dept.	Receiving clerk	20 min	
Sending goods for unloading	Receiving clerk	5 min	
Delivery acceptance	Warehouseman	15 - 120 min	
Filling in the acceptance slip	Warehouseman	5 - 20 min	
Sending acceptance slip to purchase dept.	Warehouseman	1 min	
Waiting for bill		10 - 120 min	
Comparing bill and acceptance slip	Purchasing officer	3 - 10 min	
Agreement?			Yes - 99%, No - 1%
Reconciliation with the supplier	Purchasing officer	30 - 120 min	
Liquidation of the bill	Purchasing officer	1 min	
Sending the bill to accounting dept.	Purchasing officer	1 min	
Payment	Financier	10 min	
Bookkeeping	Accountant	10 min	

Table 2: Activities in "TO-BE" model

Duration of the simulation		2 years
Employees	Number	Hourly rate
Purchasing officer	1	10 EUR
Purchasing director	1	15 EUR
Receiving clerk	1	10 EUR
Warehouseman	1	7.5 EUR
Financier	1	12.5 EUR
Accountant	1	12.5 EUR
	"AS-IS" model	**"TO-BE" model**
Time for one transaction (Cycle time)	10 days	5 days
Costs of each transaction	54.8 EUR	30.7 EUR

Table 3: Parameters and comparison of the two models

7. CONCLUSIONS

The Internet and the World Wide Web along with the rapid development of the new technology and the current market conditions demand new models of performing business. The corporate value chain links different processes and players in the domain of e-business. Therefore, most traditional organisations will not be able to conduct business in the traditional way any more. One of the ways of accomplishing these goals is BPR, which uses additional features included in simulation modelling methods. In this research, the "virtual project" of B2B e-commerce implementation was modeled using iGrafx Process process mapping and simulation tool. The costs and benefits of the e-business implementation were analysed and two different scenarios were compared. Business process modelling and discrete-event simulation proved to be valuable mechanisms for realising the real business value of B2B e-commerce.

The use of the new information technologies and Internet is related to significant changes in business. The adoption of presented simulation tool by businesses could help to avoid a number of major BPR mistakes such as:

- lack of understanding of the opportunities available to companies implementing e-business,
- lack of employees' skills and knowledge of BPR methods and tools,
- high investment costs related to business process identification, analysis and modelling,
- difficulty in capturing existing processes in a structured way,
- inability to accurately predict the outcome of a radical change and to recognise the dynamic nature of the processes.

The example presented in Section 6 shows that iGrafx as well, as the most other simulation tools offers a number of advantages:

- Simplicity and ease of use. Many simulation tools are fairly simple and easy to learn and use since they use a limited number of symbols, but they are more powerful in the representation of system complexities using flexible linking of processes to sub-processes or external documents,
- The use of simulation tools enables the visualisation of the system being modelled using presentation-quality process diagrams,
- Simulation enables powerful "what-if" scenarios for varying simulation variables,
- The ability to trace animated simulation,
- It provides resource, schedule, and cost analysis,
- The main advantage of simulation tols is the ability to handle concurrent, parallel, or asynchronous activities.

These characteristics of the simulation modelling tools accomplish the typical objectives of BPR: they increase service level and throughput, reduce total process cycle time as well as waiting time, the number of activities, resources and inventory costs. Simulation tools are "cost-effective" methods which quickly explore "what-if" scvenarios, find a problem solution or provide a better problem understanding, because they are supported by a number of software tools that enable graphical representation of the system by the executable models.

The main objective of this research was to explore the opportunity for B2B e-commerce implementation and the ability of simulation modelling as a method for adopting e-business successfully. As the buying and selling of goods and services is one of the most important functions in any enterprise, in the first phase of the research, a "prototype" of B2B e-commerce model was developed. This research revealed the usability of simulation tools in BPR projects by facilitating the presentation of the business process models to the managers and end-users in order to get their validation and evaluation. The benefits of the developed model should be the focus of further research which would determine if it could be implemented as a general B2B e-commerce process model for guiding companies' performance improvement.

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