CONCEPTUAL MODELING AND EVALUATION OF E-BUSINESS PROCESSES USING CLOUD BASED FRAMEWORK INSIGHT MAKER

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Abstract: Today's e-business processes require constant qualitative adjustments and improvements. Regarding economics implications, the best approach is to evaluate their conceptual modeling, after planning and prior to implementation. The basic idea is to make savings, which in the following examples will be a shortening of the time of the process, and therefore a cheaper price of a product, service, or both. To achieve those goals and the expected guidance for making decisions for changes, in this paper is described and used Insight Maker which is web-based, general-purpose modeling and simulation tool. It is designed to make modeling and simulation accessible to a wider audience of users. Insight Makers has integrated all three general modeling approaches: agent-based modeling, system dynamics and imperative programming in one modeling framework. This open source framework, give an opportunity to making different conceptual models, rearranging and reengineering the business processes, simultaneously making re evaluation of changes. In this paper, the used examples, specifically, models and simulations, show us, graphical and numerical results that allow an unambiguous evaluation of the changes.

Keywords: e-business modelling, evaluation, Insight Maker

1. INTRODUCTION

The concept of business process re-engineering (BPR) was introduced in the late 1990s as an idea that periodically a redesign and reorganization of an organization is needed to reduce costs and increase productivity and service quality. The role of ICT as an enabler for organisational rethinking has been enfaced in much literature from the field of conceptual modelling and business processes re-engineering. [1],[2],[3],[8]. Given the relationship between conceptual modelling and the business processes development it is very important to note the following items: Business is managed as a set of specific but interconnected business processes that are modelled using software solutions, and furthermore, the ICT strategy should be integrated with business strategy [1]. Many studies have shown that prior re-engineering of business processes, simulation and evaluation is recommended, as support for decision-making for change [2],[3],[4],[9]. Depending on the modelling process, different approaches were developed, such as process processes (EPCs, ARIS House of Business), Semantic Object Model (COM), Bonaparte and ACCESS / STAR and many others. At the same time, e-Commerce" and e-Office indicate that in the future more and more business processes will be implemented electronically, which implies parallel development and change of business processes and software solutions for their reorganization [6]. The enhanced

process should be better support for organizational goals, which means removing unnecessary procedures, and then redesign assisted and realized using ICT, as well as "streamlining" of organizational operations [10].

2. CONCEPTUAL MODELLING AND SIMULATION AS A TOOLS OF BPR

A model is a representation of some system of interest. The model should be always, similar with system, but simpler. Before doing any changes on the real system, the model should be build and tested.

1. 1. CONCEPTUAL MODELLING

Building a model is time consuming process which requires good knowledge of a system that is being modeled. In this context, conceptual modeling has particular significance for capturing the basics of the system that needs to be realized. The conceptual model is always only approximation of the real system, and it is very important to find a balance between simplicity and real situation. To ensure the model validity, it is necessary the use of model validation techniques which includes simulation procedures where under a known common input, the outputs of the simulation model and the real system are compared [1]. The simulation model is a mathematical model developed with the simulation software, which is able to use deterministic or dynamic variables, depending of values of inputs and outputs (according the time – static or dynamic, according the values- fixed or stochastic) [1], [11].

1. 2. SIMMULATION

The simulation means experimenting with different conceptual models to understand and predict behaviour of the proposed system. In order to obtain accurate results, the simulation needs to be done before an existing system is altered or new system built. Based on the real result of simulation, suitable improvement measures can be identified without lengthy real-time walkthroughs. These possible improvements can be verified before implementation, and can be easily evaluated without impacting existing processes. All these benefits substantiate simulation as an essential activity before updating and implementing processes within the organization [2]. Simulation is a component of a business rules engine. It is a solution to both off-line design and on-line operational management problems. Engineers derive rules from the mental models experts provide on how their processes work and how to make decisions that will help them forecast how a change might impact those decisions. Formalizing and simulating these models makes the automation of business rules more robust. In the design of new business rules, simulation provides a way to validate that processes will work as designed [3].

1.2.1. Simulation of business process models (BPM)

There are a lot of different BPM tools in market, which usually follow different methods. Each of them follows a standard approach, but the most modern being BPMN standard. Some of modelling software support simulation as an extra feature, but not as a main purpose of a software. The modelling software is not there to provide simulation, but to

provide an environment to model processes, maintain and share these models. The business process models provide a static representation of the process being studied, in contrast to the simulation which adds a dynamic component, representing the process as active, although it is still a model. Additional information is required in the BPMs, such as activity times, arrival information, resource availability and routing logic that can be executed within the simulation. Some of those information, it is not always easily added, for example process modelling tools do not tend to have objects to represent queues and constraints for these queues. Additionally, the overall control method that determines the routing or prioritization of the work, the ability to add this logic, which was a large part of stand-alone simulation tools, is usually not well covered in the simulation provided for BPMs. Business process tools can be very detail oriented. Given that these tools are likely to be owned by ICT or business analysts they are very suited towards the design and implementation steps of the project cycle [4].

3. E-BUSINESS PROCESS MODELLING AND SIMULATION

The business models are usually represented by a mixture of informal textual, verbal and ad-hoc graphical representations. Very often there is a gap between business executives and the IT developers who need to create e-business information system.

3.1. E-BUSINESS PROCESS MODELLING

There is a lot of different approaches concerning e-business process modelling. Some of them are ARIS/EPC, SOM, Bonapart and INCOME/STAR. In the practice EPC (Event-driven Process Chains) of the ARchitecture of integrated Information Systems has a dominant role. There are several reasons of EPCs popularity: a variety of commercial tools for EPC, the great success of the SAP suite of business applications tremendously promoted the use of this method, EPCs have also been investigated quite thoroughly in research. When ARIS is used for business process modelling, first step is to identify the core process of the business and represent them as EPC, which consists of an alternating sequence of events and processes, also called functions. The resulting process model serves the documentation of existing process, the planning of new process or their combination. If the EPC contains some new processes, the reengineering should be done. E-business process demand a high degree of automation, due to quick changes in electronic markets, a fast realization of the process models. The large percentage of electronic parts in the overall business process leads to huge software projects delaying realization [6]. There are two reasons for delay:

- *A lot of details necessary for the implementation of the model typically require a reorganization of the original model*- The solution of the first problem is making syntax and semantics of the modelling language as precise as possible. There is a gap between precision and intelligibility. Exact formal models like Petri nets are usually not well understood. On the other hand, models like the EPC are easily understandable, but have a lack of formality.
- *In the EPC, business objects, such as information and documents processed and manipulated by the process, are associated with a large degree of freedom* - This fact makes it difficult to object-oriented approach in the modelling and implementation of software solutions [6]. The solution of this problem requires the integration of

business objects into the process model. An object-oriented concept needs to be chosen for integration and extend EPC to EMC (Event-driven Method Chains).

Today on the market there is a great number of tools that can be used for creating EPC diagrams. Some of these tools support the tool-independent Event-driven Process Chain Markup Language (EPML) interchange format. There are also tools that generate EPC diagrams from operational data, such as SAP logs. The EPC diagrams use symbols of several kinds to show the control flow structure (sequence of decisions, functions, events, and other elements) of a business process. To product software from models of complex business processes, control structures alone are not enough. For example, almost any process in a company includes business objects such as documents. If they are not considered in the process model right from the start, a later integration will be very difficult.

In object-oriented EPC is visible which methods are invoked, but not in which order. If some weak spot is discovered in a later phase it leads to a revision of the EPC and going back to a modelling phase. To avoid such cycles, methods should take the place of the functions, not classes. The class is connected to its methods via an edge, likewise all attributes are connected to the class. The resulting diagram is called Event-driven Method Chain (EMC).

3.2. E-BUSINESS PROCESS SIMULATION

The simulation has an important role in modelling and analysing the activities in introducing BPR since it enables quantitative estimations to be made on the influence of the redesigned process on system performances. Many organizations use the simulation to analyse e-business processes at some stage [2]. But not all of them use it in a structured and efficient way. The reason for this is a lack of training, a limitation of existing tools, or a greater focus on design rather than the simulation itself. The majority of simulation software implements a model using the discrete-event method[3]. The reasons for introducing a simulation in the modeling process can be summarized as follows: simulation enables modeling of the process dynamics, possibility to examine the influence of random variables on the process development, quantitative approach for determining the effects of reengineering, providing visualization and animation processes and facilitating communication between clients and analysts.

4. INSIGHT MAKER- CLOUD BASED OPEN SOURCE TOOL FOR MODELLING AND SIMULATION

Insight Maker is an open source, web based software for modeling and general purpose simulation tools. It is designed to make modeling and simulation available to a wider audience of users. Insight Maker integrates all three general modeling models: agent-based modeling, system dynamics, and imperative programming in a single modeling framework. Its graphical interface has a client side implementation, which means that the code can be executed on each user's machine. It support some advanced features like model scripting and optimization. There are the possibilities to build a model, run a simulation, and embed the model in the web site. [11]

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4.1. WORKING FEATHURES OF INSIGHT MAKER

Insight maker as a high performance environment, which quickly performs the simulations with minimal resource requirements, has three basic criteria that its own modelling and simulation tools should possess: performance, features and accessibility. The highest priority is given to the accessibility over other components, which means that it is user friendly tool. The second priority is given to the features, and the lowest priority is given to performance. The final result is reduced speed of tool, and significant limitations of the performance. Insight Maker, as a web based tool, provides user account management and model sharing and searching.

4.1.1. Technologies used behind Insight Maker

Insight Maker Insight Maker uses standard open-source technologies and runs on a generic Linux/Unix server. Existing open source technologies and solutions were used to increase the portability of the system and also to reduce the cost of development. The technologies that are used are:

- MySQL database to store the data on the server
- PHP and content management system Drupal are used to store data and implement server-side logic
- Lighttpad is used as the actual server software
  While building Insight Maker authors included number of previously developed packages from third party: Ext JS, MxGraph, JQuery, Durpal, Oxygen Icon Pack, Scratchpad-Kan Academy.

4.1.2. Modelling paradigms

Insight Maker support two different modelling paradigms and using each paradigm alone or using both of them together, it is able to create the most of the planned models.

- *System dynamics modelling*- concerns itself with the high-level behaviour of a system. It helps to understand and aggregate operations of system on a macro-scale. It is great for focusing on really important in the model and cutting unnecessary details. The main building blocks for constructing system dynamics models, also known as primitives are: Stocks, Flows, Variables, and Links.

- *Agent Based Modelling*- purpose is to allow the user to model individual agents within a system or/and population, and explore the differences between individuals in population. The primitives, known as main building blocks for constructing agent based models, are: States, Transition (with triggers: timeout, probability, condition), Agent population, and Actions.

5. AN EXAMPLE OF E-BUSINESS PROCES MODELLING AND SIMULATION USING INSIGHT MAKER

This section shows the use of the tool in modelling and simulating the B2B process, using Insight Maker. The aim was to explore the possibilities of the tool in the domain of modelling e-business processes. This example does not show all the features of the tool, since only one set of them was sufficient to complete the Agent Based Modelling task. To accomplish this goal, B2B process which is described in an early works [8], has been modelled and simulated using Insight Maker. Following study refers to a business change effort undertaken by a virtual company. Further, the processes AS IS and TO BE, both of them has been modelled and simulated. The study emphasizes the assessment of savings in terms of time and cost for one purchase transaction execution. Briefly described, an AS IS business process defines the current state of the business processes in an organization, and the analysis goal in putting together the current state process is to clarify exactly how they works today. Unlike them, TO BE business process define the further state of a business processes in an organization, and the goal of analysis is putting together the future state, and to clarify how the business process will work, at some point in the future, once change was made.

The capabilities of e-business process modelling in Insight Maker are limited. There is no activities and decision constructs so for implementing the process agent based modelling was used and their constructs agent state and transitions.

5.1. AS IS – MODELLING AND SIMULATION OF A VIRTUAL COMPANY

Each activity is represented as an Agent State. Also, each activity of the process has its duration. This duration was used as timeout trigger in Insight Maker to trigger the transition between the States. For example activity Order approval is implemented as Agent State. It transits to next State "Sending order to supplier" after 10 minutes expires. All the transitions are made like that. When the activity last for some random period in interval of 1 to 3 hours, timeout is random number where minimum is 1 hour and maximum is 3 hours. Generally, In general, all the primitives should be presented on models created in Insight Maker. All rectangles represent the States, and for all of them, their start activity is "false", which means, that at the beginning they are inactive. The other primitives shown on the models are Transitions. They come in form of arrows. Because of this constraints the model in Insight Maker looks slightly different. Figure 1., present AS IS model of following virtual company.
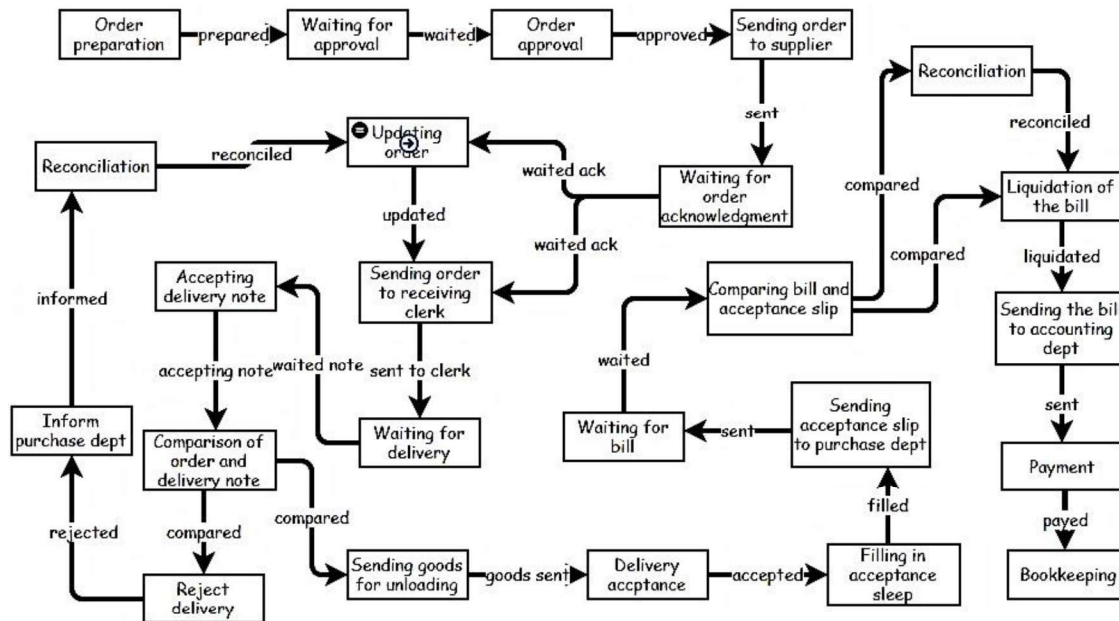
Figure 1. AS IS model in Insight Maker

The process is changing from one State to other, through Transition. Depending on the role, some Transitions are triggered with different time intervals that can be tolerated during the execution of the process, and can be marked as "waited". During the simulation of processes, they can accept a random value, under the proposed time intervals, and then State "Waiting for approval will stop being "active", and State "Order approval" will became "active", as it has presented on Picture 2. After making five simulations, of AS IS process, with different time of processes execution, experimental result shown that:

AS IS Average time (hours) = [Simulation1.time(172hours) + Simulation2.time (144hours) + Simulation3.time (242hours)+Simulation4.time(202hours) + Simulation5.time(223 hours)] /5 =983/5 =196.6 hours

Depending of activity, there are many different time intervals to finish the activity tasks, for example, such as for some of them "Sending order to supplier" – duration 10min, "Waiting for order acknowledgment" –duration (0.5- 48 hours), "Waiting for bill" – duration (1-3days), "Wainting for delivery"- (1-7days).
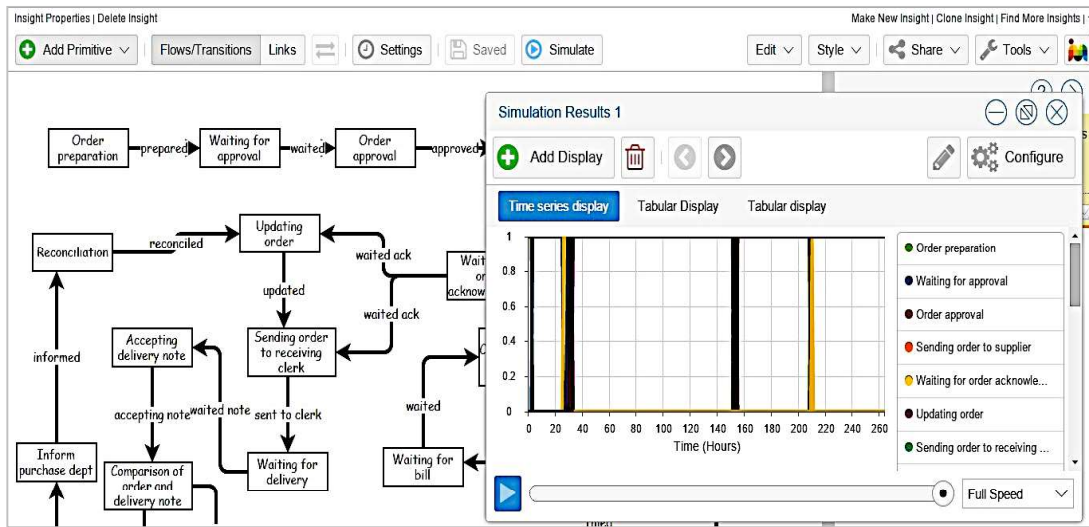
Figure 2. AS IS model with simulation of time executing

Figure 3 shown, during the simulation, that the Tabular Display columns, in fact, represent the States in the model.
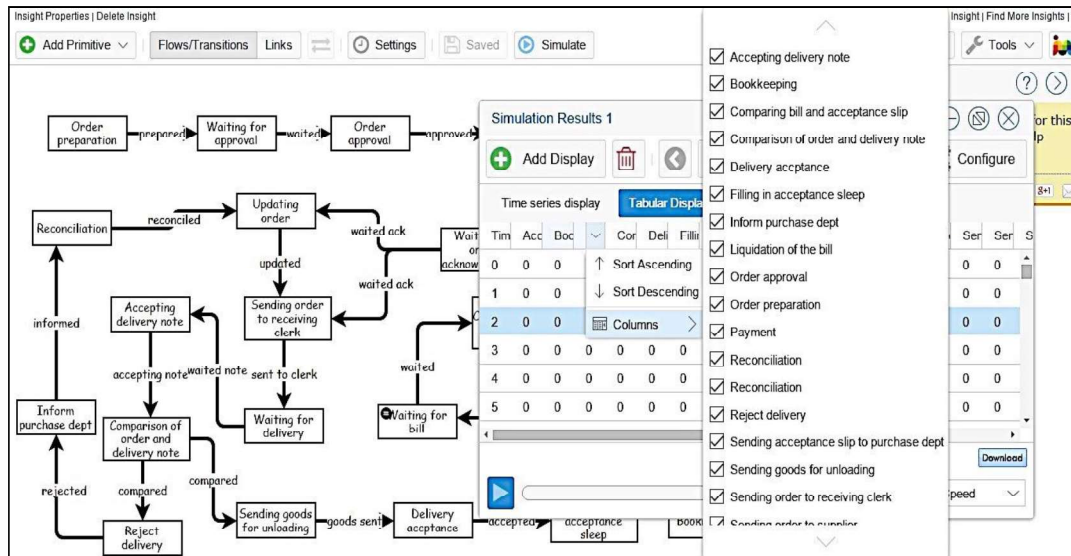

Figure 3.Tabular Display of States

Whenever an agent is in a country, the value of this State is 1, unlike the rest States, where it is 0. These results can be exported as CSV file.

5.2. TO BE- MODDELING, SIMULATION AND EVALUATION OF CHANGES OF AN VIRTUAL COMANY

TO BE model is developed, changing the order and activities from the previously analysed company, in order to compare the results with those of the previous AS IS model.

On Figure 4. are defined the further state of a business processes in previously considered virtual company.
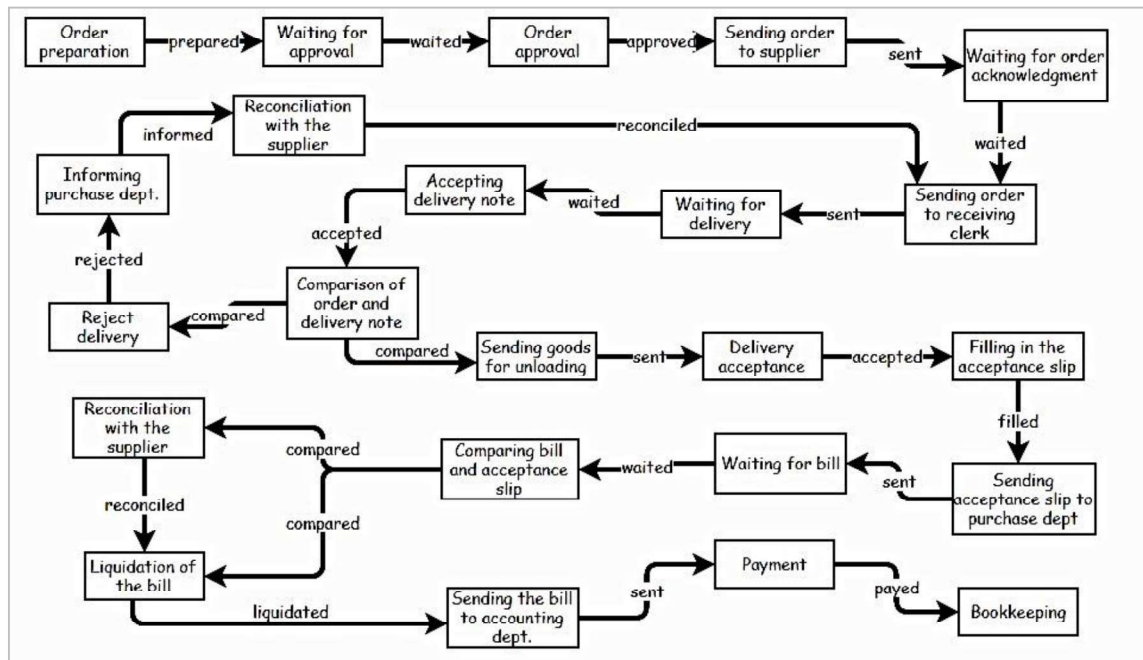

Figure 4. BE model of previous virtual company

It can be noted that, in the TO BE model, some of previously present States in AS IS model, such as, "Order Acknowledgement" and "Updating order" are discarded.
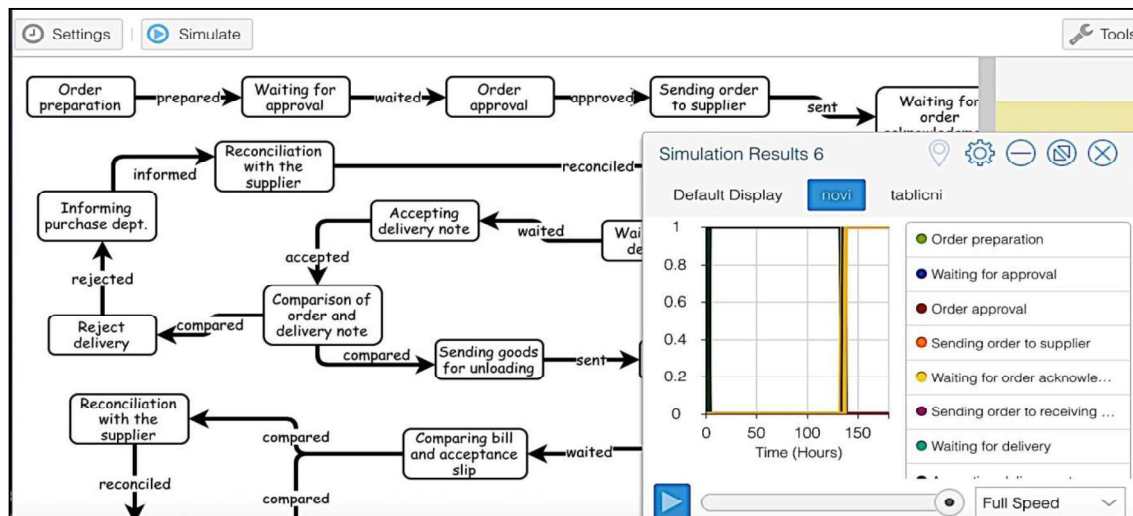

Figure 5. TO BE simulation

There are also changes in the duration of some time intervals, such as State "Waiting for bill" –duration (10-120min), and other. Figure 5., shown the result of one of simulations. After making five simulations, of TO BE process, with different time of processes execution, experimental result shown that:

TO BE Average time (hours) = [Simulation1.time(156hours) + Simulation2.time (120hours) + Simulation3.time(63hours) + Simulation4.time(83hours) + Simulation5.time(120 hours)] /5 =542/5 =108.4 hours

5.3. EVALUATION AND INTERPRETATION OF ACHIEVED RESULTS

After 5 simulation cycles made for both models, using Insight Maker : AS IS model created for an initial virtual company and TO BE model, created for the same company with proposed changes whose impact needs to be evaluated, it can be perceived that TO BE process should be improved. The average time to complete all task and business processes, for TO BE model is 108.4 hours, which is significant shorter than average time for AS IS model, 196.6 hours. The result will be different if more simulation cycles are performed. Use of Insight Maker, for e-business process modeling prove that re-engineering would be successful in this case, because, shortened time to perform activities, means saving for a company. But, even the reduce of time is significant, the Insight Maker does not have the option of calculating the money spent on resources and duration of the activities which could influence the results.

6. CONCLUSION

Insight Maker is an open source tool and all of its functionalities are completely free to use. Its main strength is that it is collaborative tool so more person can work on the same time. Moreover, it is web based application so to use it, it is necessary to have just internet connection and browser. No installation is required. Employees on community forum answers very quickly on user problems. There is plenty of video tutorials and user manual as a source of learning to work with this tool.

Big weakness of this tool is its slow learning curve. It takes a time to learn to work with it. User need to be familiar with 2 types of modelling and all the building blocks. The modelling and simulating e-business processes in this tool is extremely challenging task. The biggest problem is that it is not the primary purpose of the tool, so there is no explanation of how to do that. Since it is new tool user community is very small and no one until now how worked on this problem. The tool does not support BPMN process modelling so there is no constructs like activities or decisions. In order to make model and simulate in Insight Maker, the advices of employees on community forum were listen.

Today there is growing trend of popularity of cloud. Everything is trying to move on the cloud. That is the big opportunity of this tool. It is completely web based. Moreover, user can create different models, and they even trying to improve Insight Maker. On community forum they can suggest what could be implemented next.

The treats to the tool are based on financial support. Since everything is on servers, increasing the price of the servers could eventually lead to situation where use of the tool will not be free of charge any more. Also, its creators and supporters can cancel financial support and stop maintaining and developing the product.

All in all, Insight Maker is very powerful tool, but in purpose of e-business process modelling is still not the best choice because it is not supporting BPMN, there is no explanation of how to do it and there is no possibility to add the costs to sources or activities. The simulation gives accurate directions and results, but only sufficient for pre-evaluation. Additional measures are needed to confirm the results.

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