A NOVEL TOOL FOR THE DESIGN AND SIMULATION OF BUSINESS PROCESS MODELS

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ABSTRACT

In this paper, a novel software is presented, serving both as a Business Model (BM) design tool and as a Decision Support System for the measurement and assessment of different BMs, towards specific Key Performance Indicators (KPIs). One of this tool's novelties lies in its capability to easily model and assess BMs that are oriented to Mass Customization (MC), through a set of dedicated functionalities and KPIs. This capability is demonstrated and evaluated through a case study, having stemmed from the shoe industry.

KEYWORDS

Business Model, KPI, Simulation, Mass Customization, software tool

1. INTRODUCTION

Over the years, global business and the economic environment are changing rapidly. The environment is being developed and becomes more and more competitive and uncertain, thereby making business decisions increasingly difficult. Of course, any manager or operator does feel the way his business works and the way it produces whatever products or services for the market, but there is still the need for a systematic way to be found that would be defining the scope of this business, describing the way one's enterprise operates as a productive unit and finally for strategic decisions to be made. The people in business, are faced with questions, which they would find much easier to answer if there was a dedicated method or a set of procedures - tools through which they would be able to understand which is the Business Model (BM) and the actual elements forming part of the BM, so that they communicate more easily and compare to other similar companies or even to try changing some of the factors of production in order to explore business opportunities without a great risk. Osterwalder (2004) defines a BM as a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic for earning money. It is a description of the value that a company offers to one or several categories of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams.

The objective of the work presented in this paper, was the development of a software tool for the design, simulation and assessment of BMs, emphasizing on Mass Customization (MC). In the following chapter, the state of the art on similar tools is reviewed. Based on the limitations of these tools, the capabilities of the new software are pointed out in Section 3. In Section 4, the tool is applied to a case study, coming from the shoe industry, in order for its applicability to be investigated. In the same section, the results are discussed, while in Section 5, conclusions are drawn.

2. EXISTING TOOLS FOR BM ASSESSMENT

Over the past few years, a large number of new commercial software tools, dedicated to the design, simulation and assessment of business models, sprang up. Most of these tools define business processes, having graphical symbols or objects, with individual process activities depicted as a series of boxes and arrows. Special characteristics of each process or activity may then be attached as attributes to the process. For the aforementioned description, there is a wide range of notations and languages, dedicated to the BM's representation. The Business Process Modelling Notation (BPMN) is a widely used standard of business process modelling, and provides a graphical notation for the specification of business processes. Furthermore, the majority of the tools using BPMN allow for some type of analysis, depending on the sophistication of the tool's underlying methodology. The simulation performed can be either continuous or discrete-event, dynamic and stochastic. Moreover, the simulation tools typically provide animation capabilities that allow the process designer to observe how customers and/or work objects flow through the system. The capabilities of some indicative commercial tools are presented in the following paragraph.

The Adeptia BPM Suite is a web based software tool, capable of modelling and simulating a business process along with the BPMN. It helps business managers to calculate cost and time parameters of "As-Is" and "To-Be" processes (ADEPTIA website). The Bizflow Process Modeller, also based on the BPMN, has modelling, simulating, executing and optimizing process capabilities. The Process Modeller compares the As-Is and To-Be model by measuring their operational performance, based on built-in and custom-made KPIs. Some indicative KPIs are the turnaround time, lead time, customer satisfaction and delivery time (HANDYSOFT website). ARIS Business Architect & Designer is a business process modelling tool, aiding IT managers to discover the relationships between processes and the used resources. Furthermore, it provides a wide range of templates and supports many architectural concepts (BPMN, BPEL etc.). ARIS Simulator belongs in the same software family and simulates the designed models. It analyses KPI's such as the process throughput time, dynamic wait states, organizational centre utilization and cost rates in order to predict risks and identify bottlenecks (SOFTWARE AG website). The Oracle BPM Suite is another tool, based on BPMN and BPEL for modelling, managing, simulating, optimizing and executing business processes. The Oracle BPM Suite provides business managers with real-time lists, charts and KPI's analysis (ORACLE website). Similarly to the previous tools, ProVision supports a wide range of notations and languages and enables users to analyse, design and simulate business processes through the Monte Carlo and other discrete event simulators. The "As-Is" and "To-Be" analysis is another feature of ProVision which compares information such as that on service level, time, resources, error and cost reduction (METASTORM website). Finally, Prosim uses the IDEF3 language and is capable to automatically generate simulation models, analyse the efficiency of current models and test the strength of the proposed scenarios (KBSI website).

Besides the commercial software available, several scientific papers have been published on tools and methodologies for the modelling and simulation of BMs which, in the near future, could be commercialized as well. Some indicative works are reported hereafter.

Barjis (2009) proposed a method, which employed the DEMO Methodology, developed by Dietz (2006) for the modelling of business processes, but adapted graphical notations and formal semantics so as to generate models that led to an automatic analysis or simulation. Soshnikov and Dubovik (2004) presented an approach combining a knowledge-based business process description with an industry-standard functional decomposition in order to obtain a structured process modelling. Moreover, the approach could provide out-of-the-box a technology for business process simulation by logical inference in a corresponding knowledgebase. Finally, Ren et al (2008) from the IBM China Research Laboratory, introduced an IBM asset named Supply Chain Process Modeller (SCPM), which provided a tailored business process modelling and a simulation environment for business consultants. This effort represents a viewpoint of how a better trade-off can be achieved between the usability and flexibility of a business process tool.

3. BUSINESS PROCESS MODELLER AND SIMULATOR

The "Business Process Modeller and Simulator" (Figure 1) with the acronym "BPM" is a BM design tool as well as a Decision Support System (DSS) for the measurement and assessment of BM performances. BPM provides an integrated approach to describe new business processes and process changes with the use of the tool's modelling features, specify the level of customization of the products being produced, determine alternative scenarios and strategies for these BMs, define Key Performance Indicators (KPIs) in order to measure quantitatively the BMs' performance and finally, evaluate business process models using the simulation features. Simulation enables the examination and testing of alternative BM scenarios prior to their actual implementation in the "real" environment. Finally, through BPM, the user is capable of observing the way that the level of customization affects the BM's KPIs (such as profit and lead time).

The main differentiation of the BPM compared with other existing tools lies in its capability to easily model and assess BMs that are oriented to MC, through a set of dedicated functionalities and KPIs.

3.1. MODELLING FEATURES

Modelling of the business processes is performed through a graphical BPMN editor (Eclipse 2001). The BPMN is a standard of business process modelling and provides a graphical notation for specifying business processes in a *Business Process Diagram*, based on a flowcharting technique very similar to the activity diagrams from the Unified Modelling Language -UML). The Resources are also modelled in BPM, in a flexible way. The flexibility lies in the tool's capability to formulate resource groups and alternative resources. The different types of resources that can be set are: Human, Equipment and Software. Cost attributes (fixed and/or variable cost) that may characterize the resource is also possible to be specified.

In BPM, the process arrival rate and process instance data can be modelled (see Figure 2). The BPM supports two types (uniform and normal) to model the arrival rate distribution. The BPM supports two ways of specifying the input data; it can be generated or it can be imported directly from either an Excel or a flat file.

After the Business Processes and Resources have been modelled, the assignment of the latter to the processes may take place. Process time and quality attributes characterize such assignments (see Figure 3).

In order to easily include in the model customization related information, two dedicated Graphical User Interfaces (GUIs) were developed: the first one provided information about the market segment, while the second one described the value proposition (Figure 4).

In the "Market segment" GUI, the profile of the customer(s) can be determined by selecting one or more profiles, from the predefined ones available in the GUI, which better describe the customer(s). This functionality enables the direct comparison of the profile with the KPIs (e.g. profit) under investigation and obviously, is of great interest in the case of MC. In the same GUI, the market share per country is possible to be specified, aiding in taking managerial decisions regarding the production volume per season, the material ordering, the arrangement of the logistics etc.

In the second GUI, the "Value Proposition", the value of the product proposed by the company is expressed through the determination of the product type, the cost range, quality drivers as well as the level of customization described in a quantitative manner. These parameters can be later included in the KPIs' expression, in order for the influence of the value proposition to the company's BM to be investigated.

In BPM, a number of KPIs to be calculated during simulation, can be determined:

- Company strategy KPIs: impacts/restrictions of the company strategic objectives (in relation to the basic shoe design)
- KPIs for the Logistics: suppliers, customers etc.
- Manufacturing KPIs: time, cost, production parameters
- Local PI calculation at each alternative process/routing
- Cumulative KPI calculation for a business scenario simulation
- Global KPI estimation at strategic level (e.g. KPIs for a whole season's production)

In BPM, there is a set of built-in KPIs. These KPIs are the Cost, Time, Quality and Flexibility indicators.

- The cost KPI reports the total cost of the resources, performing the tasks of one business process instance.
- The time KPI reports the total time for each process instance to be completed.
- The quality KPI measures the quality of a process instance.
- The flexibility KPS measures the sensitivity of the business process to changes using the Penalty of Change Method (Chryssolouris 1992, Alexopoulos 2005)

However, the tool also provides the possibility of user defined KPIs. Such an example is the KPI "Profit". Since a BM allows expressing a company's logic of earning money, the "Profit" can be considered as a standard one for any BM simulation. This KPI has not been integrated into the default ones of the BPM, due to the fact that each company uses its own expressions for the calculation of profit. Finally, Jufer et al (2010) have determined in their study, a set of KPIs related to MC, which could be employed by BPM. Javascript is used for describing user defined KPIs.

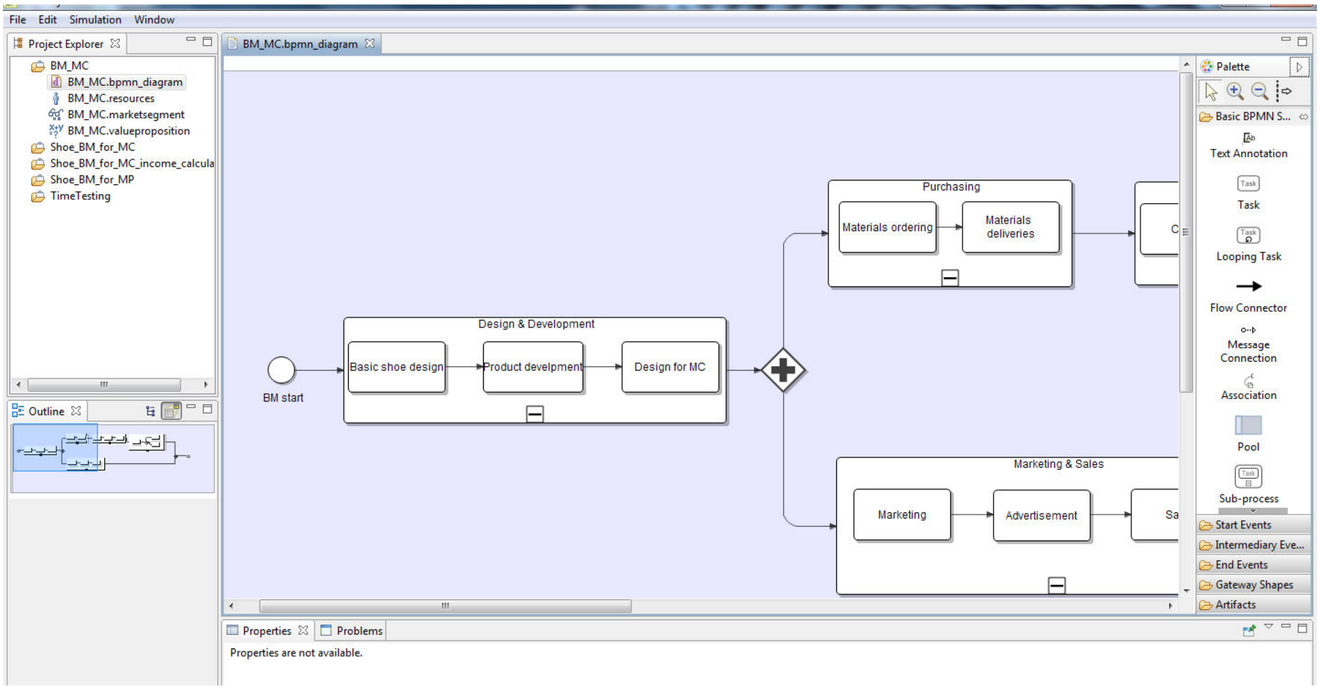

Figure 1 - Business Process Modeller and Simulator – BPM software tool

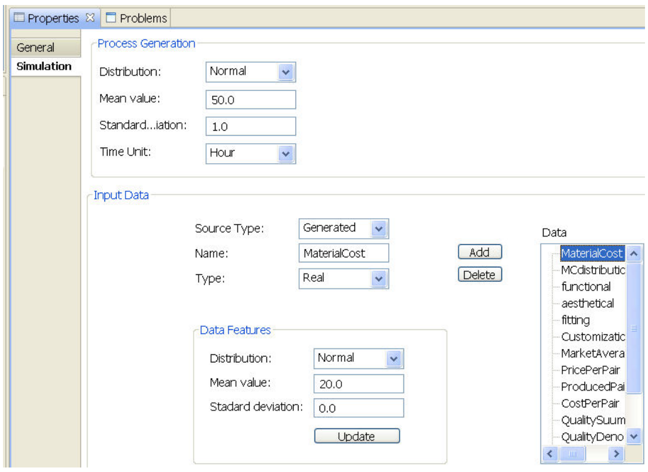

Figure 2 - Preparing the simulation input

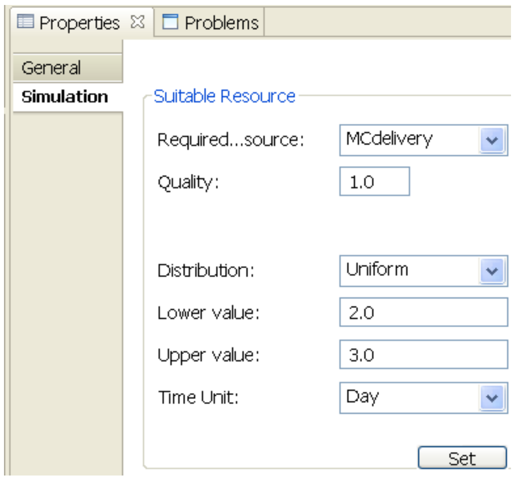

Figure 3 - Specifying resource process time and quality

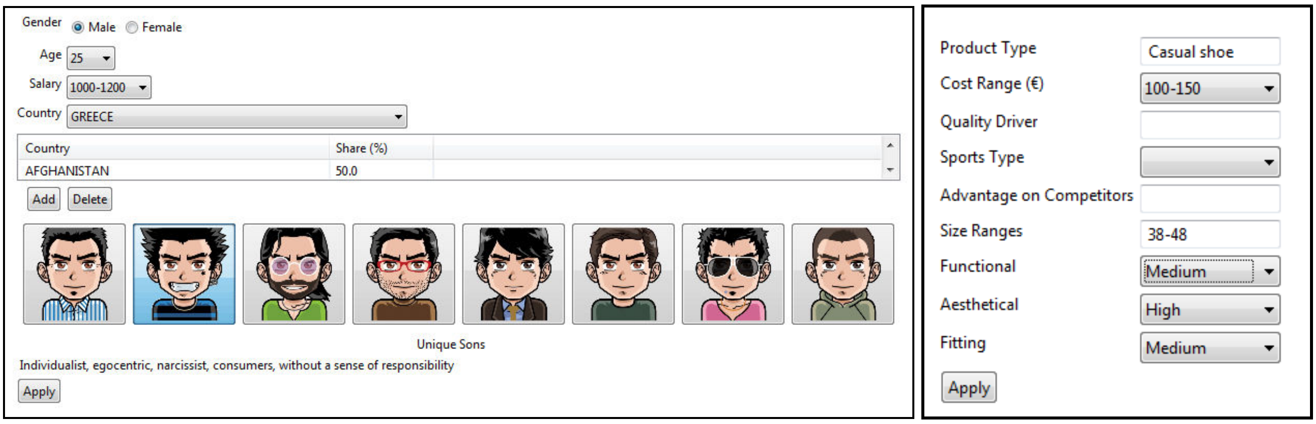

Figure 4 - Market segment (left) and value proposition (right) GUIs

3.2. SIMULATION FEATURES

In order for the BM generated in BPM, to be simulated, the process generation as well as the simulation time are determined by the user. The process generation time is possible to be defined in a probabilistic way, through a standard or uniform distribution. The results data are stored in Excel spread sheets. Each time a different simulation scenario is created (by altering some the BM attributes) and therefore, a new simulation is run, and also a file is generated with new results. This feature enables the easy storage of the previous results, in order for the different scenarios and business strategies to be easily compared and evaluated. For this assessment, multi-criteria decision making approaches can be employed, taking into consideration the KPIs, used in the model, in order to identify the optimum BM (Chryssolouris, 2006). At a conceptual level, the simulation is performed in a typical way in which entities / and parts move through a series of queues and buffers, acquiring and releasing resources as they move through the business model domain. The entire model is driven by a sequence of discrete events, which occur when a task is completed, and the entity movement that occurs as a consequence of these events occurring. At the very low level, the business process is simulated with the use of a Discrete Event Simulation engine (DesmoJ, 2011). However, the core of the BPM is a set of objects that wrap DesmoJ objects and map them directly onto the BPMN diagram symbols.

4. CASE STUDY

4.1. DESCRIPTION

The BMs of two different shoe industries have been assessed with the help of the BPM tool. The first shoe industry is massively producing shoes, having no customization options, while the second one may produce highly customizable shoes.

The business processes, constituting the BM of each case, are almost identical (Figure 5). The BM initiates with the "Product Design and Development" process, where the conceptualization, design and development of the shoe is taking place. The "Material Purchasing", "Manufacturing" and "Logistics" processes follow, for the shoe production and delivery. At the same time, a "Marketing and Sales" process is run for the shoe.

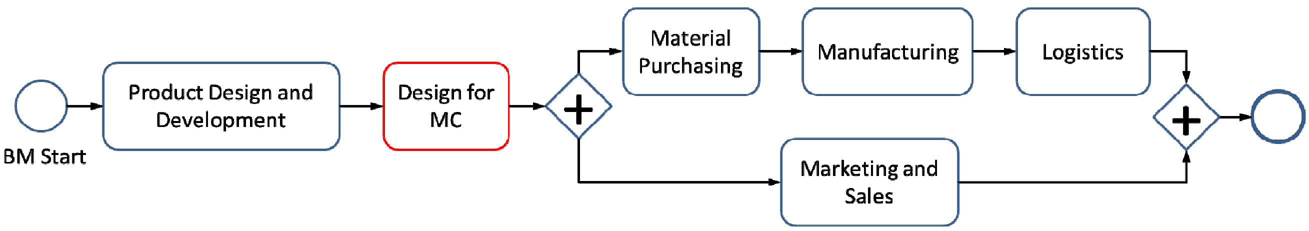

Figure 5 - Shoe industry's BM abstract representation

Table 1 - BM modelling and simulation data

	Mass Production	**Mass Customization**
Process generation time	6 months	12 hours
Simulation time	1 year	3 months
Produced pairs/Simulation time	1500	1
Customization types	N/A	1. Functional 2. Aesthetical 3. Fitting
Customization levels and coefficients	N/A	1. Low = 0.03 2. Medium = 0.2 3. High = 0.3
Business Processes data		
“Product Design and Development”	Cost (€)	
	22500 ± 7500	2 ± 0.5
“Design for MC”	Cost (€)	
	N/A	60/hour
“Material Purchasing”	Cost (€)	
	150 – 375 K	MP cost * *[Customization level]* (see Eq. 5)
	Time (hours)	
	Pre-ordered	4-240
“Manufacturing”	Cost (€)	
	90 – 150 K	7.5 - 12
	Time (days)	
	35 - 50	1 – 3
“Logistics”	Cost (€)	
	N/A	4 – 5
	Time (days)	
	N/A	1 - 3
“Marketing and Sales”	Cost (€)	
	18 – 24 K	1.2 – 1.6

The afore-described BM representation can be considered as abstract and top level. Each of these business processes may be explicitly described through a set of sub-processes.

The differentiation between the two productions lies in the “Design for MC” process (red box in Figure 5) that is required in the case of the customized shoe production, in order for the customization features, provided by the customer, to be designed according to the shoe model. Additionally, the attributes characterizing each business process are completely different for the two cases. For instance, the cost of material purchasing in the case of the customized shoe production is higher, since a build-to-order production is followed. On the other hand, in the case of mass production, the materials required for the season’s production are ordered all together and thus, a better price is achieved.

The main data utilized for the modelling and simulation of these BMs are listed in Table 1. All of them stem from a real shoe industry. For the case of MC, three customization types are considered, each one having three levels.. The levels’ coefficients provided, are user-defined and configured according to several aspects, such as statistical data on the price the customer is willing to pay for the shoe and the company’s particularities. These coefficients act as an accession to a couple of costs and prices (shoe pair’s price, material cost etc.), affected by the addition of the customization options.

The KPI of interest in this study is the profit, obtained by each case, in order for the two different production strategies, as well as the lead time (the time required from the shoe order by the customer, until its delivery to him) to be compared. Additionally, the effect of the customization level on the profit is also examined. Since, the profit is not built-in KPI, the equations from which it derives are given below:

Profit = [Income] – [Expenses] (1)
Income = [Price per pair] * [Produced pairs per season] (2)
Expenses = [Cost per pair] * [Produced pairs per season] (3)
Price per pair = [Market average price] * [Customization level] (4)
Customization level = 1 + ([Functional] + [Aesthetical] + [Fitting]) (5)

4.2. RESULTS - DISCUSSION

A set of graphs has been generated in order to for the results to be better visualized and compared. In the graph of Figure 6, the profit/pair for the two production types is compared. It is obvious that through the production of customized shoes, the profit can be drastically increased (up to 661 %). This is mainly observed due to the fact that the extra money the customer is willing to pay for a customized shoe, is much more compared with the additional production expenses, accruing from the customization.

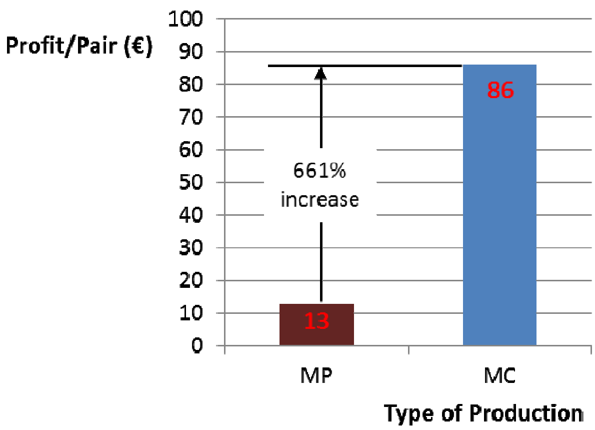

Figure 6 - Profit/Pair for the different production types

Another interesting graph produced, is the profit/pair versus the different customization levels, for the MC case (Figure 7). It can be easily seen that the higher the customization level is, the higher the profit/pair. The reason that the profit is not kept constant, is that the price the customer is willing to pay, is getting higher with the customization level being increased. However, the production cost is not relatively increased from level to level and thus, a higher profit is observed.

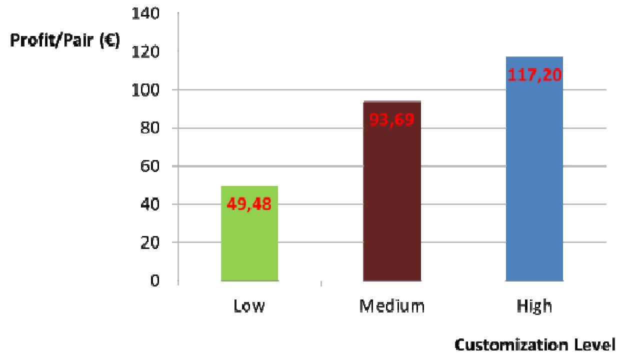

Figure 7 - Profit/Pair for the different customization levels

The last graph derived from the simulation results, is the time required for each event (the event starts with the shoe order and ends with its delivery) to take place (lead time), for the cases of MP and MC (Figure 8). The time for the MP refers to the whole season's production, while for the MC to the production of a single pair. As it can be noticed, although the time in both cases does not increase, there is a fluctuation from event to event around a value. This means that all the BM processes are carried out on time and thus, no delays are observed on the event's execution. For the case of MC, the time ranges from 4,45 to 28,09 days. This range may be acceptable by some companies, while by some others it may not. In the latter case, remedial actions should be taken in order for the process time, in some time-consuming tasks, to be reduced. The same actions should also be taken with reference to the increase in time from event to event. This would happen if some processes were not accomplished on time, causing delays in the execution of the event.

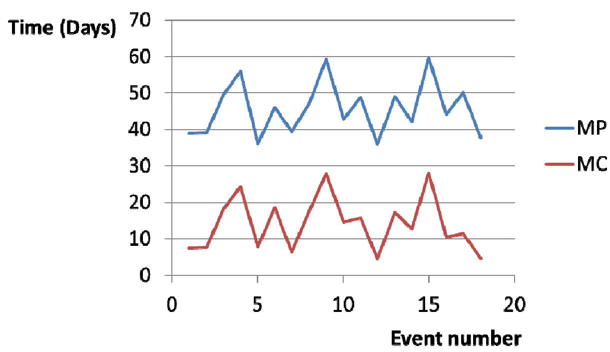

Figure 8 – Time versus event for MP and MC

5. CONCLUSIONS

A novel tool for the design and simulation of BMs oriented to MC has been presented in this paper. This tool, compared with the state of the art, can address customization parameters during the modelling and simulation and thus, evaluate the alternative BMs, in terms of customization aspects.

The tool's efficiency has been demonstrated and proved through a case study having stemmed from the shoe industry, where the effect of MC on the company's profit has been investigated. Additionally, it was shown that the management and post-processing of the results data is quite simple and easy, since it is stored in Excel sheets (generation of graphs, use of different sheets for each BM's results etc.).

In future work, the authors intend to enhance the BPM with more built-in KPIs with special attention being given to flexibility indicators. Moreover, the applicability of the tools will be further investigated with case studies from different industrial sectors.

6. ACKNOWLEDGEMENT

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