Business Model Pattern Execution
A System Dynamics Application

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Abstract: The dynamic aspects of a business model are key to understanding the behavior of the business and the consequences of any change. In spite of the multiple approaches to describe business models, most of them emphasize static elements and leave the dynamic ones to intuition which in turn, diminishes the overall understanding of the model. Among the approaches that explicitly present dynamic elements, we find business model patterns which provide a visual representation of the dynamic behind the business by portraying information, value and money flows. Although the representation delivers adequate insights on the dynamics, it is possible to enhance them by executing the patterns. To visualize the dynamic behavior and the effects of changes and time in any component, we present an approach based on system dynamics.

1 INTRODUCTION

The study of business models is fundamental to understand the enterprise's behaviour and the effect of changes. Since businesses are complex systems that can only be analyzed by identifying parts and relations among them, one must acknowledge the dynamic behaviour and implement mechanisms that support complexity management. The business model becomes relevant in this scenario as it provides the necessary description to understand the business. Since it has become a topic of interest among researchers, multiple approaches and definitions have emerged.

One of these approaches is based on business model patterns (Romero et al., 2016). In it, a business model is defined in terms of four core processes: Transformation, Supply, Delivery and Monetization. The last three can be described with patterns, as they are support processes that do not differ significantly between enterprises. Each pattern is built in terms of participants, activities and flows. The last are key to represent the dynamic behaviour of the business, as it it possible to establish how value, information and money are flowing through the business' different elements. Furthermore, as the patterns are presented in zones, they can be assembled depending on the nature of the business.

Although the flow representation gives a first view on the dynamic aspects of the business, it is necessary to enhance their visualization to recognize the effects that are unleashed as they establish relations among components, and time goes by. This not only provides a better understanding of the business, but also allows to foresee the possible consequences of any change. For doing so, one should execute the patterns but, given that the current representation is not executable it is necessary to modify it. This paper presents a system dynamics application in which business model patterns are expressed in terms of system dynamics, and executed to visualize the different relations and the possible effects of any change. By providing an initial configuration of a business model, and defining the rules that regulate each flow, it is possible to execute it and describe the behaviour of the business and the dependencies that determine it.

2 BUSINESS MODELS

As there is no universal definition on business models the concept is not very clear therefore, one needs to understand both what a model and what a business is. A model is an abstraction of a reality; a representation that allows the analysis of a system without dealing with the system itself (Selic, 2003). The business on the other hand is often used as a synonym for enterprise. Enterprises are systems made up of interrelated resources that act together with the environment to attain a particular goal (Giachetti, 2010). They may

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range from companies to small stores that, in spite of their differences, are characterized by a high level of complexity. The business on the other hand, is traditionally perceived as a dimension of the enterprise. Regarded as the function of an enterprise, it explains what the enterprise does (Hoogervorst, 2009).

2.1 Business Dynamic Behavior

In spite of being a part of an enterprise, businesses too are complex systems. This, not only because of the amount of elements and relations that make it up, but also, because of the complex dependency network that is established as they influence each other over time. This network determines a dynamic behaviour that is responsible for the multiple effects that a single change can inflict in the business. Understanding this behaviour is essential for studying the possible consequences of any alteration however, static business model approaches are not enough for doing so.

Since some dependencies emerge from other relations or are subject to time, they simply can not be portrayed in static terms. Nonetheless, many approaches leave the dynamic behaviour to the modeler's intuition as the associated cost of the model is higher. Therefore, it is necessary to find mechanisms that diminish the cost and encourage dynamic models. The cost of the model may be evidenced in the construction process or in the analysis, therefore, tools that automate analysis or constructions processes are highly valued as they save time and effort.

2.2 Business Model Patterns

The work presented in this paper is based on business model patterns (Romero et al., 2016). These patterns are built based on a proposed business model definition: the way in which an organization gathers supplies, transforms them into a product or service, delivers and monetizes it. This definition acknowledges four processes: Supply, Transformation, Delivery and Monetization. The transformation process is unique for every enterprise but the remaining three can be described in terms of patterns. All the patterns are presented as zones that can be arranged depending on the business characteristics. This allows to consider them as modular constructors that contain the description of a process and that, depending on its position on the complete model, will define the overall behaviour. Each pattern contains participants, activities, gateways, processors and flows. The last ones are essential to portray the dynamic aspect of the business.

3 SYSTEM DYNAMICS ON PATTERNS

Although patterns can be used to analyze the business' dynamics, they suppose a higher cost. So, to facilitate their application one should establish a mechanism to either fasten the building process, or simplify the analysis. In order to reduce the cost associated to the analysis one should find means to facilitate either the process of obtaining results, or the process of interpreting them. One useful approach is System Dynamics. With it, one is able to analyze the model for a desired period of time based on an initial configuration. Furthermore, considering the structure of the approach and the building blocks that must be used, it is possible to maintain a relation with the visual representation of the patterns.

3.1 System Dynamics

The complexity of systems emerges not only because of the amount of components, but because of the relations that arise with time. Although it is possible to identify certain cause-effect relations, the inherent feedback of the complex systems leads to other effects that can not be foreseen from a linear perspective. (Sterman, 2001). System Dynamics is a well know approach to analyze complex systems and their non linear behaviour based on stocks and flows modeling. Through stocks, one is able to represent accumulations (of materials, money, people...) that can be measured in time. Flows on the other hand, are the product of movement through time. Flows carry what stocks accumulate and depending on their type, they will increase or decrease the stock. The relation between stocks and flows is established through information links (Kirkwood, 1998). In order to create a system dynamics models, one should identify accumulations, flows and, through the use of information links, establish the equations that regulate said flows.

3.2 Pattern Equivalence

Since business model patterns are presented in a static way, they must be translated to an executable representation. To do so, equivalences between the system dynamics components and the pattern's must be found. Since system dynamics considers stocks, flows and information links, and patterns include zones, flows, gateways, processors participants and activities, there is not a one to one equivalence. Furthermore, defining the corresponding representation also depends on the way in which system dynamics will be applied. In our case, to build the model and execute it we used the software iThink by isee Systems.

3.2.1 Flows

The conversion of the pattern model begun by defining flow equivalences. This was based on the purpose of the system dynamic model and in particular, in what was going to be analyzed. Since patterns consider three flow types, depending on the type that would be monitored, the equivalence between stocks and flows was be established. For matters of this research, the value flow was given priority and so, stocks and flows were associated to it.

Information flows were given the equivalence of information links since there was an interest in visualizing the movement throughout the different components, but not in the particular values. However, if an information flow triggers another information flow, the result of the interaction should be modeled with a converter (Auxiliary Variable) in order to be stored. For instance, if a participant generates a request to get a value from another participant in order to make a calculation, the result of the latter needs to be stored. This considering that the result will be used to trigger other flows. Converters should also be used when the information flow is associated to a status notification.

Finally, money flows were monitored with an Excel file that is updated as the model is executed. This, since there was a need to keep trace of the accumulation of money, and it allowed a better analysis of financial components. Table 1 presents the equivalences between pattern and system dynamics flows.

3.2.2 Participants and Activities

The equivalences of participants and activities were granted with the stocks and flows. As there is a concern for the system's overall behaviour, we did not include activities as part of the equivalences although they can be associated to the sources and sinks of the flows, that most if not all the time, are associated to the accumulation.

Participants on the other hand, were represented either by stocks or converters. The last ones being defined as auxiliary variables that keep trace of certain values. The decision between both representations depends on the participant and whether it associates with a value flow at some point. If the participant generates or receives value then it is represented with a stock; if it only receives money or information, then it is represented with a converter (auxiliary variable). Table 2 presents said equivalences.

3.2.3 Processors and Gateways

Considering the graphical notation of iThink and the clear differences between the different flow types, processors were not used in the equivalence. Gateways on the other hand, were already included in the flow representation of system dynamics flow.

3.2.4 Zones

As patterns are enclosed in a zone, the iThink model was build in a similar way. By drawing a frontier (square) around each system dynamic pattern that was modeled, it was possible to maintain a zone-like equivalence. It is expected that the iThink zone contains the system dynamic components relevant to the portrayed pattern.

3.2.5 Pattern Conversion

The general conversion from patterns to iThink models is presented in Table 3. First off, one must identify the number of zones in the pattern and portray them with the equivalence. Next, participants are differentiated between those that receive or trigger a value flow, and those that do not. In the general business model pattern, the three participants are related to value flows and therefore they all are presented with a stock.We then proceeded to define the value flows. According to the pattern there are two value flows that connect participant 3 and 1, and participant 1 and 2. Consequently, the flows in iThink should connect the stocks in the same way. Finally, we represented the information flows with converters and flows. To do so, we followed the order established in the pattern. In this case, we have a first flow that comes from another zone, so, to represent and store its value one should define a converter in the triggering zone and in the receiving zone, both connected by an information link. There is also an information flow (generated by the previous one) that triggers another information flow. In this case they define a decision and so, they should be connected to a converter that generates the fourth flow.

The previous process was followed to convert all defined business model patterns.Table 4 presents the conversion of the Deliver Engineer to Order Product pattern. As it is possible to evidence the number of iThink zones is correspondent to the number of zones in the pattern. In this case it is important to note that Logistics is presented as a converter as it does not involve value flows. Furthermore, as there are two flows that arrive/leave other zones, the correspondent stocks of the zones are portrayed,

Table 1: Flow Equivalences.

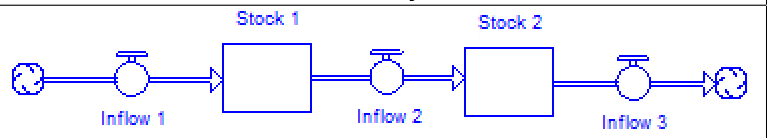
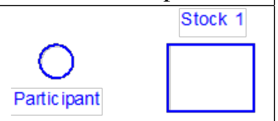
Information Flow	iThink Component
- In -.-.-.-.-.-	
Value Flow	iThink Component
— V———	

Table 2: Participant Equivalences.

Participant	iThink Component
Participant	

3.3 Study Case: Editorial

In order to test the equivalences and dynamic model, we used a study case based on an editorial. Editorial de los Alpes offers textbooks written by teachers and professors for schools and universities in 12 cities.The edition of a book starts with the enrollment of its author. To do so, a visitor stops by schools and universities to promote the editorial services and talk teachers and professors into the authors call. Depending on the visit success, a number of potential authors will respond to the call and send the corresponding manuscript. Considering the textbook demand and the available manuscripts (from the catalog and the new authors) certain books will be edited and printed. Once the copies reach the warehouse, they are delivered to the editorial offices in the remaining 11 cities. As the copies arrive, the city office pays for the corresponding order and proceeds to deliver them to libraries and hypermarkets according to the demand from their clients.

3.3.1 Pattern Model

To build the correspondent system dynamics model, we first had to build the complete business model in terms of patterns. First, we defined the zone configuration based on the processes that the editorial performs. As portrayed in Figure 1, there are 7 zones. 2 supply zones (placed one on top of the other as they are performed simultaneously) that account for the materials needed to edit and print the books, and the authors, 1 Transformation zone, 2 delivery zones associated to intermediaries and the final client, and 2 monetization zones (for the city offices and client).

With the zone configuration we identified the patterns. Figure 2 and Figure 3 present the two views of the pattern model. In the case of Figure 2 it is possible to see the supply zones with a source to stock pattern. The transformation zone remains a black box with the editorial performing the transformation process, and one delivery zone (Deliver Stock Product). Figure 3 presents the city office monetization zone with an asset sale pattern, and the delivery (Deliver Stock Product) and monetization (Asset Sale) zones for the final client.

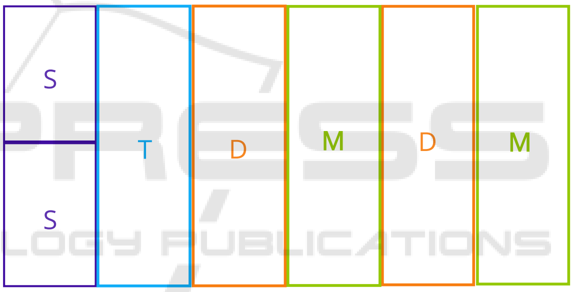


Figure 1: Editorial Zone Configuration.

3.3.2 System Dynamics Model

Based on the pattern model and the previously defined equivalences we translated the model resulting in the one presented in Figure 4. In order to build it, a similar process to the pattern conversion was implemented. First, zones were portrayed equivalently to the pattern model, second, patterns were converted with their initial equivalence maintaining the connections in the business pattern model. It is important to note that the Editorial and Transportation participants were modeled as conveyors (a special stock type) to model the edition and transportation time.

4 PATTERN EXECUTION

With the executable model we proceeded to perform its execution with two scenarios. The initial configuration run, that shows the behavior of the edito-

Table 3: General Pattern Conversion.

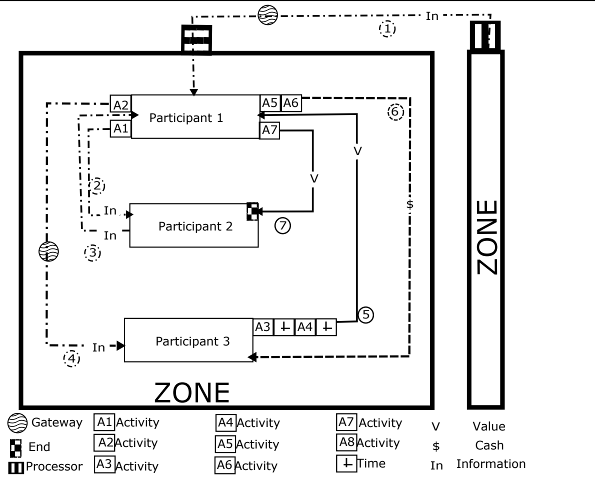
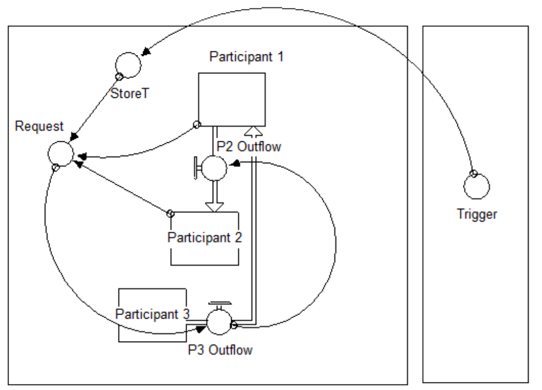
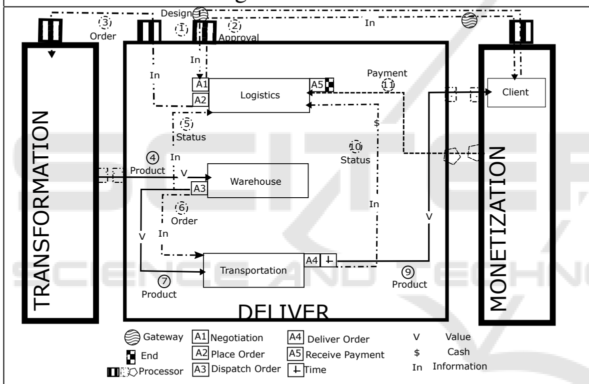
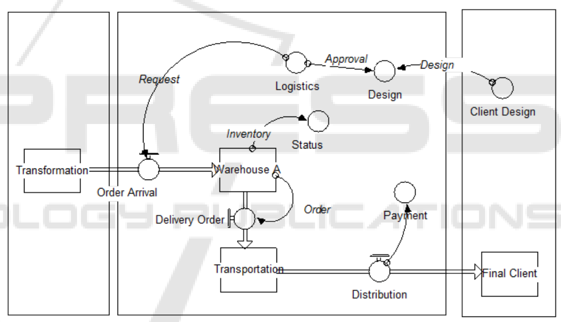
Pattern Composition	iThink Equivalence
	

Table 4: Sample Conversions.

Deliver Engineer to Order Product	iThink Deliver Engineer to Order Product
	

rial with an initial parametrization, and the experiment scenario in which two initial parameters were changed in order to visualize the reaction of the editorial.

4.1 Execution

The first execution considered an initial configuration for the editorial, these parameters will be referred to as normal conditions. The model was executed with its initial configuration in a 60 month run. Furthermore, the equations for gateways and converters were defined in terms of if-else business rules. In particular, warehouses would dispatch materials depending on the order, if the order was bigger than the warehouse level, then the warehouse level would be dispatched, if not, the order. Other equations considered demand verifications that determined elements like the number of authors who answered the calls.

Table 5 presents part of the results of the first run. In it the following variables were measured: sales, final client (Accumulation of Sales), copies in edition (Editorial) and in transit (Transportation, Car), raw materials (Warehouse) and copies in store (City Warehouse, Book Warehouse, Intermediary). All measures are done in terms of copies/month. For the raw materials, the calculation was made considering the amount of materials needed for a copy.

The obtained results show that under the initial conditions, the editorial's capacity to respond to client's demands diminishes as delays in transportation avoid warehouses to receive an optimal number of copies. Furthermore, as the intermediaries are the ones that deal with sales directly, they present a drastic reduction of their inventory as clients demands are daily. In the end, this behavior can only be perceived with time and that, in order to have a better performance, the editorial should increase its capacities.

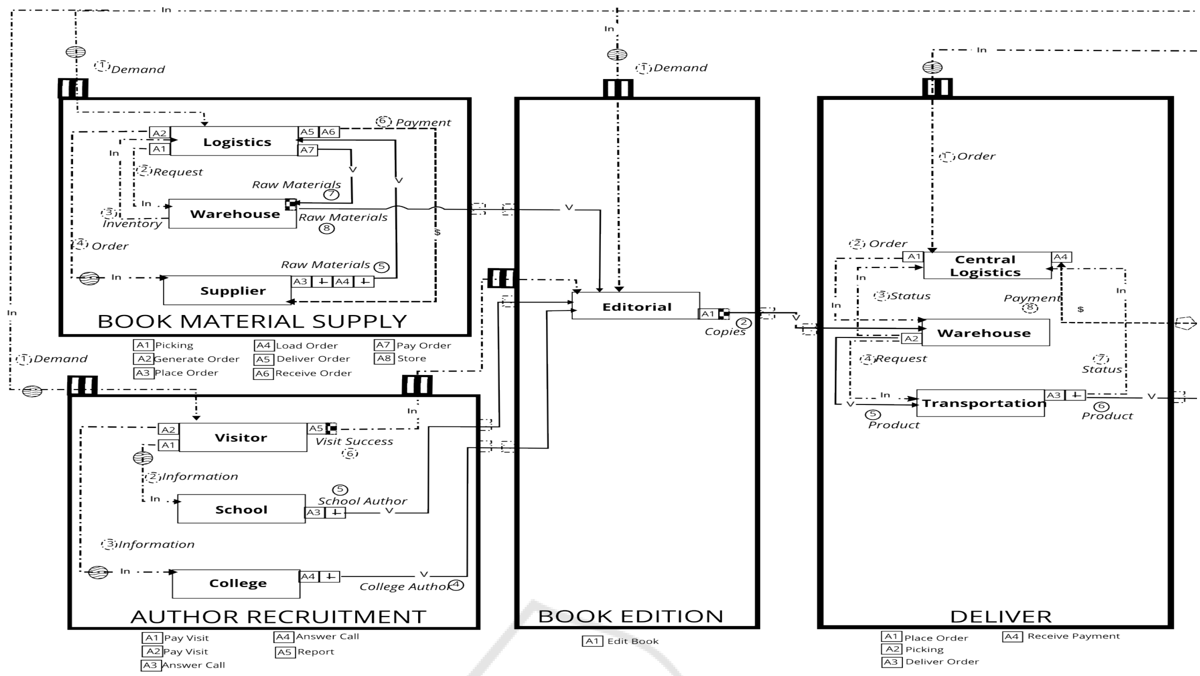


Figure 2: Editorial Business Model View 1.

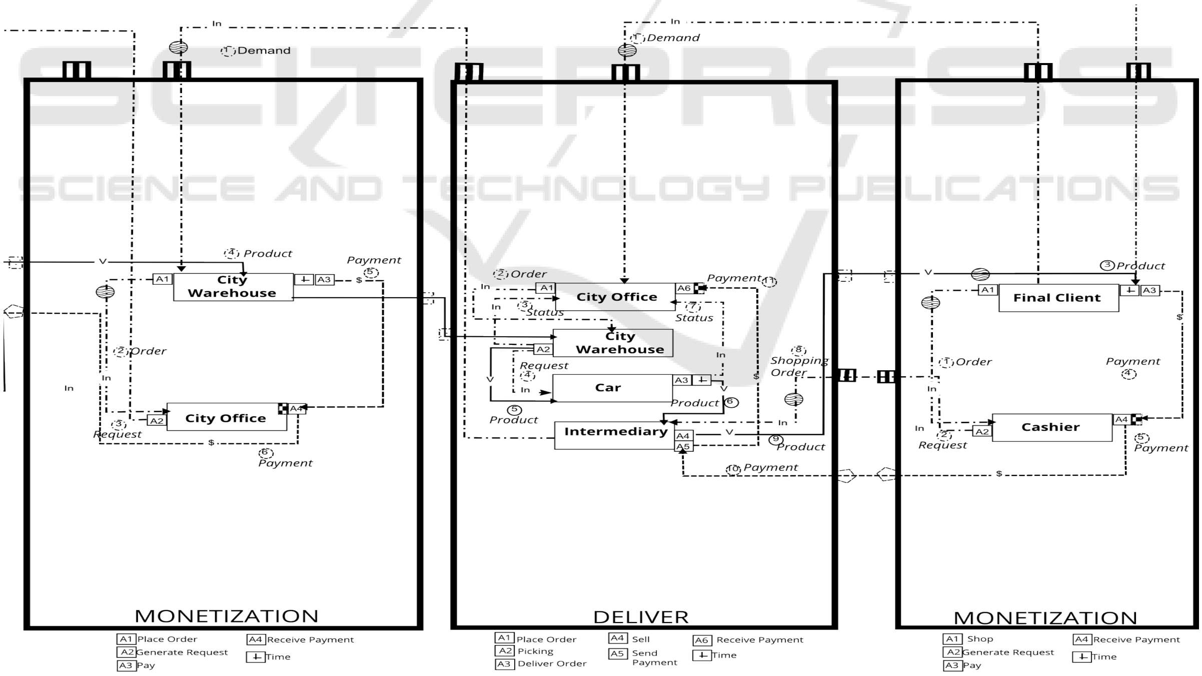


Figure 3: Editorial Business Model View 2.

The second execution considered two scenarios. One in which the client demand was doubled and one with a double edition capacity. For each scenario, besides the modified parameter, every other condition remained as in the initial configuration. Table 6 presents part of the results of both executions.

As it is possible to evidence, in the first scenario a double demand leads to sales doubling and an earlier decrease in demand response capacity (month 10 and not in 40). The other behaviours remained similar as they depended in transportation capacities were not changed. For the second scenario inventories increase

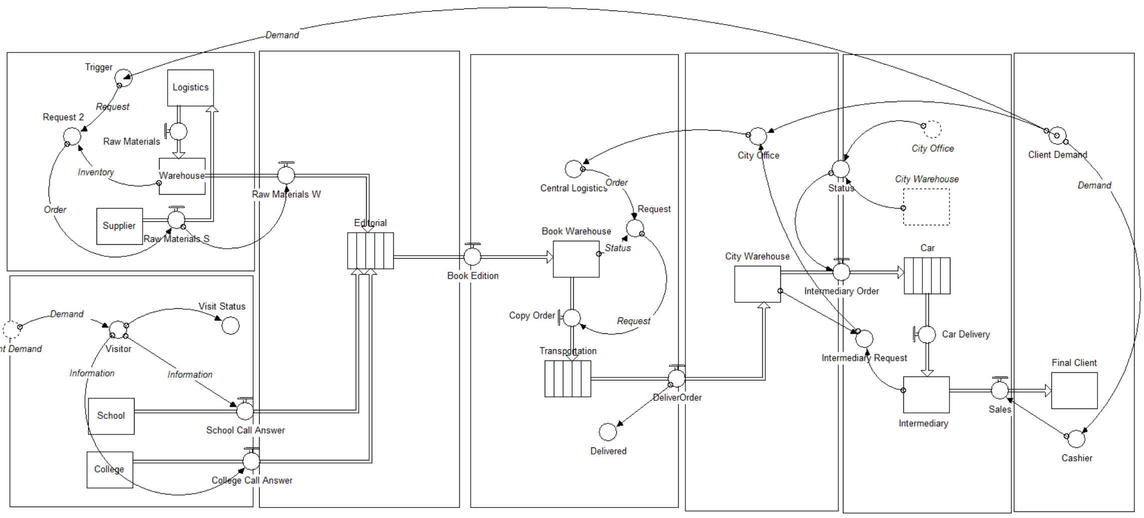
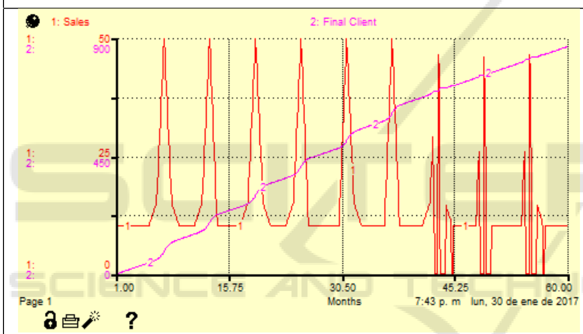
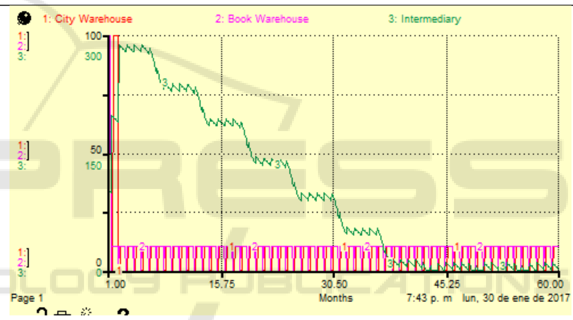


Figure 4: Editorial Business System Dynamic Model.

Table 5: What if Analysis-Initial Behaviour.

Sales	Edition
	

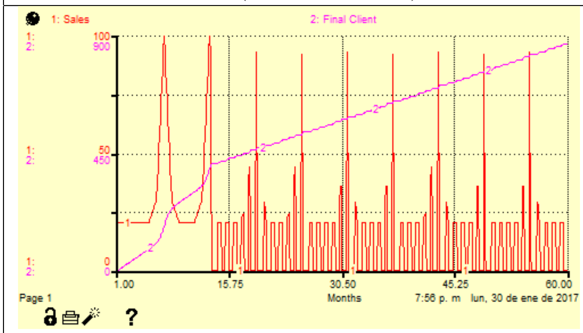
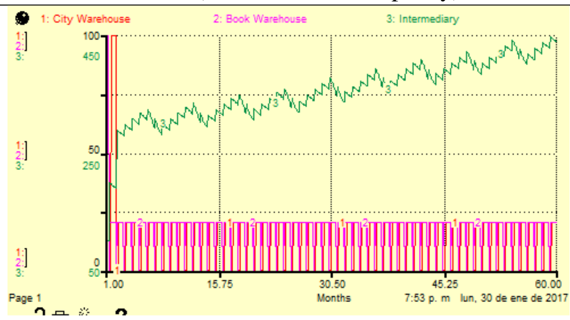
and in the intermediaries case, they tend to accumulate.

The execution of both scenarios contribute to the further understanding of the editorials behaviour. It is important to note that in spite of a regular behaviour in several months, drastic changes may emerge as the accumulation of delays will eventually affect performance. Moreover, it is possible to evidence that edition and transportation capacities are key to the editorial for they establish whether the business is able to respond to clients demands or not.

5 RELATED WORK

The use of system dynamics in enterprise analysis is presented in various works as the approach proves useful to understand the overall behaviour of complex systems. The simulation capacities of the approach have been used in researches regarding what if analysis of enterprises (Sunkle et al., 2014), canvas simulation (Romero et al., 2015) and resource allocation (MacDonald et al., 2003). In the first case, what if scenarios were tested for the intentional model of the enterprise. Other works have also attempted to understand and even forecast the nonlinear behaviour proper of businesses. Such is the case of the work presented in (Hoptroff, 1993) in which neural nets were used to forecast and model relevant business elements like cash flows, stocks and sales. It is clear that the complexity behind businesses has motivated researches for understanding and managing it. Furthermore, in order to guarantee an appropriate comprehension of the businesses, the effects of time in the relations of the system must be acknowledged while considering that static representations are not enough to fully understand the business behaviour.

Table 6: What if Analysis-Final Behaviour.

Sales (Double Demand)	Edition (Double Edition Capacity)
	

6 CONCLUSIONS

This paper presented an approach to dynamic business models by executing business model patterns with system dynamics.By establishing equivalences, a complete business pattern model based on a study case was built and tested under two scenarios to illustrate the scope of the approach. The results clearly portray the effect of time on the relations between agents and the overall success of the enterprise, and reflect the importance of evaluating the business model under dynamic conditions for its complexity is only revealed with time.

In spite of businesses being complex systems, analysis like the one presented in this paper contribute to complexity management. Although achieving a complete understanding is not trivial, the fact that from a static business model one can derive an executable one that leads to valuable insights on the business, proves to be useful. Approaches like system dynamics, which have systems as part of their core concepts, provide an intuitive mechanism to constructing executable models and easing their analysis. Furthermore, if general equivalences are established, the translation of static models to executable ones is accelerated.

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