Dynamics of Business Models
–
Long-ranging Impact Assessment of Business Models in the Capital Goods Industry

Christian Lerch
Fraunhofer Institute Systems and Innovation Research
Competence Center Industrial and Service Innovations
Breslauer Str. 48
76139 Karlsruhe, Germany
Phone: +49/721 6809-320
Email: Christian.lerch@isi.fraunhofer.de

Gregor Selinka
Fraunhofer Institute Systems and Innovation Research
Competence Center Industrial and Service Innovations
Breslauer Str. 48
76139 Karlsruhe, Germany
Phone: +49/721 6809-320
Email: Gregor.selinka@isi.fraunhofer.de

In recent years, new business models are becoming increasingly more important for manufacturers in the capital goods industry. However, manufacturers of plants still hesitate to offer these customer-oriented solutions, due to existing uncertainties resulting from economic risks. The offer of innovative business models requires a stronger integration of the supplier into the life cycle of a plant and hence into the production phase of the customer, leading to the consequence that manufacturers have to restructure their previous activities extensively. Due to the financial risk connected herewith, decision models are required, which identify and assess the impacts resulting from the implementation of these innovative business models. Aspects like time delay, due to the reorganization of the service department or the set up of adequate human resources have to be considered. Therefore, the aim of this contribution is to develop a system dynamics model for the analysis of long-ranging consequences due to the implementation of an exemplary business model.

Business Models, Capital Goods Industry, Availability Guarantee, System Dynamics.

1 Introduction

Business models become more and more important for enterprises of the capital goods industry (Grönroos 2000; Baines et al. 2007). On the one hand, business models are able to increase the competitiveness of industrial enterprises and on the other hand, they help to open up new markets that are not accessible by means of traditional products (Wise/Baumgartner 1999). Accordingly, the offer of these customer-oriented solutions as a combination of product and services hold high potentials for manufacturers.

However, due to existing uncertainties manufacturers of plants still hesitate to offer these innovative solutions to their clients. One reason for this situation might be intra-company changes becoming necessary due to the implementation of business models (Homburg et al. 2003). To offer these innovative solutions, suppliers of plants have to restructure their previous activities extensively. The decisions connected herewith have long-ranging impacts for the change from a manufacturer to a customer-oriented solution provider (Oliva/Kallenberg 2003; Gebauer 2004). Due to financial risks connected herewith, decision models are required, which identify and assess the impacts resulting from the implementation of business models.

Aspects like time delay due to the reorganization of the marketing department or the set up of adequate human resources have to be considered, just as the transfer of market risks from the client to the supplier (Baines et al. 2007). Furthermore, there are a lot of different factors concerning industrial changes which often influence each other and are characterized be feedback structures and delays (Forrester 1961, Jahangirian et al. 2010). Finally, enterprises changing from a manufacturer to a customer-oriented solution provider can hardly estimate the impacts of a decision during that process.

This paper tries to show the dynamics arising from implementing new business models in the capital goods industry with the aim of supporting manufacturers during this strategic change. Hence, the procedure of this paper is as follows: First, the methodology of business models will be discussed to work out the dynamics and its long-ranging consequences resulting from the offer of business models. Afterwards, a system dynamics model will be presented regarding an exemplary business model from the capital goods industry. The work closes with a recapitulation of the results.

2 Dynamics of business models

2.1 Observed dynamics of business models

The chances and risks arising due to an implementation of innovative business models can be regarded in various case studies (Lay et al. 2007). For example, some enterprises noticed the lack of some competences needed to offer the new services only after their market entry. Other enterprises calculated a lower effort as actually needed for offering these services. Accordingly, these services involved a negative profit margin and the new implemented business model failed after a short period of time (Lay et al. 2007).

Other case studies give positive examples. Numerous companies highlight the high customer satisfaction leading to a long-ranging customer loyalty and hence to a higher competitiveness. Others report from delayed cross-selling effects onto other product groups due to innovative service offers (Lay et al. 2007). Finally it gets obvious, that implementations of innovative business models have impacts onto a company that often occur delayed and after a longer period of time. Moreover, business models have influences on other factors that affect the enterprise, too. Hence, the introduction of new business models seems to bring up dynamic coherencies with a high degree of complexity and a long time horizon.

These facts lead to the possibility of regarding the impacts of innovative service offers by means of system dynamics with the aim of explaining the long-ranging interdependencies arising from an implementation of business models. For a better understanding, the methodology of business models will be discussed as well as existing approaches regarding their dynamic components.

2.2 Methodology of business models

In literature, there exist numerous classifications describing business models and their subtypes (Mathieu 2001; Molinari-Tosatti et al. 2002; Davies et al. 2007; Lay et al. 2009). A widespread typology, basing on Tukker 2004, distinguishes into three different kinds of business models (fig. 1).

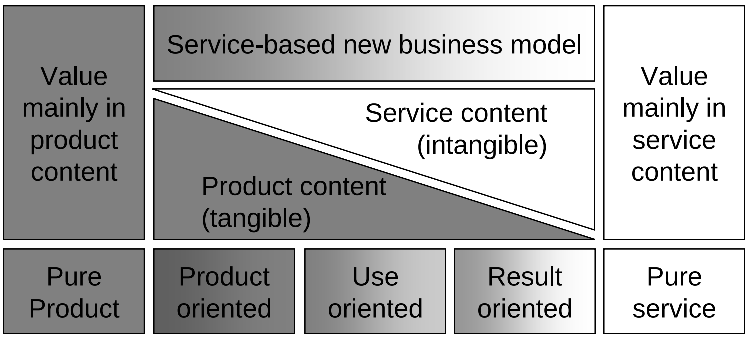

Figure 1: Typology for business models (Tukker 2004).

- Product-oriented business models describe the core product, flanked with traditional service like maintenance and repair, installation or financing. Manufacturers use these services to stimulate the sales of their core products, only.
- The second type are use-oriented services that aim to increase the utilization of plants. Possible examples are the availability guarantee or the supply of temporary production capacities by means of mobile machines.
- Customers of result-oriented services pay the provider for a result and not for the sheer product anymore. This kind of business model describes outsourcing contracts or classic BOT-models.

There are a lot of different possibilities to configure these business models. The different business models in the capital goods industry differ in shares of product and service contents. The range of services offered includes product-oriented services, which are necessary to use the product (e.g. maintenance), use-oriented services which contain the possibility of a customer to use a specific product (e.g. product leasing or pooling), and so-called result-oriented services, where the tangible product plays a minor role and the costumer and manufacturer agree on a result and make no agreements on how this result is reached. The share of the service component increases when product-service systems contain product-, use- and result-oriented services (Tukker 2004).

The term business model has become common to describe a business concept or a business strategy of a company. The economic sciences use a more specialized definition of this term. Herein, a business model consists of three parts (Timmers 1998; Lehmann-Ortega/Schoettl 2005):

- Value proposition: Defines the kind of utility for the customer or other players resulting from the business activities.
- Revenue Model: Constitutes the type of payment from the customer to the providers.
- Value chain configuration: Describes the different players, their roles and their contributions towards the value creation.

By means of these criteria it is possible to describe various types of business models. The offer of a classic business model, classified as product-oriented service (fig. 1), comprises the value proposition of a product with high quality and productivity. The provider gets paid by the client in the form of the sales price. Moreover, the provider builds the plant while the operation is done by the customer. In comparison to this, a BOT-model includes a value proposition where the provider delivers serial parts to the clients. The provider builds and operates the plant and gets paid for every delivered serial part.

Finally, the question arises on what are the impacts of these different business model criteria when it comes to dynamic coherencies existing between the implementation of a business model and its success afterwards.

2.3 Basic dynamic structure of business models

It seems likely to build a dynamic structure of business models by means of the criteria "value proposition", "revenue model" and "value chain configuration". Accordingly these three components will be analyzed in terms of their interactions with the aim to build a first generic structure for the dynamics of business models (fig. 2). The dynamic consequences of the value proposition can be described by means of the price and the service quality. The customer expects a special quality level defined by the value proposition. Moreover, the client compares the sales price with the expected quality. Both parameters configure the utility for the customer. Consequently, the higher the utility, the higher is the number of sold business models. This factor has high impacts on the component revenue model.

The revenue model holds three factors. The first factor describes the revenues, depending on a high degree on the sold number of business models. The second one is defined by the costs arising from the offer of the business model and depending on its value chain configuration. Moreover, the number of sold business models has impacts onto the price level by means of learning effects. Finally, the revenue model has influences on the value proposition and hence onto the satisfaction of the customers. The difference of costs and revenues leads to the benefit for the enterprise, influencing the last component of business models, the type of value chain configuration.

The value chain configuration is described by one factor only. The development of internal resources and structures defines the activities necessary for a company to supply such business models. The higher the benefit of a business model, the higher the interests of an enterprise to enhance the internal resources and structures. This component seems to be the critical driver for successful changes of manufacturers to solution providers as described above. Consequently, the question arises which strategies lead to successful changes and which strategies should be avoided. Moreover, this critical driver cannot be described by means of one factor only. The reason for this situation is as follows: Observing the generic dynamic structure of business models, the assumption arises that the value proposition as well as the revenue model are independent from the kind of business model. In comparison to this, the value chain configuration depends on a high degree on the kind of business model. Accordingly, there exists no generic structure for this component. For further analysis, the individual dynamic structures have to be developed for every single business model.

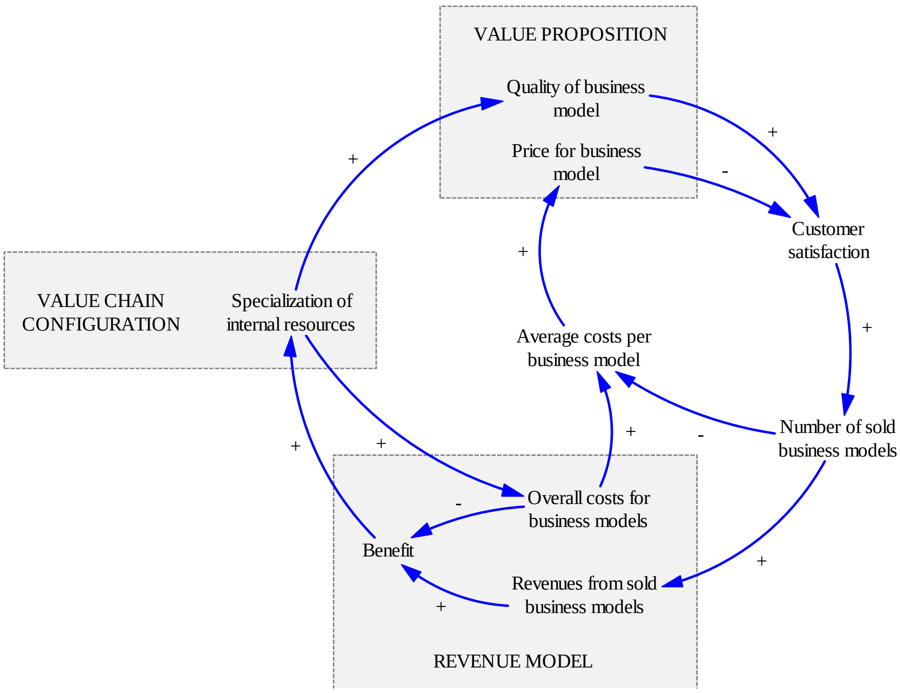

Figure 2: Basic dynamic structure of business models.

For these reasons a system dynamics model is developed in order to analyze the different dependencies and influence factors within the new business model describing maintenance contracts offering guaranteed availabilities. Hence, the focus of this system dynamics model lies on the value chain configuration and its influences on the other factors. The aim of such a model is to help support manufacturers in the capital goods industry when planning to introduce a new business model offering maintenance contracts including guaranteed availability.

3 Exemplary business model “Availability guarantee”

3.1 Background and impacts

In reality it is nearly impossible to design a plant which runs without any failures over its life cycle. This fact holds high potentials for designing innovative business models with the aim to distinguish a company from its competitors. The classic buyer supplier relationship implicates on the one side, that the customer buys a plant and runs it using its own personnel. On the other side the provider builds the plant and delivers it to its customer. One exemplary type of innovative business models is to supply a contract which guarantees a specific availability of a plant. The aim of this contract is to reduce downtimes and hence, to increase the productivity of a plant. In contrast to the classic business model, the plant manufacturer arranges repairs and additional preventive maintenances. The provider and the client agree on a certain availability the plant has to deliver. The manufacturer then has to arrange all maintenance tasks necessary to reach the agreed guaranteed availability. Furthermore, the provider and the client have to agree about the payment. In general, two scenarios are possible: If the plant reaches the agreed availability, the client has to pay the normal rate defined in the contract. If the plant does not reach this availability, the provider has to bear the arising costs. (Lay et al. 2009).

Maintenance contracts offering guaranteed availability have far reaching consequences on corporate and product design of the manufacturer. The producer needs its own maintenance staff to perform all the maintenance tasks or has to engage special maintenance companies. The product design has to be adjusted to achieve the required availability, too. As the manufacturer has to perform all needed maintenance tasks including preventive and reactive maintenance tasks, he also must have the relevant information about the condition of the plant. Furthermore, the producer must plan the different maintenance tasks and their durations in order to plan the arising downtimes (Lay et al. 2009).

Regarding figure 2, it gets obvious that there exist interdependencies between obtained availability and customer satisfaction and hence, between obtained availability and long-reaching success of the business model. Therefore, a specific dynamic structure for the business model “Availability guarantee” will be developed, basing on the conclusions of figure 2.

3.2 Dynamic structure

As described above, the customer satisfaction depends on the compliance of the value proposition. Furthermore, the value proposition gets influenced by the organization of internal resources. For the business model “Availability guarantee” the internal resource “staff” will be required. Accordingly, the question arises of what are the interdependencies between staff and availability and how both factors are developing over time. Moreover, it is of interest what strategies are possible for an enterprise to control the availability and hence, the long-ranging success over time.

Due to the definition of the availability it seems likely to regard its individual factors and to work out the dynamics in this way. The availability gets calculated using the Mean Time Between Failures (MTBF), which describes the running time of the plant between two breakdowns, and, the Mean Time To Repair (MTTR), which defines the average time needed for one repair. Therefore, two loops will be regarded controlling the availability. The MTBF-loop describes the influencing factors for the mean time between failures whilst the MTTR-loop observes the factors influencing the mean time to repair (fig. 3).

The availability of a plant has impacts onto the number of sold business models because the higher the availability, the higher the customer satisfaction and hence, the higher the sold business models (see fig. 2, too). Consequently, the stock of customers increases, leading to higher numbers of repairs. This results in a higher workload for the responsible staff of maintenance and repairs. Like shown in figure 3, the staff workload has central influences on both, the MTBF-loop and the MTTR-loop. On the one hand, a higher staff workload leads to a lower number of preventive maintenance tasks. If the number of preventive maintenance tasks decreases, the mean time between failure decreases after some time, too. Finally, the lower the MTBF, the lower is the availability of a plant. On the other hand, the staff workload has influences on the MTTR-loop, too. The higher the staff workload, the greater is the MTTR and hence, the greater are the downtimes. Consequently, a higher downtime leads to a lower availability. An overview about the complete dynamic structure gives figure 3.

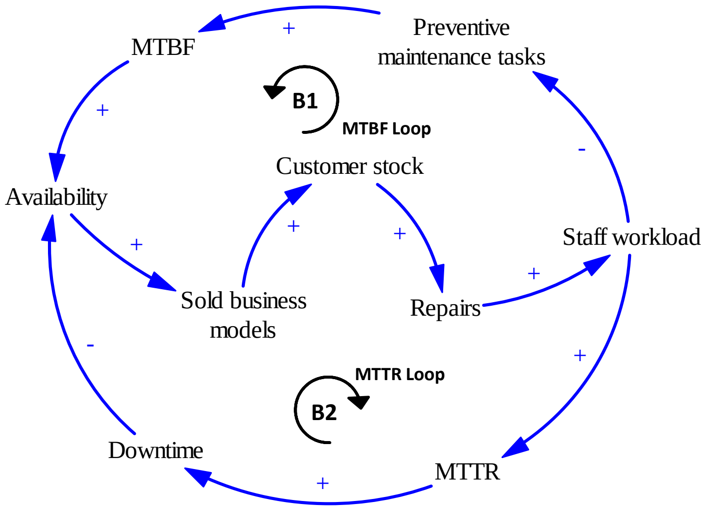

Figure 3: Dynamic Structure of the business model “Availability guarantee”.

3.3 Modeling stocks and flows

The sector modeling MTBF, MTTR and availability form the central part of the model. The connections within this sector are shown in figure 4. The stock “defective equipment” describes the overall number of plants which are currently not useable because of running repairs, running preventive maintenance tasks and waiting times. If a failure occurs, the number of unusable equipment increases and then again decreases after the respective MTTR. The downtime due to preventive maintenance tasks is modeled in the same way. Planned maintenance tasks increase the number of unusable equipment for the duration of the maintenance task. Depending on the monthly number of unusable plants the average monthly downtime of a plant can be calculated. Together with the operating time the resulting availability is evaluated.

The factors that influence the unusable equipment and hence the availability are the number and duration of preventive and reactive maintenance tasks. A higher number of preventive maintenance tasks results in a higher downtime. But a higher preventive maintenance effort may increase the MTBF and reduce the number of occurring failures. Thus a higher preventive maintenance effort can reduce the downtime due to needed repairs and optionally the overall downtime. However, a higher maintenance effort also has negative effects. As the overall staff capacity is fixed, a higher number of maintenance tasks reduce the available staff capacity for required repairs. A higher remaining staff capacity decreases the overall MTTR by reducing waiting times for available staff in case a failure emerges. This results in shorter downtimes and higher plant availability.

The pictured feedback loop in figure 4 is closed by the connection between availability and preventive maintenance effort. If the availability increases, the maintenance effort will be reduced. The arrangement of this connection is a major strategic decision that has to be made when planning the implementation of the new business model.

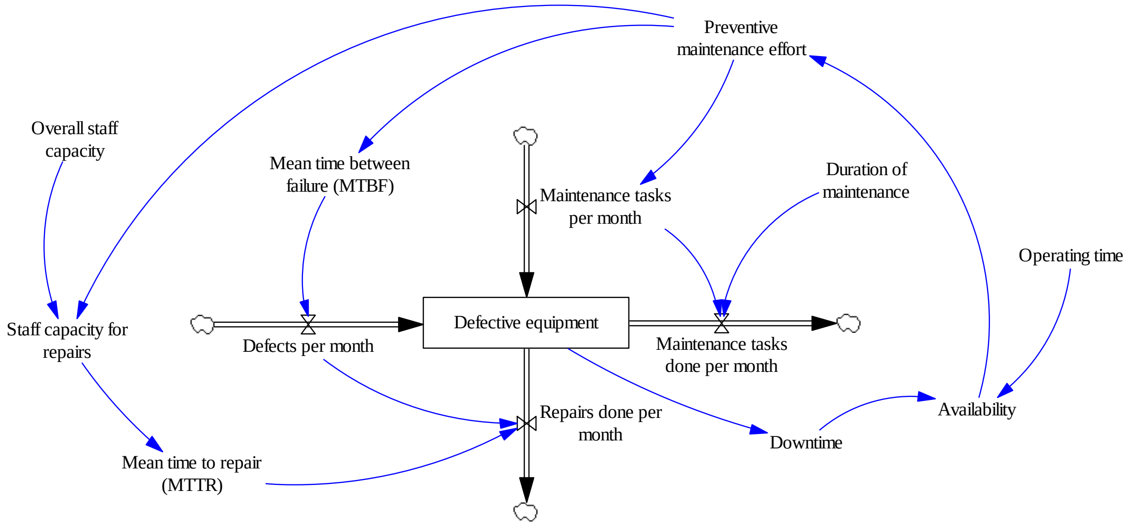

Figure 4: Stocks and flows for the maintenance and repair sector.

Besides the described sector, the model includes additional sections that describe the market behavior and the revenue model. The market is described by using the diffusion model of Bass, wherein the new customers are split up in so-called innovators and imitators. Imitators are customers characterized by the willingness to invest in new and innovative products. Buying well-established and well-known products is typical for imitators. Shortly after introducing a new business model the amount of innovators is high compared to the number of imitators. But this relation changes over time, when offering new business models (Bass 1963). A third group of customers are repurchasers - customers that are satisfied with the performance of their plant will invest in a new one after their maintenance contracts have expired.

In this model the success of the business model “Availability guarantee” is examined by comparing the net present value which arises in different simulation runs. The costs of the new business model, offering maintenance contracts with guaranteed availability, consist of personnel costs, costs of material, manufacturing costs for the plants and penalties in case of non-achievement of the agreed availability. Furthermore, costs for the implementation of the new business model are taken into consideration. Sales revenues form the positive component of the net present value.

3.4 Simulation runs

Beyond the background described above, two major questions might be of interest for enterprises planning to provide availability guarantees. Therefore, the following aspects will be analyzed in this contribution:

- What are the impacts on the long-ranging success of the described business model, depending on the level of availability?
- What are the influences of the staff capacity and the staff workload on the long-ranging success of the business model?

The main focus of the model should lie within the strategy aspects concerning maintenance staff and level of availability. First, the user of the model has to decide how many workers to employ for all emerging preventive and reactive maintenance tasks. Secondly, the connection between the real availability and the offered availability must be specified. In order to describe this connection, the percentage of the actual availability that will be subject-matter of the following contracts must be set.

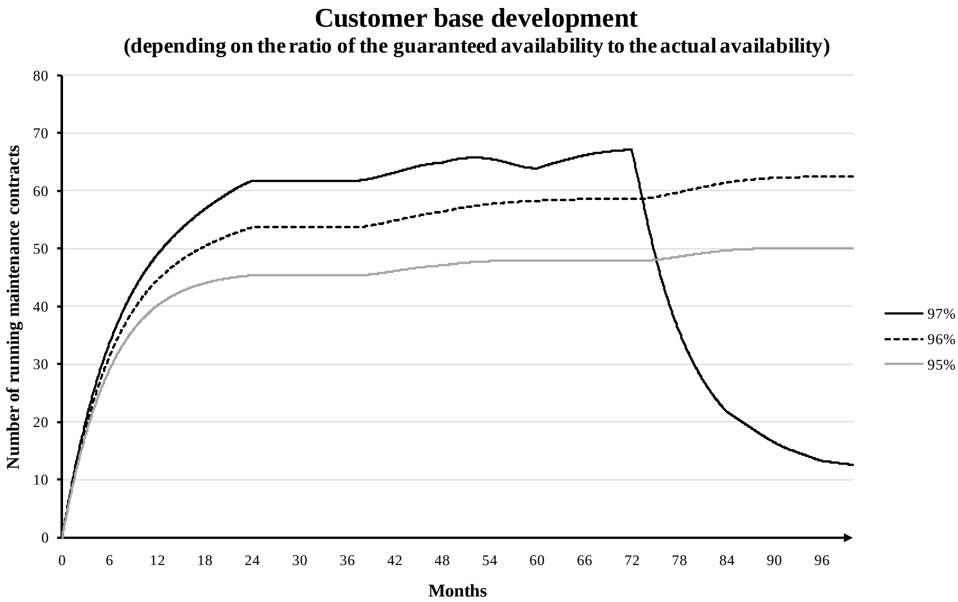

Figure 6: Running contracts.

Figure 6 shows the number of running availability guarantees over time depending on the percentage of the guaranteed availability at the actual availability. The contract period is fixed at 36 months in all simulation runs. After three years, the former customers become potential customers and, depending on their satisfaction, have to decide whether they want to invest in new plants and maintenance contracts. This causes the characteristic steps at month 36 and 72. The probability of becoming a repurchaser is greater the higher the degree of fulfillment of the maintenance contract. Figure 7 shows the corresponding net present value development.

If the manufacturer offers 97% of the actual availability as guaranteed availability he will not be able to fulfill the contract as the staff capacity is fixed during the simulation runs. Therefore, the customers become dissatisfied and do not invest in new plants after their contracts have expired. This results in a decreasing number of customers (see figure 6). As the manufacturer has to pay high contractual penalties to its customers, the net present value is decreasing, too (see figure 6).

The staff capacity is high enough to perform all needed maintenance tasks to achieve an availability of 96% or lower. Offering a lower guaranteed availability the manufacturer sells less maintenance contracts and therefore only generates lower revenues. However, he is able to fulfill the contract conditions, the customers are satisfied and therefore invest in new plants after the contract period. Over time the manufacturer can generate higher revenues compared to the run in which a higher percentage of the actual availability is subject matter of the maintenance contract.

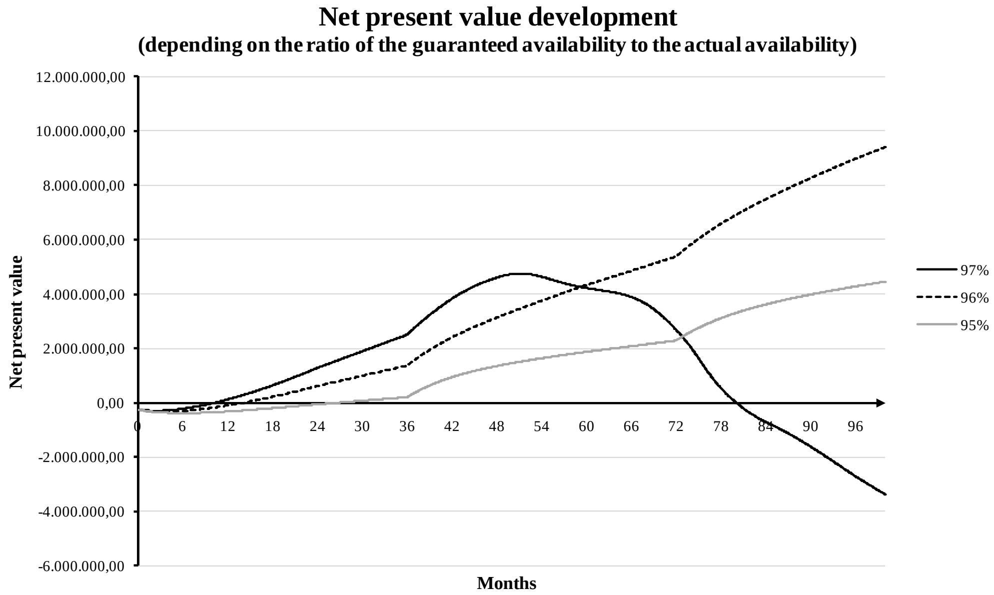

Figure 6: Net present value development

4 Results and findings

For a better understanding of the dynamic complexity and the coherencies of the different factors on the net present value, multiple runs were simulated. Therefore, various levels of availability were regarded as well as different numbers of employees. The results of these simulation runs is visualized in figure 8. Results containing a negative value are plotted grey, a net present value greater than zero is plotted black. The runs shown in figure 6 and figure 7 are marked by a star.

The table shows the existing coherency between the number of employees and the offered availability on the net present value. Moreover, the values show the trade-off between chances and risks resulting from an implementation of the regarded business model. The lowest net present value reaches a level of -18.37 million euro whereas the highest net present value achieves a level of 11.09 million euro.

Furthermore, the success of an implementation depends on both the availability and the staff capacity. If the staff workload is too low, the costs for employees are higher than the revenues of the new business model. On the other hand, a staff workload reaching nearly 100 percent leads to a lower customer satisfaction and hence to a breakdown of the system.

The observed influence factors and their complex connections (which often include feedback structures and delays) have a great impact on the success of a new business model. Regarding the two major questions discussed above, the following findings can be made:

- Both, the offered level of availability as well as the staff capacity has high influences on the long-ranging success of the exemplary business model. Moreover, there exists a coherency between these factors and the net present value, shown in figure 8.
- Furthermore, enterprises offering availability guarantees should regard the staff workload. Like described above, a corridor exists between the availability and the staff capacity leading to a long-ranging success of the business model.

The focus of the model described in this article is placed on maintenance staff and its workload. During the simulation it has been recognized that the planning of emerging preventive and reactive maintenance tasks is a very important factor when looking at the success of the business model “Availability guarantees”. The described system dynamics model is a first approach to help manufacturers in the capital goods industry when planning to introduce availability guarantees. As mentioned before there are a lot of aspects that have not yet been considered or may be modeled in different ways.

Net present value		Number of employees			
		4	5	6	7
Ratio of the real and the offered availability	95%	8.46 Mio.	4.46 Mio.*	0.49 Mio.	-3.54 Mio.
	96%	-12.81 Mio.	9.41 Mio.*	5.41 Mio.	1.41 Mio.
	97%	-16.90 Mio.	-3.37 Mio.*	11.09 Mio.	7.09 Mio.
	98%	-17.88 Mio.	-14.04 Mio.	-9.79 Mio.	10.13 Mio.
	99%	-18.89 Mio.	-18.37 Mio.	-1.44 Mio.	10.98 Mio.

*) These runs are shown in figure 6 and figure 7

Figure 8: Overview about simulation runs.

Finally, it gets obvious that system dynamics is able to analyze and to describe long-ranging consequences resulting from the implementation of new business models. The exemplary business model “Availability guarantee” was able to show, the existence of feedback loops and delays between the observed factors, leading to different net present values in dependence to various strategies.

5 Literature

Baines, T.S., Lightfoot, H.W., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J.R., Angus, J.P., Bastl, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., Michele, P., Tranfield, D., Walton, I.M., Wilson, H., 2007, State-of-the-art in product service systems, Journal of Engineering Manufacture, 221/10, pp. 1543-1552.

Bass, F. M., 1963, A dynamic model of market share and sales behavior. Proc. Winter Conf. Amer. Marketing Assoc., Chicago, IL.

Davies, A., Brady, T., Hobday, M, 2007, Organizing for solutions: System sellers vs system integrators, in: Industrial Marketing Management, Vol. 36, No. 2, pp. 183-193.

Forrester, J. W., 1961, Industrial Dynamics, The M.I.T. Press and John Wiley and Sons, Inc., New York, London.

Gebauer, H., 2004, Die Transformation vom Produzenten zum produzierenden Dienstleister, Dissertation der Universität St. Gallen, St. Gallen.

Grönroos, C., 2000, Service management and marketing – A customer relationship management approach, Chichester.

Homburg, C., Fassnacht, M., Guenther, C., 2003, The Role of Soft Factors in Implementing a Service-Oriented Strategy in Industrial Marketing Companies, in: Journal of Business-to-Business Marketing, Vol. 10, No. 2, pp. 23-51.

Jahangirian, M., Eldabi, T., Naseer, A., Steriouglas, L. K., Young, T., 2010, Simulation in manufacturing and business: A review, in: European Journal of Operational Research, 203, pp. 1-13.

Lay, G., Kinkel, S., Ostertag, K., Radgen, P., Schneider, R., Schröter, M., Toussaint, D., Reinhard, M., Vieweg, H.-G., 2007, Betreibermodelle für Investitionsgüter – Verbreitung, Cancen und Risiken, Erfolgsfaktoren, Fraunhofer IRB Verlag, Stuttgart.

Lay, G., Schröter, M., Biege, S., 2009, Service-based business concepts: A typology for business-to.business markets, in: European Management Journal, 27, pp. 442-455.

Lay, G.; Schröter, M., Armbruster, H., 2009, TCO als Ausgangspunkt für die Entwicklung dienstleistungsbasierter Geschäftsmodelle in der Investitionsgüterindustrie, in: Schweiger, Stefan (editor): Lebenszykluskosten optimieren, Gabler, Wiesbaden, pp. 153-179.

Lehmann-Ortega, L., Schoettl, J.-M., 2005, From buzzwords to managerial tool: the role of business models in strategic innovation. CLADEA, October 22-24, Santiago de Chile, Chile.

Mathieu, V., 2001, Product Services: From a service supporting the product to a service supporting client, in: Journal of Business and Industrial Marketing, Vol. 16, No. 1, pp. 39-55.

Milling, P., Maier, F., 1996, Invention, Innovation und Diffusion - Eine Simulationsanalyse des Managements neuer Produkte, Duncker & Humblot, Berlin.

Molinari-Tosatti, L., Pierpaoli, F., Urbani, A., Jovane, F., 2002, Service Manufacturing: The New frontiers for manufacturing in Mass Customization, The 35th CIRP-International Seminar on Manufacturing Systems.

Oliva, R., Kallenberg, R., 2003, Managing the transition from product to services, International Journal of Service Industry Management, 14/2:160-172.

Thun, J.-H., 2004, Modelling Modern Maintenance - A System Dynamics Model Analyzing the Dynamic Implications of Implementing Total Productive Maintenance, in: Coyle, Jonathan et al. (editors): Collegiality - A harmony that achieves consensus on the issues, Oxford.

Timmers, P., 1998, Business Models for Electronic Markets, in: EM - Electronic Markets, Vol. 8 - No. 2, pp. 3-8.

Tukker, A., 2004, Eight types of Product-Service System: Eight ways to sustainability? Experiences from SUSPRONET, Business Strategy and the Environment, 13, pp. 246–260.

Wise, R., Baumgartner, P., 1999, Go downstream – the new profit imperative in manufacturing, Harvard Business Review, 5, pp. 133-141.