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Simulation and optimization of value In Service Networks

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SIMULATION AND OPTIMIZATION OF VALUE IN SERVICE NETWORKS

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Master of Science Thesis

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Abstract

Modern business systems are becoming more complex over time since the cost and speed of storing and exchanging information is becoming lower and the number of participants is becoming higher. Firms focus on profitable activities that offer a competitive advantage and outsource the others, building profitable cooperation with other firms. Large Systems are created and develop in an environment that is always changing both in requirements and in the number of participants. Therefore we need an intelligent way to analyze them and provide a methodology to estimate and increase the value of the various participants in such dynamic conditions. Furthermore it is necessary to simulate the service system in order to examine its evolution overtime. The simulation results help analysts to detect and improve weaknesses of the network that may lead our system to instability and unprofitability in the future. The constructive co operation between the participants of the network and the minimization of conflicts of interests among the participants of the network is a crucial part for its viability. In this master thesis we propose a methodology to estimate value in a service network. We calculate the optimal value and simulate the behavior of the network over time, using optimization (excel solver, mathematica) and simulation tools (ithink tool).

ΠΡΟΣΟΜΟΙΩΣΗ ΚΑΙ ΒΕΛΤΙΣΤΟΠΟΙΗΣΗ ΤΗΣ ΑΞΙΑΣ ΣΕ ΔΙΚΤΥΑ ΥΠΗΡΕΣΙΩΝ

ΒΟΣΚΑΚΗΣ ΕΜΜΑΝΟΥΗΛ

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Πανεπιστήμιο Κρήτης
Τμήμα Επιστήμης Υπολογιστών

Περίληψη

Οι σύγχρονες επιχειρηματικές δομές γίνονται όλο και πιο πολύπλοκες. Η ανάγκη για ταχύτατη διάδοση και επεξεργασία των πληροφοριών γίνεται εντονότερη, ενώ ο αριθμός των εμπλεκομένων σε αυτές τις δομές αυξάνει. Οι εταιρείες πλέον επικεντρώνονται σε δραστηριότητες στις οποίες λίγες εταιρείες μπορούν να τις ανταγωνιστούν, με αποτέλεσμα να αποκτούν ανταγωνιστικό πλεονέκτημα έναντι των υπολοίπων. Τις υπηρεσίες που χρειάζονται επιλέγουν να τις λαμβάνουν μέσω συνεργασιών που συνάπτουν με άλλες εταιρείες. Αποτέλεσμα αυτού του τρόπου λειτουργίας είναι η δημιουργία δικτύων υπηρεσιών τα οποία είναι μεγάλα σε μέγεθος και λειτουργούν σε ένα περιβάλλον το οποίο συνεχώς μεταβάλλεται. Συνεπώς κρίνεται απαραίτητη η ύπαρξη μιας μεθοδολογίας που όχι μόνο θα αναλύει τα δίκτυα αυτά αλλά θα υπολογίζει και την αξία που παράγεται μέσα σε αυτά. Επιπλέον πρέπει να έχουμε την δυνατότητα προσομοίωσης της εξέλιξης των δικτύων αυτών στο χρόνο, ώστε να βρίσκουμε τρόπους να βελτιστοποιούμε συνεχώς την αξία που παράγεται από τους συμμετέχοντες στο δίκτυο. Στόχος αυτής της εργασίας είναι να προτείνει μια μεθοδολογία η οποία θα υπολογίζει την αξία που παράγεται μέσα σε ένα δίκτυο υπηρεσιών. Ακόμη, με τη βοήθεια κατάλληλων εργαλείων, θα ερευνήσουμε τις συνθήκες κάτω από τις οποίες, βελτιστοποιείται η αξία αυτή. Επίσης, θα εξετάσουμε την εξέλιξη της στο χρόνο, εντοπίζοντας στο δίκτυο χαρακτηριστικά που αυξάνουν την αξία του και στοιχεία που την μειώνουν. Τέλος θα μελετήσουμε τις σχέσεις που αναπτύσσονται μεταξύ των συμμετεχόντων στα δίκτυα υπηρεσιών και τις πιθανές συγκρούσεις που μπορεί να υπάρχουν.

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CHAPTER 1: INTRODUCTION

The emerging service economy and the evolution of information technology have increased the complexity of how of organizations evolve in a world of interactions and partnerships. We observe that large and vertically integrated firms are replaced by globe-spanning networks. Service networks consist of interdependent companies that use social and technical resources and cooperate with each other to provide value for their participants based on service creating networks [24]. The analysis of service networks has 2 perspectives.

The operational point of view focuses on the management of the business processes and the monitoring of financial and operational measures of performance also called *Key Performance Indicators* (KPIs) in order to evaluate or improve them [71].

From the business point of view, the service network needs to define the activities that achieve its business goals such as cost cuts, market share increase, profit increase, customer satisfaction increase etc. In this master thesis, we focus on the business approach of service networks.

The main goal of a service network is to create value for its participants. The participants join the network if they believe that they will gain more value by participating in the network than staying out of it. The most important factor for the validity of the analysis of the service network is the measurement of the value acquired by the participation in the network. Consequently, the challenge is to investigate models that help analysts and the participants of service networks to compute and optimize this value. We consider that an economic entity within a service network has value when it satisfies the entity's needs and its acquisition has positive tradeoff between the benefits and the sacrifices required. If a service is valuable for the service network, the participants are willing to offer commodities tangible or intangible for its use. In this master thesis we extend the value calculation approach proposed [24] and optimize value under specific assumptions.

We observe that the value of the participants depends not only on the subtraction between revenues and costs but also on the expected profits of the participants for the next period. Expected profits express the additional value being accrued by the relationship levels that the various participants develop when they sell goods and services to other participants or to the end customers. This value is related to the intangible assets of an entity and on the degree of satisfaction this entity obtains from its customers.

We perform simulation experiments to investigate the fluctuation of value under different circumstances. The results of these simulations provide predictions about the future of the network in order to increase its adaptability to the changes of the environment. Additionally, a firm is able to choose the optimal cooperation within the service network according to its interests and make decisions about joining the service network or not and when. At the same time, the firm is able to create the conditions that will attract other firms to cooperate with it for example by offering a service that is valuable for the network. Joining the network doesn't means that there are no difficulties. In general, the choices and the interactions among the participants of a network force them to reach an equilibrium that serves their interests.

Customer Satisfaction of the participants plays an important role in value calculation and in increasing the profitability of the network. Customer satisfaction measurements help firms to take strategic decisions building profitable co operations and increasing their value. Keeping customer satisfaction on high levels you increase their loyalty and attract more customers and participants, increasing your possible choices. There are a lot of different approaches that have been proposed to measure customer satisfaction. In this master thesis we measure satisfaction using the methodology proposed in the American customer satisfaction index [40]. There are many tools available to the analysts that help them to simulate and optimize value in a service system. These tools not only help to take the best decision but also they decrease the time needed to analyze data before the strategic decision is taken.

1.2 THESIS CONTRIBUTION

In this master thesis we propose a methodology to identify and calculate value in service systems. We needed to propose this methodology avoiding adapting one of the theories of value that already exist because in the new dynamic environment that service networks emerge connectivity and profitable cooperation are the main sources of creating value. We apply this approach in a car repair service system, using simulation and optimization tools, to examine the network's evolution over time. We examine the following issues:

- We investigate the circumstances under which it is profitable for a firm to participate in the network and how the internal conflicts of interests influence its value.
- We identify key stone participants (participants that create the most value for the network).
- We determine participants' optimal strategic decisions (cooperating or not with someone, joining or not the network etc)).

In the secondary part of our work, we apply our model to a conventional car OEM service network and analyze the followings.

- We calculate the value of each participant and determine its level with respect to.
- We determine the circumstances under which it is profitable for the participant to join the network.

- We examine the relationships that are developed between the participants and how their choices influence the value of the others and the total value of the service network. In particular

Then, we transform the initial model(outsource selected services) in order to investigate the changes of value and the possible reactions of the participants. We use the results to show that value optimization and the continuous change of the environment push the network to restructure itself in order to remain competitive.

- We determine the time interval in which we observe positive effects in profitability in the transformed network compared to the initial one.
- We examine the reactions of the participants of the network when new entities appear in the market and are willing to participate.
- We observe that the changes in the service network have positive effect on some participants and at the same time force others to abandon the network.

In our experiments we have assumed that value depends on mean repair price and mean repair time. Value is optimized in respect to mean repair price.

This work is a part of the work performed in the Transformation Services Laboratory of UOC that intends to model, simulate and analyze the evolution of service systems.

1.3 Thesis Organization

The rest of this master thesis is organized as follows. Chapter 2 presents the appropriate theoretic background for defining and calculating value and describes the traditional way of creating value and why it is not profitable today. The chapter ends with the definition of customer satisfaction, its importance and its most famous barometers. Chapter 3 provides the theory of service networks. It explains their structure, their benefits and their main problems. Chapter 4 gives the theoretic background about simulation, optimization and dynamic systems. Additionally, it compares the most important simulation tools and explains why we have chosen the ithink tool to run the simulations. Chapter 5 presents in detail the methodology proposed to identify and estimate value in service systems. In Chapter 6 we present the case study we used to test the methodology. We describe the functions we used and the transformations of the initial network in order to test and simulate its behavior within time. The results of the simulation and optimization are presented in Chapter 7. The last chapter discusses the work done in this master thesis and proposes future work.

CHAPTER 2 – THEORETIC BACKGROUND

In this chapter we will give the appropriate theoretic background about value. We will say a few words about the definitions of value given by some of the most famous economists. In addition we will describe the way firms created value in previous years and we will explain why this way is insufficient in our days. Finally we will refer in short to customer satisfaction and its most famous barometers

2.1 VALUE

Main pursuit of every organization through its strategic decisions is to maximize the offering value of its production processes and receive reward for its activity. The term ”value” is often met in many different domains with different definitions. Before we define ”value” we will refer to existing definitions from the Economic and Social sciences which helped us to build our own.

Quesnay and other French writers of the 1750s and 1760s (The Physiocrats) were the first economists to begin to analyze production rather than simply circulation in the endeavor to find the source of surplus value (ebrary) [3]They believed however that only agricultural labor was truly productive[1].

The first economist who talk about value and tried to make a theoretic concept was John Stuart Mill (1806 - 1873). In his book Principles of Political Economy [2] presents the concept of Value roughly as follows : 1. there are two kinds of value, use and exchange value, but these are commensurable. Use value is what you would be prepared to pay for something, and exchange value is the average market value; use-value can be less but never more than exchange value; 2. use-value is not of concern to political economy; 3. (exchange) value is a relative, not an absolute concept. 4. value is distinguished from price because of the variable ”purchasing power of money” and may be measured against an overall general average of other commodities rather than just one (i.e. money); 5. value fluctuates according to supply and demand around a ”natural value” He goes on to reduce the concept of value to a nothing, without actually dismissing it. It is a kind of ”proper price”, since if price differs from value it is because someone has been ”rooked” or there is a temporary distortion in the market. Mill says that: ”There is nothing in the laws of value which remains for the present or future writer to clear up” [2].

Another very famous theory of value is ”marginalism” , pioneered by Leon Walras, Stanley Jevons, and Carl Menger, has been highly influential in economics. William Stanley Jevons (1835 - 1882), in his book The Theory of Political Economy (1871) explained the marginal utility theory of value [5]. He claimed that the utility or value to a consumer of an additional unit of a product is inversely related to the number of units of that product he already owns. Another worth remarkable marginalist was Alfred Marshall, according to his theory marginal utility on the demand side and marginal effort on the supply side jointly determine price [6].

Sir William Petty in his book “A Treatise of Taxes and Contributions” [7] introduced the labor theory of value (LTV), which is a theory in economics according to which the values of commodities are related to the labor needed to produce them.A lot of economists adopted and expanded LTV like Danid Ricardo, Karl Marx etc. Adam smith accepted the LTV for pre-capitalist societies but saw a flaw in its application to capitalism. It is worth to say that the most famous labor theory of value is Marx’s theory. In Chapter One of”das Kapital”, Marx points out that (exchange)value has no connection with the physical properties of a commodity, and value is ”the very opposite of the coarse materiality of their substance”. The most important commodity of all, labor-power, is a”service” not a good [9]. Marx defined the value of the commodity as the “socially necessary abstract labor” embodied in a commodity.

Adam Smith (1723-1790), was the first to complete a comprehensive theory of political economy, saw labor as the sole source and measure of value [8]. According to him, value”in use” is the usefulness of this commodity, its utility. There is a classical paradox which is often expressed when considering this type of value. Here, once again in the words of Adam Smith: The word VALUE, it is to be observed, has two different meanings, and sometimes expresses the utility of some particular object, and sometimes the power of purchasing other goods which the possession of that object conveys. The one may be called ’value in use ;’ the other, ’value in exchange.’ The things which have the greatest value in use have frequently little or no value in exchange; and on the contrary, those which have the greatest value in exchange have frequently little or no value in use. (Adam Smith paradox) Nothing is more useful than water: but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it. Value ”in exchange” is the relative proportion with which this commodity exchanges for another commodity(in other words, its price in the case of money).

A theory that contrasts LTV is the subjective theory of value (or theory of subjective value). An economic theory of value that holds that ¨to possess value an object must be both useful and scarce¨ , with the extent of that value is dependent upon the ability of an object to satisfy the wants of any given individual [11]. ”Value” here refers to exchange value or price.

As the problem of environmental pollution grows and influences every part of human life some economists proposed the green theory of value. They said that we have to modify the way that we implicit”value” in GDP taking into consideration some environmental factors. For example tearing down of a forest is counted as adding to the GDP, as is filling the atmosphere with pollution, while the production of garbage disposal units necessary to restore the damage is counted as adding even further value. The solution seriously proposed is to re-calculate the GDP by counting

as negatives the various factors of environmental degradation and counting the cost of restoring that damage as a deduction from the profits made in causing the damage [10].
One of today's most famous economists Steve Keen refers to "value" as the innate worth of a commodity, which determines the normal ('equilibrium') ratio at which two commodities exchange [12].
Resource base view (RBV) claims that resources have value in relation to their ability, inter alia, to meet customers' needs is consistent within RBV [13][14][15]. According to [40], customers' perceptions of the value of a good are based on their beliefs about the goods, their needs, unique experiences, wants, wishes and expectations. Customers assess the overall value of a product on the perceptions of what is given and what is received. A resource has also been defined as valuable if it either enables customer needs to be better satisfied [16] [17] or if it enables a firm to satisfy needs at lower costs than competitors [18]. Perceived value is defined as the ratio of perceived benefits relative to perceived sacrifice [19]. As observed, each theory defines the word value or valuable in different ways according to author's goals and perspective. We don't fully adopt any of them because each is defined in a different time period and in a different economic field. Trying to define value in a way to fit in today's economic environment, our notion of value approaches to Monroe's & Bogner's theory [23][8], as described above. It is very important to say that we need at least 2 sides for the existence of value; the one that offers something valuable to another. Thus, in the following lines value creation is described from both end-customer and service provider's perspective. As already mentioned, value is deeply connected with the needs of humans and organizations (entities). The degree of their satisfaction in combination with their intensity represents the extent of value received. An analysis of needs would be beyond the scope of this paper. Value may vary from entity to entity due to the influence of needs on human goals. Furthermore, from the customer's aspect, perceived value is often enhanced through several marketing techniques, which increase the intensity of specific needs. appropriated benefits worth sacrifices from the perspective of the entity. A lot of research has been done to analyze and quantify via complex mathematic models and game theory customer's goals and views and then estimate the value that some services or products represent for him.

2.2 VALUE CHAIN

Maikl Porter proposed a model to explain the value creation process [20]. He argued that value creation is better understood by disaggregating the creation process of the firm into discrete activities, In particular, value can be created by differentiation along every step of the value chain, through activities resulting in products and services that lower buyers' costs or raise buyers' performance. The basic assumption underlying the disaggregation is that activities are the building blocks by which a firm creates a service that is valuable to its customers. Different activities have different economics and contribute differently to the valuable characteristics of the product.

The value chain is a systematic approach developed by Maikl Porter to examine the production process and the development of competitive advantage.

The value chain is governed by a two-level generic taxonomy Of value creation activities [20]: Primary activities are directly involved in creating and bringing value to the customer, whereas support activities enable and improve the performance of the primary activities. More detailed primary activities are:

Inbound logistics. Activities associated with receiving, storing, and disseminating inputs to the product.

Operations. Activities associated with transforming inputs into the final product form.

Outbound logistics. Activities associated with collecting, storing, and physically distributing the product to buyers.

Marketing and sales. Activities associated with providing a means by which buyers can purchase the product and inducing them to do so.

Service. Activities associated with providing service to enhance or maintain the value of the product.

The primary activity categories-particularly the inbound logistics-operation-outbound logistics sequence-are well suited to characterizing the main value creation process of a generic manufacturing company. Marketing is included as a primary activity category as these activities inform the customer of the relevant product characteristics and ensure product availability on the market. Similarly, the inclusion of service as a primary activity category follows from the fact that service can be critical for the value realized by the customer.

The set of generic activity categories is a template for identifying critical value activities that provide a basis for understanding and developing competitive advantage from the perspective of the firm as a whole. The value chain is not meant to model the actual flow of production. The generic support activity categories of the value chain are:

Procurement. Activities performed in the purchasing of inputs used in the value chain.

Technology development: Activities that can broadly be grouped into efforts to improve product and process.

Human resource management: Activities of recruiting, hiring, training, developing, and compensating personnel.

Firm infrastructure: Activities of general management, planning, finance, accounting, legal, government affairs and quality management.

Figure 1 shows the generic value chain diagram. The sequencing and arrow format of the diagram underlines the sequential nature of the primary value activities. The support activities in the upper half potentially apply to each and all of the categories of primary activities. The layered nature of the support activities are apparently meant to tell us that activities are performed in parallel with the primary activities. The margin at the end of the value chain arrow underlines that the chain activities are all cost elements that together produce the value delivered at the end of the chain.

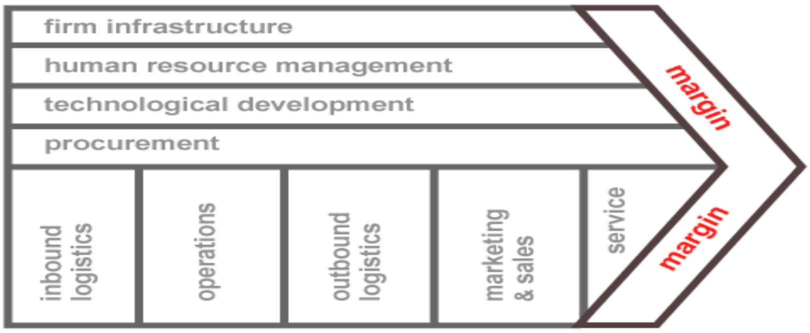

Figure1-Porter's value chain

2.3 VALUE SYSTEM

The value system is a tool to analyze how a company positions itself relatively to other companies. The idea in the value system was to make explicit the role of a company in the overall activity of providing a product to a customer. [21]

It allows understanding if all the companies involved in the sale process are truly collaborating or if they have conflicts of interests. It also allows comparing a company with its competitors). The value system makes explicit who are the suppliers and what are the channels of the given company. Porter argues that uniqueness can be created through technology-based product innovation or marketing innovation, or via activity linkages throughout the value system. Value system linkages can produce uniqueness if they allow more exact satisfaction of consumer needs. Uniqueness in meeting buyers' needs may be the result of coordination with suppliers. Examples of channel linkages that can lead to uniqueness include: training channel members in key business procedures, joint sales programs, and subsidizing sales- or service-related investments by channel members. Porter acknowledges that such steps toward differentiation are costly, since "a firm must often incur costs to be unique and uniqueness requires that it performs value activities better than competitors"[22].

2.4 DISSADVANTAGES OF THE TRADITIONAL WAY OF CRETING VALUE

In the battle for satisfying increasingly demanding customers, organizations try to deliver superior value. Considering that creation of value depends on the ability to deliver high performance on the benefits that are important to the customer, what gives firms the ability to deliver performance on these important benefits is their competency in technology and business processes, namely their core competencies. Core competencies include all processes that add significant value to the final offering of the organization and are performed at such a superior level that very few competitors can emulate. In today's context, the increasing advance of technology makes definitions of core competencies narrower and sharper. Existing linear structures (supply chain models) are not sufficient to support responsiveness, innovation, specialized know-how and quality of a sole company. Moreover, research [23] has shown that vertically integrated firms suffer from inability to respond quickly to competitive changes in international markets; resistance to process innovations; and systematic resistance to the introduction of new products. As a consequence, today's rapidly changing environment motivates organizations to focus on their core competencies, by outsourcing resource-capturing activities in the effort to offer superior value cut their costs and increase their competitiveness. Value in our days is hiding in the constructive cooperation between firms. The cooperation and the relationships develop play an important role for their profitability. Consequently, more flexible structures are needed that will offer competitive services to their customers. These structures must be able to create and stop cooperation very quickly responding to the changing environment.

2.5 SATISFACTION

Until now a lot of times we have referred to customer satisfaction and its importance. In this section we will present in short some of the most important theories of customer satisfaction and the most important barometers that try to estimate this variable.

The most important theory for customer satisfaction analysis in the context of consumer behavior concerns the approach of Oliver and Churchill-Surprenant[33][34]. According to this particular methodological approach, satisfaction may be defined as a pleasant past-purchasing experience from a product or service given the anti-purchasing expectancy of the customer (Fig. 2). As it becomes obvious, the comparison process of the customer given his/her expectancies plays the master role in this particular model.

Evaluating Satisfaction.

Satisfaction is an indicator that encloses all the potential value given from intangible interactions that are allowed by the environment, but that do not appear in the original network fragments. It is a key index because influences the willingness of the customers to pay for the services offered in the service network. In other words it influences the willingness of possible participants to join the networks and the willingness of present participants to stay inside the network.. it is very difficult to express this index as a number because satisfaction is a mental condition of the customer. Thus the parameters that influence this index are not easy to be found and even if we find them it is not easy to find exactly in what extend they influence satisfaction index. The parameters that influence Customer satisfaction are tangible and intangible. The most important tangible parameters are the price service delivery time and quality of service[39]. The most important intangible parameters are expectations of the customer about the service and the comparison with the ideal service that customer has on his mind.

There are a lot of methods that try to measure customer satisfaction. These methods provide useful information regarding consumer behavior given a uniform way of customer satisfaction measurement.

The development of national customer satisfaction barometers is mainly focused on the following basic objectives [35]

Economic returns: Usually, the implemented methodology makes it possible to link customer satisfaction to economic returns, mainly though the correlation with financial performance indices.

Economic stability: A uniform national customer satisfaction index should help determine what percentage of price increases represent quality improvement and what are caused by inflation.

Economic link: A measure of the quality of economic output and productivity measures is essential for interpreting price.

Economic welfare: The quality of the provided products and services, as measured by customer satisfaction, constitutes at the same time an indication of economic well being.

Economic output: A national customer satisfaction index quantifies the value that customers place on products and services, and thus it drives quality improvement.

2.5.1 BAROMETERS

There are several barometers that try to estimate customer satisfaction. The barometers have something in common however each of them has been adapted to the specific environment that it is applied. In this section we will refer to the most important of them. We will focus more on American Customer satisfaction index because it is the most widely used of all and we propose its use to our methodology.

American-Swedish customer index

The analysis is based on Fornell's approach, which is a cause and effect econometric model. The main characteristic of these barometers is the multiple equations that

correlate customers values and perception for quality with their satisfaction and loyalty, as it is expressed through price elasticity and repurchase intentions[36][37].
American Customer Satisfaction Index (ACSI) was established in 1994 following several years of development and pretesting. It is produced through a partnership of the University of Michigan Business School, American Society for Quality and Arthur Andersen. The National Quality Research Center (NQRC) at the University of Michigan Business School is responsible for researching and producing the ACSI [38]. The data are collected through a computer assisted telephone interviewing system (CATI) that is based on a random digit dial selection.
Although the number of companies varies from year to year as a result of mergers and acquisitions, the survey includes 7 main economic sectors, 35 industries, and more than 200 companies with revenues totaling nearly 40% of the GNP. The ACSI also measures customer satisfaction from non-US companies with major market shares and federal-governmental services as well. Each company in the ASCI is weighted within its industry by its most recent years_ revenue. Also, relative sales by each industry are used to determine each industry's contribution to the respective sector index, as shown in the following formula
All companies, industries and economic sectors in the ASCI were measured at the same time only for the baseline year (1994). Since that baseline year, ASCI is updated quarterly, on a rolling basis, with new data for one or two sectors replacing data from the prior year. This way, ACSI provides analytical results at different levels, i.e. for each economical sector, industry or a set of selective companies included in the survey[39]

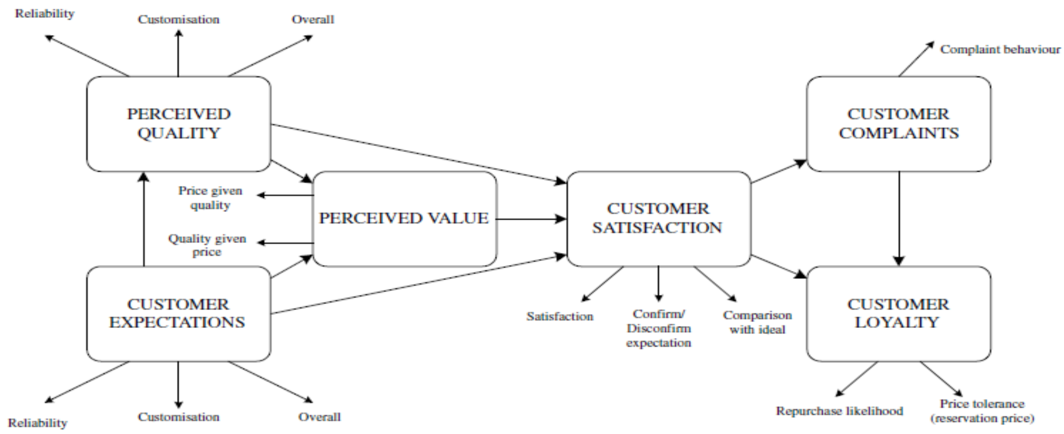

Figure 2-ACSI

Overall customer satisfaction (ACSI) was operational zed through three survey Measures: (1) an overall rating of satisfaction, (2) the degree to which performance falls short of or exceeds expectations, and (3) a rating of performance relative to the customer's ideal good or service in the category (Figure 2). Whereas the latter are commonly used as antecedents in models of transaction – specific satisfaction

(Oliver 1980; Yi 1991), their use as reflective indicators of overall customer satisfaction is consistent with that cumulative nature of ACSI, because each measure represents a qualitatively different benchmark customers use in making cumulative evaluations, such as overall customer satisfaction. More over the latent variable methodology employed to estimate overall customer satisfaction only extracts shared variance, or that portion of each measure that is common to all three questions and related to the ACSI construct's position in the model's chain of cause effect. Thus satisfaction is not confounded by either disconfirmation or comparison to an idea. Only the psychological distance between performance and the customer's ideal point, was used to estimate overall customer satisfaction (ACSI) [40][42]

More detailed the customers are asked to answer in 15 questions 3 of them are used to calculate the overall customer satisfaction index. In each one of these question he has to give a grade between 1 which means very dissatisfied and 10 which means very satisfied. The questions do not have the same importance for the index. There are weights that show us the importance of each question. These questions are: [41]

1) How overall are you satisfied from the service?

2) Considering your expectations, to what extent have these services fallen short or exceeded your expectations?

3) How close are the services offered by this provider to your ideal services?

German customer barometer

The German Customer Barometer (GCB) has been established by the German Marketing Association. V. and the Deutsche Post AG and operates on a yearly basis since 1992. Its general philosophy focuses on the following points [43]

- Supplying single industries and suppliers with data to determine their position and deficiencies in market according to customers_ perspective.
- Information on the customers'_ expectations as well as on the way through which they are modified.
- Continuous information and controlling of customer satisfaction measures.
- Developing and strengthening the customer orientation philosophy of the German industries, companies, organizations and institutions.

The required data are collected through a computer-aided telephone survey (CATI: Computer Assisted Telephone Interviewing) based on a random sample of approximately 45.000 customers, covering more than 50 industry sectors. The study is conducted separately in former West and formerEast Germany.[39] The GCB supplies important data to German companies in order to implement an internal, industry or international benchmarks. But, as Meyerand Dornach (1996) [43] state, traditional quantitative performance indicators such as market share or profitability should be combined with customer satisfaction and loyalty indicators provided by GCB. It should be noted that GCB includes an employee satisfaction survey as well. It is an industry independent survey regarding the relationship between customer and employee satisfaction andinternal customer orientation.

T**he European Customer Satisfaction Index**

(ECSI) is a new economical indicator, which has been developed by the EOQ (European Organization for Quality) and EFQM (European Foundation for Quality Management). The ECSI is also supported by the European Commission and ESOMAR (European Society for Opinion and Marketing Research), and it is sponsored by the IPC (International Post Corporation)[44]. The CSI university network, which consists of 8 European universities, has also participated in the development of the ECSI.

The theoretical ECSI model constitutes a modified adaptation of the ACSI/Fornell_s model.

It is a structural model employing stochastic approach and using simultaneous equation estimation techniques [35] [45]. As presented in Figure 3 the model includes a set of variables in order to explain customer preferences, perceived quality and other behavioral aspects. The set of latent variables can be categorized as drivers for explaining satisfaction, customer satisfaction, and consequences of satisfaction

(loyalty): these variables are image, expectations, perceived quality, customer satisfaction and perceived value.

ECSI considers the European economy as a whole, and thus, customer satisfaction indices can be compared with each other and with the European average. The ECSI model provides the ability to produce 4 levels of satisfaction indices, similarly to ACSI results:

- National customer satisfaction indices.
- Economical sector indices.
- Specific industry indices.
- Scores for companies and organizations within the survey.

The main advantage of ESCI is that provided results are comparable between companies and organizations on national, European, and global levels. ECSI has been built to be compatible with other national satisfaction barometers, especially ACSI [35] [45]. Also, the methodology may be used to produce a trend and a benchmark measure for individual companies and organizations or industries and economical sectors.

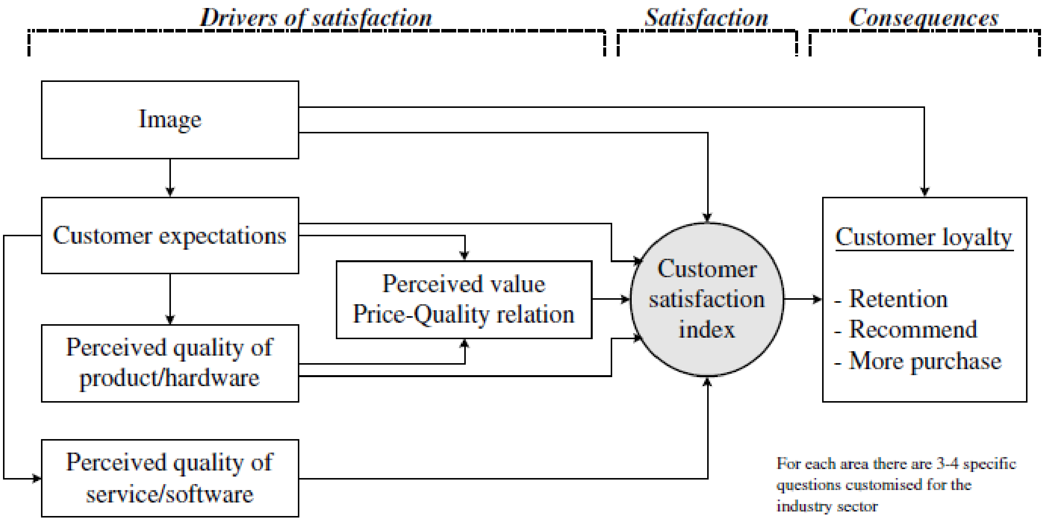

Figure 3-European customer satisfaction index

A possible, but not complete, list of value parameters is: the openness of the network to new value-creating collaborations (i.e., How easy is for a new business partner to join the network? Does all the partners benefit from its contribution?); the increase in freedom for each partner (i.e., new entities are able to diversify the number of exported services); reputation and information flow (i.e., turning an unpredictable environment to a transparent environment). All these parameters may not be easily expressed as a number, therefore a qualitative study should be possible [39] .

CHAPTER 3 - SERVICE SCIENCE THEORETIC BACKGROUND

In this chapter we give a brief definition of service networks, describing their structure and the problems that emerge.

3.1 Service networks

Globalization of the world economy has led to an increased ability of companies to outsource the planning, design, manufacturing, and distribution functions of their services around the globe. The complexity created by rapid technological advances and the complexity of service design and manufacture have led to the modularization of corporate functions in a wide range of industries Modularization allows standardization and markets for services providing those standardized functions, and is thus one of the leading causes for the predominance of the service sector in the world economy. Competitive markets evolve best-of-breed functions, which in turn encourage deconstruction of formerly vertically organized companies and industries into service systems, also referred to as value networks, to capitalize on this advantage. Service networks (and systems) are complex sets of social and technical resources which work together to create economic value. [24]. We consider everything that it is exchanged inside the network as a service from one entity to another.

A similar approach describes a Service Network as a collection of people and information brought together on the Internet to provide a specific service or achieve a common business objective. It is an evolving extension of service systems and applies Enterprise technologies, also known as enterprise social software, to enable corporations to leverage the advances of the consumer internet for the benefit of business. A service network is designed to benefit from the wisdom of crowds and desire to share information, collaborate, and self organize into communities of common interests and objectives. In business, the value of collaboration is clearly recognized, but the ability is often hampered by rigid organizational boundaries and fragmented information systems. A service network enables businesses to realize the benefits of mass collaboration despite the constraints of modern organizational structures and systems.

The term *service network* is increasingly being used within the context of service innovation initiatives that span academia, business, and government [32]

The viability of Service networks is based on strategic alliances between service providers in order to create a service that can be offered to the end customer. The strategic alliances are characterized by the following [69]

- There is greater uncertainty and ambiguity.

- The manner in which value is created- and the way in which partners capture it- is not preordained.
- The partner relationship evolves in ways that are hard to predict.
- Today's ally may be tomorrow's rival- or may be a current rival in some other market.
- Managing the alliance relationship over time is usually more important than crafting the initial formal design.
- Initial agreements have less to do with success than the adaptability to change.

3.2 Agile Service Networks

A more abstract and dynamic approach for service networks is the agile service networks model.

An Agile Service Network, also known as an Agile Service Value Network, or simply ASN, is defined as a system of interconnected entities with the following characteristics [25,26,27,28,29,30,31]:

- Each entity may be a company or different roles within the same company that are able to offer one or more services. For example in the service network of a telephone company there may be an administrative center, many local telephone centers, a customer service, a billing department, and so on.
- The connections among the entities define the relationships among the partners. Some of these relationships are defined by "contracts", that states the tangible value exchange between the two entities in terms of payment or other forms of value. Other connections reflect the intangible value that is exchanged as a side effect of contractual relationships. According to some authors the value may be also negative, in such the case it is usually referred as cost.
- The direction of the connections indicates the source of the value and the destination of the value.
- The entities and their connections are allowed to change with a certain level of flexibility: this is often referred as the agility of the service network [24].

There is not a dominant standard yet in the representation of these networks (ASN, SN). The graphical formalism is usually the corresponding graph, however different authors choose to represent and differentiate tangible/intangible interactions with dashed lines, as well as coloring the interaction with sequence numbers and cost/benefit differences (for negative and positive values).

3.3 Business Ecosystems

Service Networks are usually formal representations of whole Business Networks.

The interactions among the actors of these networks may be traditionally coordinated in two different ways: using hierarchies and markets.
Hierarchies are based on a rigid hierarchical organization among the actors of the network and their cost usually grows very fast as the network becomes larger and more complex. Markets are based on self-coordination among the actors that is based on the law of offering and demand. This is less complex and requires less explicit coordination than hierarchies, but is affected by a problem in the possible loss of the "perfect market conditions", such as the hiding of information or the creation of external opportunistic relationships for controlling and damaging the market.
These coordination methods are usually related to aggressive behaviors of companies whose main goal is to eliminate as many competitors as possible.
In the latest decades another coordination mechanism emerged: the Business Ecosystem [18] in which firms may still coordinate in the traditional ways, but with the difference that their final goal is not to remove or beat competitors, but to cooperate by establishing some value-creating virtuous circles. This last behavior has been called the "keystone behavior" [16]. Examples of keystone companies are eBay and Amazon since their core business is supporting the creation of value of other individuals/companies. An important characteristic of Business Ecosystems is that the value is an emergent property of the system that arises not only from existing actors, but, since the Ecosystem is open (unlike traditional Businesses that were used to keep everything secret and proprietary), it may also benefit from the occasional intervention of new incoming entities. In a business ecosystem the strategy, defined as the set of common cooperative and competitive behaviors that are required to obtain an emergent value, is also called the "ecology" of the network [15].

3.4 Open issues on service networks

In this section we will show some of the problems encountered in service networks and some question that have emerged.
We know from the service network theory that all activities and interactions among a set of companies (or roles within the same company) may be always represented as a service network. Current research has focused on finding efficient and intelligent ways for reorganizing such network (and therefore the underlying business processes) in order to maximize its value. In most of the works these decisions are taken by considering some sort of value function based on requirements, expected satisfaction, and collaboration alternatives, therefore each entity looks for an answer to the following questions:

- Why, as a company, should I belong to this service network?
- Why, as a company, should I choose to interact with company X instead of company Y?

- How competitions among service networks influence their profitability?
- How a network transformation influences the value of the whole service network and the value of each participant?
- How service networks interact, evolve and adapt in order to better meet the needs and aspirations of people, business and wider society.

The answers on these questions are usually analytically (or intuitively) computed.
Traditional networks tend to be conservative and closed, meaning that the role of each participant is fixed and his choices are limited. This strategy is not profitable in our days. Service networks must be opening and able to change dynamically and create new co operations with other “service providers”. What we want to point out here is to explain why a service network should check whether to start new co operations and to open itself to new value-creating collaborations

Another issue is that each participant is difficult to receive knowledge, therefore its choice whether to participate or not in the network depends on the very few available information that has to evaluate such as price information and the “fame” previously received by the service provider. Since his information is not usually easily accessible by all customers the choice tends to be non-deterministic and does not stimulate any improvement from the service provider’s side. End customers or possible participants do not have the time to search every possible service network in order to be sure that that their choice to join a particular network was the best. Most of the times they check only a subset of them asking, basic and obvious questions without learning anything else. That’s why it is very important for the service network to encourage its participants, especially the end customers to establish social networks in order to be able to be informed for the services offered and report their comments. In this way the loyalty of the participants to the network enhances the knowledge that is transmitted easily to the other participants and the network is able to improve its services or offer new ones. Furthermore it will help participants to establish new collaborations increasing their value and the adaptability of the network to the rapid changing environment.

Several other issues appear among the participants of a service network that cooperate to offer the final service. Although there are a lot of criteria that examine the viability of a cooperation between service providers there is not a way that shows exactly the value that the network will receive from this collaboration. In addition it is difficult to predict the evolution of the network and the changes that may be needed in the future. Service networks exist in a very competitive and dynamic changing environment. That’s why it is very important to be able to investigate when and how long cooperation is profitable for the network and examine the impact of a new partner entrance or a new competitor. The knowledge of the interaction between the participants inside the service network is very important for its viability.

CHAPTER 4: OPTIMIZATION – SIMULATION TOOLS, DYNAMIC SYSTEMS

In this job except the presentation of a method that estimates the value of a service network and its participants we applied this method to a case study. Then optimize this value and then simulate it's a evolution within time. Before we present this case study and the results we will say a few words in this chapter about optimization, simulation and the tools we used. Finally we will refer in short to dynamic systems because each service network is a dynamic system itself.

4.1 OPTIMIZATION-OPTIMIZATION TOOLS

In computer science, optimization, or mathematical programming, refers to choosing the best element from some set of available alternatives. In the simplest case, this means solving problems in which one seeks to minimize or maximize a real function by systematically choosing the values of real or integer variables within an allowed set. This formulation, using a scalar, real-valued objective function, is probably the simplest example. The generalization of optimization theory [46] and techniques to other formulations comprises a large area of applied mathematics. More generally, it means finding "best available" values of some objective function given a defined domain, including a variety of different types of objective functions and different types of domains.

SOLVER

There are a lot of mathematical optimization tools [47] from this wide range of tools I chose to use for master thesis, excel solver because I didn't need a powerful tool for my experiments. I just needed a tool to check my results and Solver with its user friendly environment appeared a good solution. Solver is part of a suite of commands sometimes called what-if analysis (what-if analysis: A process of changing the values in cells to see how those changes affect the outcome of formulas on the worksheet. With Solver, you can find an optimal value for a formula (formula: A sequence of values, cell references, names, functions, or operators in a cell that together produce a new value. The cell that the results appear called the target cell. Solver works with a group of cells that are related, either directly or indirectly, to the formula in the target cell. Solver adjusts the values in the changing cells you specify— called the adjustable cells— to produce the result you specify from the target cell formula. You can apply constraints to adjustable cells, the target cell, or other cells that are directly or indirectly related to the target cell. To restrict the values Solver can use in the model and the constraints can refer to other cells that affect the target cell formula.

The Microsoft Excel Solver tool uses the Generalized Reduced Gradient (GRG2) nonlinear optimization code developed by Leon Lasdon, University of Texas at Austin, and Allan Waren, Cleveland State University.
Linear and integer problems use the simplex method with bounds on the variables, and the branch-and-bound method, implemented by John Watson and Dan Fylstra, Frontline Systems, [75]

Mathematica
Another tool I used for optimization was mathematica. Mathematica is a computational software program used in scientific, engineering, and mathematical fields and other areas of technical computing. It was originally conceived by Stephen Wolfram and is developed by Wolfram Research of Champaign, Illinois. Mathematica provides you with the world's largest collection of algorithms in a single system--each able to operate across the widest applicable scope of numeric, symbolic, or graphical input. Moreover it offers Functions or data, discrete objects, diagrams, images, or annotations--*Mathematica*'s visualization engine powers professional-quality static or dynamic representations, automatically optimizing the balance between computational efficiency and visual sophistication. With integrated symbolic computation, you can work directly on precise models--transforming, optimizing, solving, and visualizing--only substituting approximate or specific numerical values where necessary. Whether it's for simulation set-up or as part of a hybrid approach with numerics, integrated symbolic computation is now recognized as an essential element of any error-free engineering or scientific workflow. *Mathematica* is the world's leading symbolic computation system, both in functionality and integration with numerics.[60]

4.2 System Simulation – System modeling

A system is understood to be an entity which maintains its existence through the interaction of its parts. A model is a simplified representation of the actual system intended to promote understanding. Whether a model is a good model or not depends on the extent to which it promotes understanding. Since all models are simplifications of reality there is always a trade-off as to what level of detail is included in the model. If too little detail is included in the model one runs the risk of missing relevant interactions and the resultant model does not promote understanding. If too much detail is included in the model the model may become overly complicated and actually preclude the development of understanding. One simply cannot develop all models in the context of the entire universe, of course [61].

A simulation generally refers to a computerized version of the model which is run over time to study the implications of the defined interactions. Simulations are generally iterative in there development. One develops a model that simulates it, learns from the simulation, revises the model, and continues the iterations until an adequate level of understanding is developed.
Modeling and Simulation is a discipline, it is also very much an art form. You can learn much about modeling and simulation from reading books and talking with other people. Skill and talent in developing models and performing simulations is only developed through the building of models and simulating them. From the interaction of the developer and the models emerges an understanding of what makes sense and what doesn't [61] [70]

System dynamics is a continuous simulation methodology that uses concepts from engineering feedback control theory to model and analyze dynamic socioeconomic systems. The mathematical description is realized with the help of ordinary differential equations. "The expressed goal of the system dynamics approach is to understand how a system's feedback structure gives rise to its dynamic behavior [48] More precisely a systems dynamics approach permits a graphical model formulation and provides the opportunity to monitor the behavior of the system during a specified period of time. This allows a dynamic analysis of the process behavior to be conducted [50].

System dynamics is a methodology for studying and managing complex feedback systems, such as one finds in business and other social systems. In fact it has been used to address practically every sort of feedback system. While the word system has been applied to all sorts of situations, feedback is the differentiating descriptor here. Feedback refers to the situation of X affecting Y and Y in turn affecting X perhaps through a chain of causes and effects. One cannot study the link between X and Y independently or the link between Y and X and predict how the system will behave. Only the study of the whole system as a feedback system will lead to correct results. [49]

The field developed initially from the work of Jay W. Forrester. His seminal book 50] is still a significant statement of philosophy and methodology in the field. Since its publication, the span of applications has grown extensively and now encompasses work in corporate planning and policy design, public management and policy, biological and medical modeling, energy and the environment, theory development in the natural and social sciences, dynamic decision making and complex nonlinear dynamics.

The essential features of system dynamics according to Forrester are.

1. Deals with entire operating machines and process rather than just isolated components.
2. Treats the dynamic behavior of not just mechanical but also electrical fluids .

3. Emphasizes the behavioral similarity between systems that differ physically and develops general analysis and design tools useful for all kinds of physical systems .
4. Sacrifices detail in component descriptions so as to enable understanding of the behavior of complex systems made from many components.
5. Uses methods which accommodate component descriptions in terms of experimental measurements, when accurate theory is lacking or is not cost effective. Develops universal lab test methods for characterizing component behavior.
6. Serves as a common unifying foundation for many later courses and practical application areas.
7. Offers a wide variety of computer software to implement its methods of analysis and design.

4.2.1 Simulation Software

System simulation software is used for developing, analyzing, and packaging dynamic non-linear feedback models. Models are usually constructed through a graphical interface or in a text editor. The models are typically built around a system of differential equations that track behavior of system elements through time. All the tools are working in similar ways using stock flows and converters to simulate the dynamic systems.

There are two types of simulation modeling: static and dynamic. Static models are systems of equations that are solved once. Dynamic models add a time dimension. Mathematical computations tied to processes are performed at time intervals, allowing the modeler to study a system as it evolves over time.

Within dynamic simulation there are two types of modeling methods: continuous and discrete event. In continuous models, time passes linearly and the processes vary directly with time.

Examples of continuous-system situations include pollution from a factory and the flow of fluid in a pipe. Discrete-event models deal with events and specific time intervals. Examples of discrete events include computer-performance evaluation and inventory dispatch systems.

In discrete-event models, the occurrence of an event drives the model, whereas in continuous models, the passing of time drives the model. Our simulation belongs to the category of continuous simulations because we examine our system in continuous time.

There are several excellent software packages designed to support system dynamics modeling. Some of these are ithink, Powersim, and Vensim.

System Dynamic simulation tools offer to the analysts a lot of advantages. Some of them are:

- They increase understanding of process dynamics
- They determine impact of existing policies, refine them, identify new improved policies
- They explore counterintuitive behavior
- They support resource and schedule estimation
- They identify potential process improvements and assess their impact
- They build a common language amongst process owners and participants, share mental models, stimulate discussions
- They identify actions to mitigate process-related risks

Vensim and iThink are the major tools for building continuous simulation models. 8 of 10 studies which adopted System Dynamics (SD) paradigm use Vensim or iThink as their modeling tool.

In the rest of this section we will describe shortly and compare some of the most important simulation tools.

VenSim

Vensim is used for constructing models of business, scientific, environmental, and social systems. It has an extensive set of analysis tools such as causal tracing, sensitivity analysis and optimization that make it a good choice for complex modeling. Unlike Ithink, Vensim has a limited set of tools for building a user interface. Contrary to ithink's stock/flow ordering, Vensim PLE documentation is alphabetized (Vensim Plus allows the modeler to choose stock/flow ordering or alphabetized ordering). Some differences between ithink and vensim are in the documentation attached to models in the Vensim in the look up functions and Initial Variables. Every Vensim model has an additional input for each stock, called "INITIAL 'STOCK NAME.'" Unlike the ithink models currently in Road Maps, where the initial value of the stock is numerically entered into the Initial Value "equation" box, in Vensim models, the name "INITIAL 'STOCK NAME'" is typed into the Initial Value box for the Stock, and the numeric value is entered in the equation of the "INITIAL 'STOCK NAME.'" For Vensim Version 3.0 (or lower), the "INITIAL 'STOCK NAME'" cannot be attached to the stock, and must be "floating." For Vensim PLE Plus and the newer versions of Vensim, the "INITIAL 'STOCK NAME'" can be attached using an arrow. This convention makes it considerably more convenient to change initial conditions while running simulations.
[51][52]

Think

IThink, is widely used from educators, research centers and large firms. It is very easy for someone to learn it and as such is the reason for its extensive use by educators in

the classroom. Ithink represents an implementation of Forrester's stock-and-flows diagrams quite faithfully (Forrester, 1961, 1969). It allows you to build a graphical model and translate it into a dynamic mathematical linear and nonlinear representation. [53]
In addition, the latest versions of ITHINK allow for the creation of standalone multimedia simulations that are now being adopted by the best business schools and the creation of web-based simulations. The ITHINK software does provide other options to vary rates over time, or utilize data forecasts from external sources. Little mathematical sophistication is required of the user, since the system provides considerable guidance in creating the difference equations that underpin system dynamics. In addition ithink models can be converted in to Matlb files for further analysis and optimization [54]. Another strong advantage of the tool is that contains modules that provide an easy way to create a high-level map for a model and break down components into hierarchical model structures or re-usable "building blocks".
Furthermore it offers sensitivity analysis that reveals key leverage points and optimal conditions. Partial model simulations focus analysis on specific sectors or modules of the model. It enables Dynamic data import/export links to Microsoft® Excel. Finally results presented as graphs, tables, animations, QuickTime movies, and files creating a user friendly environment. Ithink does not support multidimensional arrays (>2D). But usually this is not a problem. [55]

Powersim

Powersim, has the characteristics of a combination of Ithink and Vensim. It includes an extensive set of user interface components and also an extensive set of model analysis tools. Powersim Studio has a steeper learning curve than either of the other System Dynamics software packages but also offers more usability. Powersim was the only one of the three software packages (Ithink, Vensim, Powersim) that could handle a large 6 element array structure. However if the arrays are big, a lot of memory and process capabilities are needed. The main problem for Powersim is that all these capabilities increase its cost very much. Consequently it is used most for very complex problems and in powerful computers.
Powersim's implementation of Systems Dynamics is based on several constructs. The first construct, a level, accumulates items such as money, pollution, inventory, etc. The second construct is the flow, which brings items into and out of levels. Auxiliaries--similar to formula cells in spreadsheets--and constants modify the flow. Powersim uses links to tie the model constructs together. It includes more than 150 functions that are broken into 16 groups, including financial, mathematical, statistical, control, graphics, and historical functions. Like the other products, Powersim can run models with animation. Key values, graphs, and tables can be displayed directly on the model window, making it easy to view results. The

Multiuser Game object lets several users run the model concurrently to cooperate with or compete against one another.[56] [57]

Extend

Extend is primarily used for building discrete event simulation models. 7 of 9 studies using discrete event simulation paradigm chose *Extend* as their modeling tool. Moreover, *Extend* is capable of building continuous models, thus it can be used in hybrid simulation modeling. In the 5 studies which proposed hybrid simulation models, 3 of them used *Extend*. [58]

Vensim, Ithink and powersim have similar capabilities however I choose to use ithink tool because of its user friendly environment and its ability to create hierarchical models that make it easier for someone who is not familiar with dynamic systems to understand any model. Furthermore hierarchical model enable someone who just wants to have a general idea about the model to see only the highest level and not be occupied with useless details.

CHAPTER 5: VALUE CALCULATION METHODOLOGY

There are many open issues in service networks as we described in chapter 3. In this chapter we propose a methodology for calculating value in one time interval and explain briefly the difficulties that are encountered. Then, we define the value optimization problem considering many time intervals.

5.1 DIFFICULTIES IN CALCULATING VALUE

We consider that an entity within a service network has value when it satisfies the entity's needs and its acquisition has a positive tradeoff between the benefits and the sacrifices required. The most important characteristic of a service network is the value of each participant and the total value of the network. The computation of value enables analysts to determine, if the network is profitable or not, who the most important participants are and if it is profitable for a possible participant to join the network.

However any effort to estimate value in service networks encounters some problems. One of the most critical problems in order to estimate value is to distinguish the value created by the participant due to its offerings and the value that is created by the cooperation with another participant. In other words, analysts need to determine the value that a participant contributes alone to the service network. Tangible assets offered by the participants inside the network are easy to be evaluated while intangible assets such as knowledge are not. In order to overcome this difficulty analysis we define the goals of each participant and determine the services that must be offered to achieve each goal. Then, they will be able to decide how valuable are the services offered and exchanged inside the network for each participant.

Although determining value the contributions of partners in a service network seems to be simple in principle, it is difficult in practice. According to the study of Doz, Y., and G. Hamel described in [62] there are five characteristics of participant contributions called value conudra that are responsible for the formulation of value.

1. The alliance between the participants brings together non traded assets that are hard to value.
2. The relative contribution of each participant to alliance success is hard to assess, even retrospectively.
3. Much of value, and the costs, of an alliance accrue outside the relationship, making it difficult for partners to monitor each other's balance of costs and benefits.
4. The relative value of each partner's contribution may shift over time in ways that are difficult to anticipate and recognize.

5. Partners may be less than totally forthcoming in declaring the value they seek from the alliance.

We take into consideration these difficulties by considering that everything that is exchanged inside the network is a service and then we identify all tangible and categorizing intangible services exchanged between the participants. Then, we estimate the cost of any service we have identified. In this way we can easily determine the revenues and the costs of each service provider because the cost for a service is revenue for its service provider. Finally, we consider that the cost of a service for a customer is the revenue for the service provider.

5.2 Methodology

5.2.1 General issues

Service networks are very sensitive dynamic systems that change overtime because they depend on many parameters.

Our Methodology is based on the fact that value characteristics are different for the various participants of the service network, since each participant has different goals to achieve. For example, some entities may need to develop technical knowledge through their participation, while others to increase their customer base. In complex systems (in simple service systems it is not very important) with many participants it is important to identify the goals and specify the variables and the restrictions that effect its value in order to make accurate estimations. Secondly we need to take into consideration the offerings of each potential participant in the network. We study cases in which the current participants of the network refuse to cooperate with new entries. This can happen for several reasons (eg. There are other more profitable potential participants). The entrance of an entity may lead to the exit of other entities or to lead other potential participants to cooperate with competitive networks.

5.2.2 Value estimation

In this subsection we describe the calculation process of value in several situations. This information will then be used to take decisions about the profitability of participating in the network. We first define the parameters that will be used in the analytical definition of value. Each of these parameters is evaluated for each time interval the duration of which is properly chosen by the business process manager. To distinguish among different time intervals we use the notation T_1, T_2, … T_N.

Revenues $R_{ij}(T_N)$ of participant *i*, are the payments that each participant *i* receives for the services he offers to participant j. $R_{ij}(T_N) = \sum_{\kappa}(c_{ji}^{k})$

Costs $C_{ij}(T_N)$ of the participant i, are the amount of money each participant i pays in order to be able to participate in the network and offer his services to other participants. $C_{ij}(T_N) = \sum_{k}(c_{ij}^{k})$

Satisfaction index $SAT_{ij}(T_N)$ measures the importance of a relationship and the willingness of *j* to interact with participant *i* inside the service network. Its analytical definition and evaluation depends on the actual problem.

In this master thesis we calculate customer satisfaction using the methodology described in the American Customer Satisfaction Index[40] Further information about this methodology are given in chapter 2.

Past values of Revenues, Costs, and Satisfaction index can be used to predict future expected values of the same parameters using, for example, autoregressive with mobile average models as done in [24].

Expected profits $Ep(T_N)$ of participant *i* obtained due to its relationship with participant j**,** for an entity in the network is the difference between expected revenues and expected costs multiplied by the variation of the expected *Satisfaction index* provided that participant *i* is not an end customer.

$$Ep(T_N) = \delta\overline{SAT}(\overline{R_{ij}}(T_N) - \overline{C_{ij}}(T_N))$$

$\delta\overline{SAT_{ij}}$ is the variation of the expected satisfaction of participant i due to its interaction with participant j in the service network. It is defined as follows: $\overline{SAT}_{ij}(T_N) = \mu_i SAT_{ij}(T_N) + \psi_i \overline{SAT}_{ij}(T_{N-1})$

where μ, ψ>0 and μ+ψ=1.

The definition of the relationship value v_{ij} is different for customers (entities that do not have direct revenues) . The expected profits Ep_{ij} is defined as follows:

$$Ep_{ij}(T_N) := u_{ij}(\delta\overline{SAT_{ij}}, C_{ij})$$

where *u*(…,…) represents the utility function of end customer *i* interacting with participant *j* and measures the value customer *i* obtains by using the service.

The **total value** for each participant *i* at time T_N is the sum of its revenues and the expected profits minus its costs that come from its relationships with all participants *j* inside the service network:

$V_i(T_N) = R_i(T_N) - C_i(T_N) + Ep(T_N)$ where, $R_i(T_N)$ are the revenues of the participant come from its relationships that creates inside the service network. $C_i(T_N)$, are the costs come from its participation into the service network. $Ep(T_N)$, are the expected profits from its participation into the service network.

The **total value of the network** is the sum of the value of each participant.

$$V_{networki}(T_N) = \sum_j V_j(T_N)$$
.

In other words we
define the **value** of each non-customer participant as the sum of its profits (revenues minus costs) increased by the expected profits.

The expected profits can be used as a measure to compare profitability of competing networks in order to encourage new entities to join the network. In addition a possible future work to obtain value (due to high participation costs or unprofitable relationships) forces the net to restructure itself into another system. An important factor that affects the above decisions is the selection of the time horizon in which the calculations are performed. It must be long enough to compensate for the changes of the dynamic system and short enough to offer the right incentives for participants' strategies [24].

At this point, it is very important to mention that it is not always profitable for the companies to increase customer satisfaction. Sometimes the increase of customer satisfaction demands a lot of effort and capital for the participants. This investment might be risky for a potential participant and discourage him to participate and foster relationships inside the service net. Consequently the strategic decisions of a participant have to increase not only the customers' satisfaction but also agree with its partners choices and preferences.

Finally, it is worth mentioning to mention that, obtaining and further optimize value by participating in a service network is connected with three intangible assets that a participant seeks to obtain:

- To enlarge its customer base. It most refers to small companies who want to cooperate with bigger companies or companies with large sales network.
- Receive technical knowledge by cooperating with firms that develop new technologies and innovative products.
- Receive fame or to increase their prestige by cooperating with large scale and more reliable companies.

5.3 VALUE OPTIMIZATION

We consider a service network that its participants cooperate to create value for themselves. The participants offer and receive services inside the service network. The composition of these services creates the final service that is offered to the end customer. The main goal in a service network is maximize total value even if some of the participants might not be satisfied. This goal can be divided into two sub goals. First the service network wants to increase its end customers. Second it wants to decrease the cost of the services being offered. On the other hand each participant wants to maximize its own value. It's important to mention that the optimal strategy of a participant is not optimal for the others or the service network.

In this master thesis we perform simulation to determine the optimal value of each participant in the service network, by examining the fluctuation of mean repair price. The solution of this problem reveals the mean repair price that each partner maximizes its value. In addition we study the profitability of the network when one of the participants maximizes its value and how the other partners may react. This means that we cannot set a common price for all participants that maximizes their value simultaneously.

5.4 PARTICIPANT STRATEGIES

Then the question that emerges is how a network transformation influences the profitability of the network and its participants. Furthermore we have to study the impact of one participant's strategic decisions on the others and on the functionality of the service network. Different partners may have different business goals, which may possibly be conflicting. For instance, one partner may be more interested in customer satisfaction, which may require an increase in costs to be achieved. This may be unacceptable for partners whose first priority is cost reduction. Furthermore we examine for each possible participant under which circumstances it is profitable for him to join the network. The evolution of value overtime discovering the situations that one network is more profitable than the other is another problem that we deal with. Except that, it is important to know how long needs the network after the transformation to become more profitable than the initial one. Finally we have to analyze the impact of the arrival of new possible participants that are willing to join the network to its total value and to the value of its participants.

CHAPTER 6 - CASE STUDY

In this chapter we examine the behavior of car repair service network overtime. We examine the fluctuation of value over time based on the methodology described in chapter 5.

We chose this network because of its structure (existence of decision model) and the plethora of data we had on our disposal [24] that enable us to examine the open issues of the service networks. In the following subsections, we will first refer to what is happening today car repair service networks. Then we describe the business objectives, difficulties, and metrics that are involved in this service system. We used the Ithink simulation tool to perform simulation experiments.

6.1 OTHER CAR REPAIR SERVICE NETWORKS.

The majority of the websites that are occupied with car dealers, car OEM, suppliers etc just advertize car dealers or certified car manufacturers of a specific brand. These sites do not offer any other service to their visitors and does not propose to anyone what is the best choice

An attempt very close to our case study is described in [63]. Where the authors propose the replacement of the traditional car Sales and Distribution (S&D) chain (manufacturer, the importer and the dealer), with a more IT-based model that replaces many of the activities of importer and dealer. The model tries to cut costs and offers the ability of direct sales through Internet-based middlemen. However there is a resistance to the use of this system from many of the participants of the network because many of them loose a lot of their income.

Another interested approach that fits into our 3rd model of the case study is described on [64]. They examine in automotive industry under which circumstances outsourcing is profitable. Outsourcing is responsible for the creation of the majority of service networks. However sometimes it is not profitable for the company and as a result the company abandons the network. A careful assessment of a firm's assets and resources must precede any outsourcing decision so that only those activities for which the firm do not have any special capabilities or those for which the firm do not have a strategic need are outsourced. The authors analyse several outsourcing models depending on the relationship between the car OEM and its Suppliers.

Very little job has been done to evaluate the whole service network and help the participants to make the right choice for them creating profitable service networks. An interesting approach is described in [64]. This paper does not exactly estimate value. It describes an approach to worldwide production networks, concluding to certain types and metrics to calculate possible benefit for a strategic plan for a possible local plant investment. However it doesn’t have a case study that this method has been tested.

Usually car OEMs use a dealer evaluation system to choose their SCS. A DES ascertains that dealers' activities achieve business goals and satisfy agreements and requirements during the period observed by the evaluation. It uses mathematical function score cards and psychometrical properties such as validity, reliability and discriminability. The criteria are specified by the OEMs and differ among service networks. A detailed description of a dealer evaluation system is presented in [68].however very often suppliers, especially in the automotive industry, join to competitive networks and this makes it difficult to evaluate them.

Today the relationships between car OEM and their suppliers are based on Global Sourcing (a buying system based upon a worldwide monitoring and selection of most convenient suppliers). A firm has a global sourcing system in place when it can source parts through a choice which compares supplier offers on a worldwide scale. The system requires a specific organizational structure which allows not just to monitor a large number of potential suppliers scattered around many continents, but also a system of evaluation and constant control for supplier performance (actual and potential), whose costs can be borne only by major car manufacturers. As it is known "integral" applications of this form of globalization do not presently exist, but scholars and practitioners agree in expecting this form of buying strategy to be enhanced. According to some, this system would allow the selection of suppliers with the best quality/price ratio.

6.2 A CONVENTIONAL REPAIR SERVICE SYSTEM

Original equipment manufacturer sells parts that have been made by the company that has produced the car of the car-Owner. Owners of original equipment manufacturer (OEM), brand-name cars arrive for repairs at the dealerships of the OEM. Technicians diagnose the problem to be repaired, order parts, and perform the necessary repairs. However, ordering parts is a complex process, since it involves scrutinizing the failure symptoms, identifying the faulty part, asking for advice from expert technicians available from the OEM (including information about warranty-covered parts, new parts, etc), and then ordering the appropriate (possibly upgraded) replacement parts. Ordering of parts is performed by the dealer's parts manager, who first must access the parts catalog, check local, OEM, and supplier inventories and eventually submit parts orders. The dealers' technicians perform these searches and check parts catalogs and inventories every day wasting their time. The parts manager can buy parts either from third-party suppliers (TPSs) or through the OEM, from the certified supply-chain suppliers (SCSs). The repair service and the new parts are paid for by the OEM if service and parts are covered by the warranty or by the car owner if they are not. The OEM offers advice to dealers' technicians for free. The OEM collects all (new) parts, warranty, and failure symptoms information and uses the services of a content preparation provider to generate new parts catalogs and mail them to its suppliers and dealers every month. All these delays contribute to longer repair times as perceived by the car owners, thereby lowering their satisfaction. A reduction in the customer satisfaction index is typically an indicator that fewer customers are going to buy the services offered by the service network, resulting in a negative effect on the overall value of the service system. On the other hand, a rising customer satisfaction index is a good indicator of stronger sales for this brand name. However this rise brings additional costs to the service providers that have to be taken into consideration.

6.3 THE MODEL

In this subsection we present the repair service system in detail, and perform simulations using the ithink tool. We provide snapshots and graphs generated by the tool, for further understanding.
The main building blocks of our model are the supplier, the car OEM and the dealer. Figure 4, shows the first hierarchical level for calculations of the value of each entity in the service system. The green area shows the parameters for calculating the value of the dealer. The blue area presents the value calculation of car OEM. Arrows represent the flows of costs, revenues, expected profits and total value from one participant to another. Costs, Revenues, Value and expected profits are represented as modules to our model. Each module encloses a small sub-system that calculates the value of the module. Complex variables inside the model are presented as modules too. This hierarchical structure helps us to understand easier the functionality of the model. The polarity (+, -) shows weather a flow has a positive or negative impact. For example the revenues of OEM have positive impact for its value whereas the costs have negative impact. We represent technicians, the parts manager, and the help desk experts as economic entities, each of which is offering its labor as a service to the service system. For simplicity reasons, we ignore relationship costs, transaction costs, and risk costs. Relationship costs are free offerings of a participant to its customers. Transaction costs can be modeled as offerings by dealers and OEM managers supervising the exchanges of the system and risk costs can be modeled as an insurance policy offering. Operational costs such as capital equipment and utilities are presented in our model as an autonomous module called “fixed costs” (Figure 10). We measure rates of offerings and payment flows per month however, we can compute values on a yearly basis too. For simplicity reasons we assume, that some of these rates remain constant for the time period we analyze. The rates that remain constant are shown for each service network in the Appendix. In the following paragraphs we calculate the value of each participant of the service network.

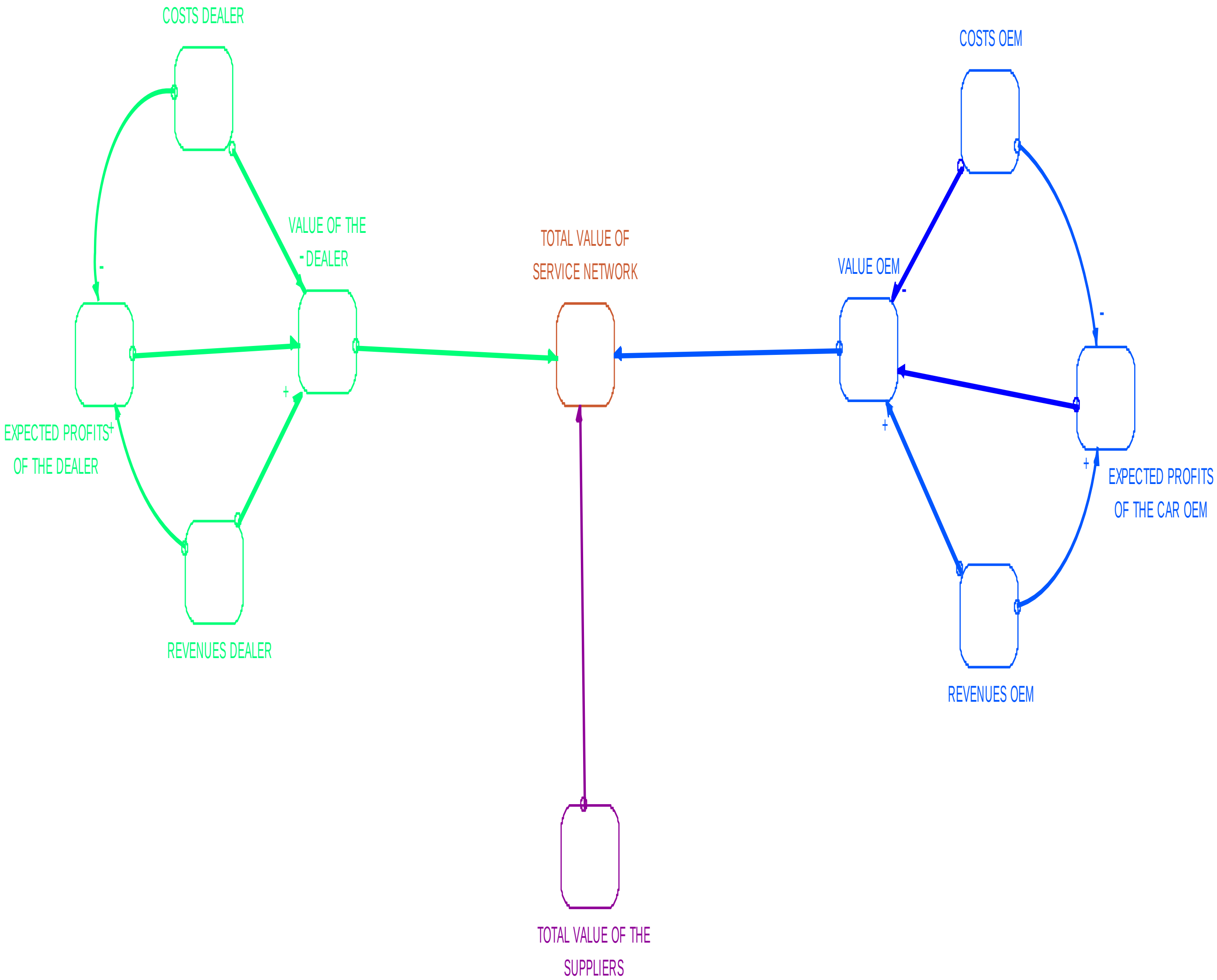

Figure 4-The first Hierarchical Level of the basic model

6.3.1 THE DEALER

Stock

The stock handling process of the repair service system is performed by the dealer as follows. We assume that the dealer has a stock of repairing materials (Figure 6). When a service request arrives the dealer checks its stock. If the stock is enough to cover the demand he doesn't order materials from the OEM. Obviously the mean repair time is decreased when the stock has all the appropriate materials.

The mean repair time r includes the time to do the technical research, the time for the parts to be ordered by the parts manager, and the time to perform the repair. In a sense, only the time to perform the repair is really useful time, as the other two components are delays introduced because the data on parts and failure symptoms is not readily accessible or may not be up-to-date. Figure 6, shows the stock handling process. In details we see 2 rhombs, the first one called, "ordering logic" that encloses a decision mechanism that determines when the car dealer will order repairing materials from OEM and at which quantity. This mechanism has two inputs, the number of repair parts that are on order and the quantity of parts that are already in stock. The other rhomb called "consumer demand logic" states how many parts are demanded from the customers. Its input the "number of parts ordered per month". We will provide further details about this variable later. Finally the variable "supplier lead time" indicates the time interval between the ordering and the receipt of the parts. We consider this time interval to be 8 weeks.

The impact of the stock to the value of the dealer has two different characteristics. On the one hand if it is good for the dealer to reduce the mean repair time because the satisfaction of his customers will increase. On the other hand as the satisfaction increase the service requests also increase therefore we need more stock to cover the demand in a lower mean repair time. Consequently the dealer has to spend more money on storing costs.

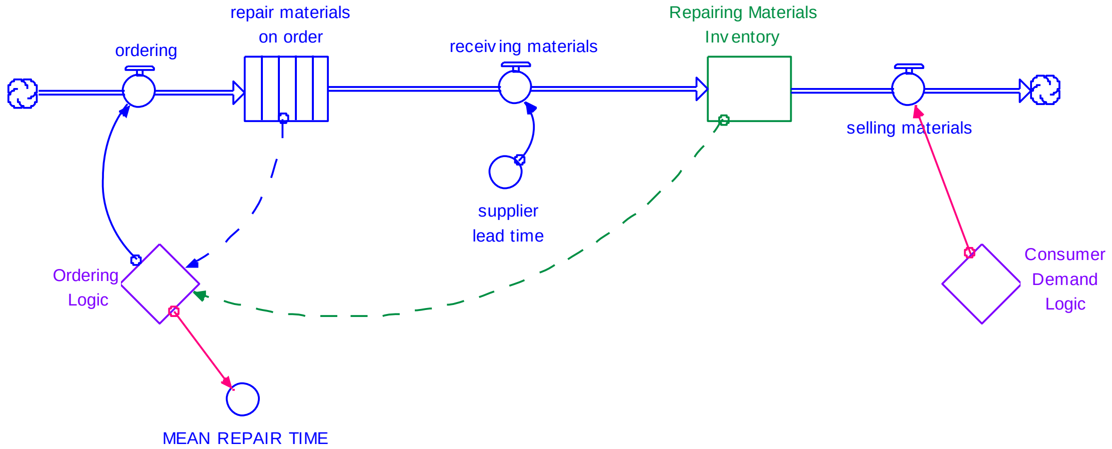

Figure 5 - Stock

We run the experiments assuming that the mean repair time is 3.5 days if the ordering process is not completed and 2 otherwise.

SATISFACTION

Customer satisfaction is very important variable for our model. It measures the willingness of end customers to buy the services offered by the network and influences the increase or decrease of the new entries. We use the American customer satisfaction index[40]. In order to calculate customer satisfaction we take that the weight for the question q1 is 0,4 (for the answer about the overall satisfaction), 0,25 for the question q2 (answer about the expectations of the customer) and 0,35 for the ideal service (q3). We put lower weight to the question that refers to the expectations because, according to official data from US government [72], it affects less the satisfaction index. Customer satisfaction is affected both by mean repair time and mean repair price. We assume that it is influenced by the price *p* and the mean repair time *r* [74]. For simplicity reasons we did not use questionnaires to determine the value of the questions. We used the following equations that connect customer satisfaction with mean repair time and mean repair price. The equations that connects mean price per repair and mean repair time are

$q1 = [(1000/p) \times 0{,}6 + (15/r) \times 0{,}4]$,

$q2 = [(970/p) \times 0{,}6 + (15/r) \times 0{,}4]$,

$q3 = [(945/p) \times 0{,}6 + (15/r) \times 0{,}4]$.

Q1,q2,q3 express each one of the 3 questions of ACSI and [.] denotes that we use the integer part of the variable. We have already described above, *r* is the mean repair time and p is the mean repair price (Figure 7). These simple equations imply that as the mean repair time or the mean repair price increases, customer satisfaction decreases.

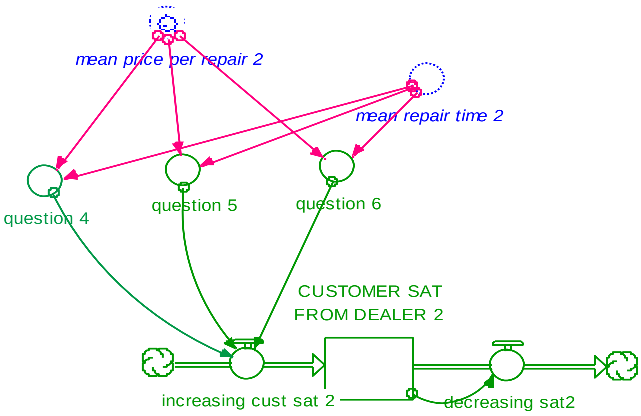

Figure 6- customer satisfaction

Total cost per repair

The dealer makes money by selling parts to replace faulty ones in customers' cars and by charging for the fault diagnosis and labor involved in part replacement. If the service is covered by the warranty, then the OEM pays for it; otherwise, it is the car owner who pays. Therefore, the total cost of each repair is $c = l_e \times r + p \times n$ where l_e is the (external) labor rate paid by the car owner, reduced to a per-hour rate, r is the mean repair time, p is the mean price and n is the average number of parts required for each repair (Figure 8). Considering that labor rate and average parts per repair remain constant the total repair cost is assumed to be a function of the mean repair time and the mean repair price.

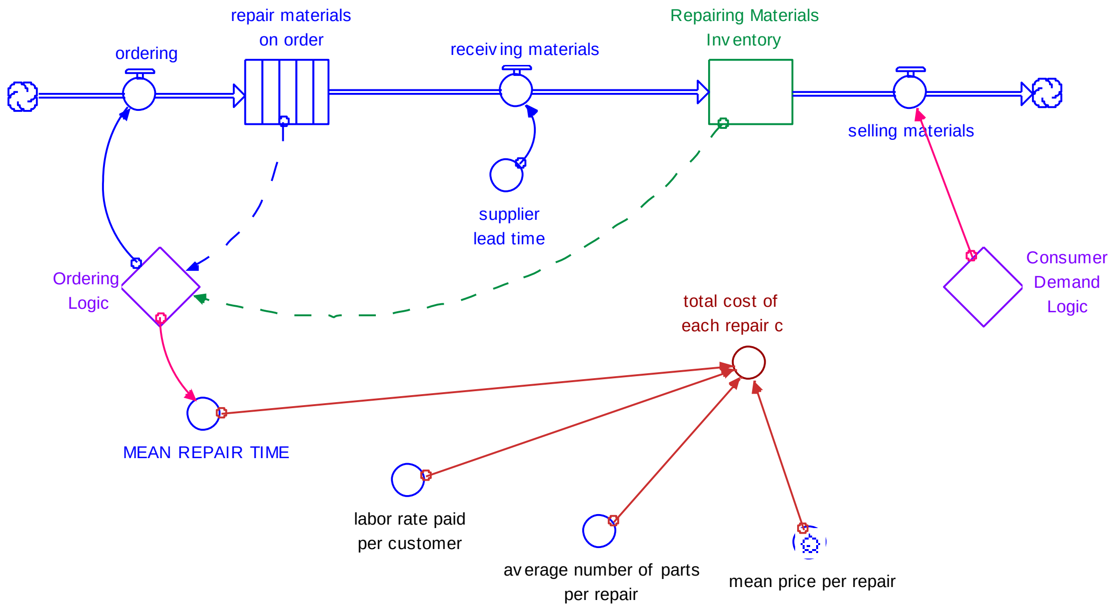

Figure 7 – Total cost of each repair

Dealer's Revenues.

Revenues of the dealer depend on the number of service requests. We denote that s is the rate of service requests that arrive at the dealer every month. Then, $s \times c$ for are the monthly revenues. As we can see from figure 9 in our model the service requests are strictly influenced by customer satisfaction.

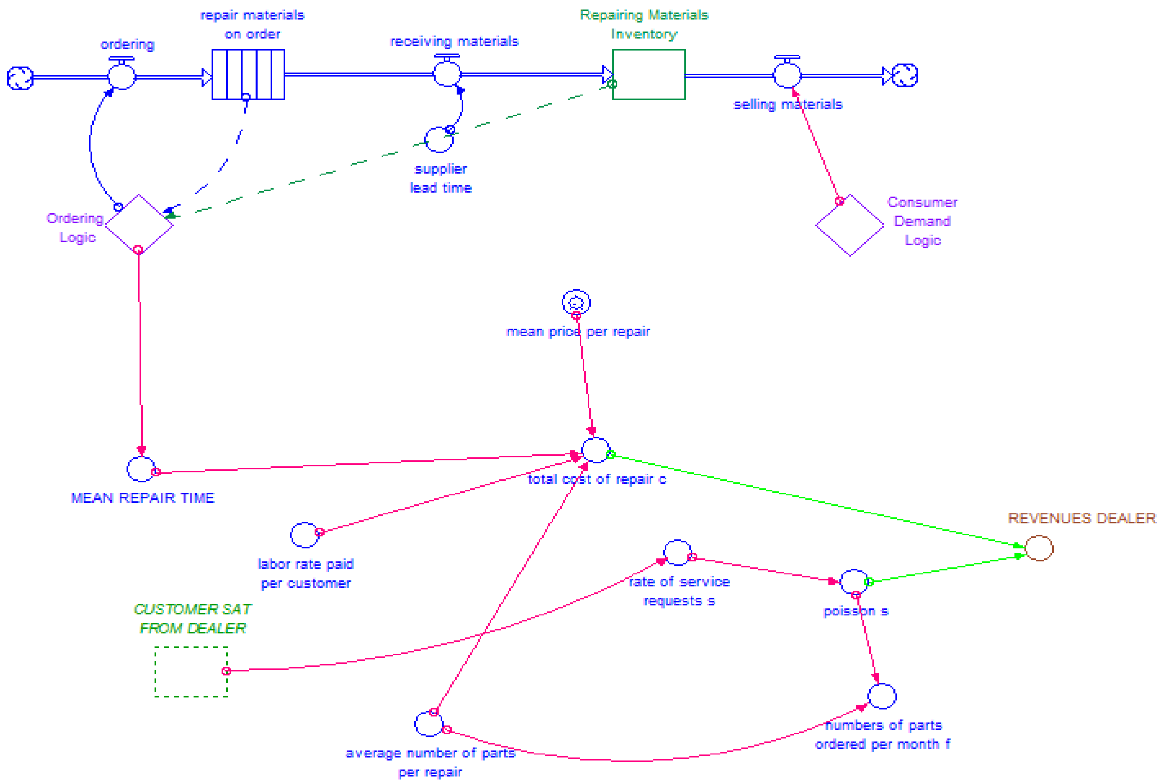

Figure 8 – Revenues of the dealer

The dealer also purchases labor from the parts manager at a rate of l_{pm} per month. As we mentioned before service requests are directly connected with customer satisfaction. This is due to the fact that satisfied customers bring more customers while unsatisfied customers discourage them. We consider that the two variables are connected through the function. This function is $s = -SAT^2 / 25 + 7 \times SAT$ where s represents the service requests and SAT the satisfaction. We also consider that the service requests are produced by the poisson distribution with mean being. The outcome of the function that connects the service requests with customer satisfaction.

The dealer's cost:

The dealers purchase labor from their technicians at a rate of Nl_T, where N is the number of technicians and l_T is the technicians' labor rate per month. The cost of the purchases of the dealer depends on the service requests and on the price OEM charges The cost of the purchases are given by the formula $P_d = f(a \times p_0 + (1-a)p_s) + l_{pm} + Nl_T$ (figure 10) where *f* represents the total parts ordered per month, N the number of technicians, p_0 is the price that car OEM sells its services to the dealer and p_s the average price that TPS offer to the dealer for their services. we run the simulations assuming that a=80%. We also consider that the number of technicians is connected with the number of service requests. As the service requests to the dealer are increased the number of technicians increase too.

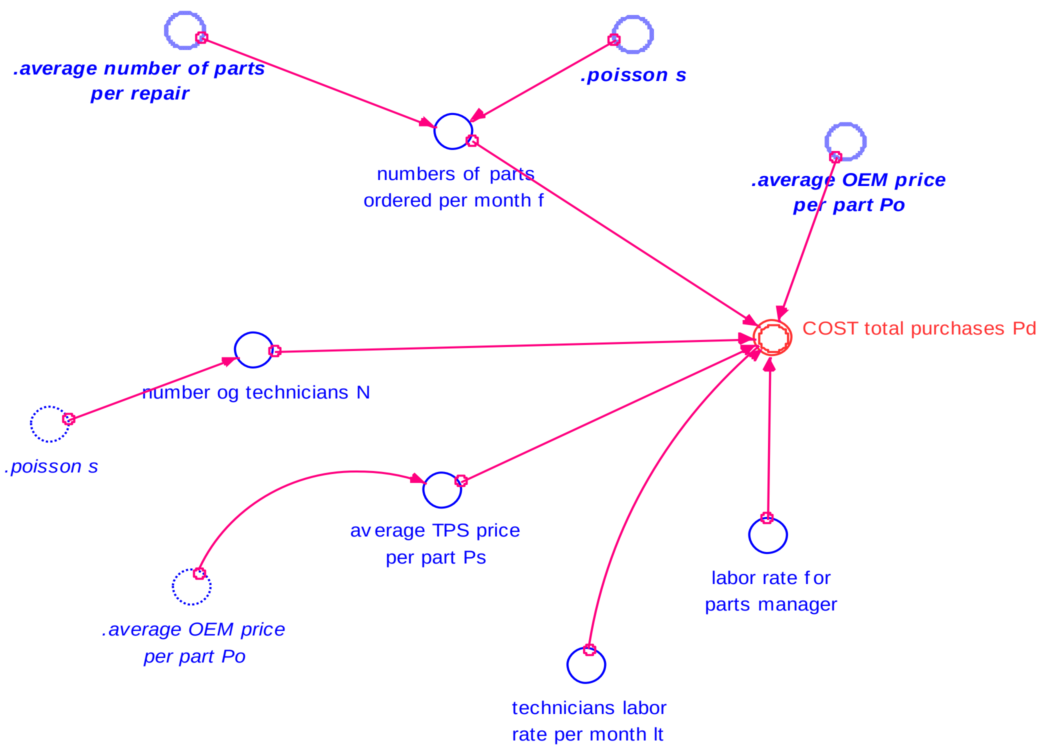

Figure 9 – Cost of total purchases

The total cost of the dealer is $C_d = P_d + I + FC_d$ (Figure 11) where *I* is the cost of maintaining stock of repairing parts and FC_d is the fixed cost of the dealer. The fixed cost is the sum of utilities, rent and other costs. It is clear that cost is changing dynamically and depends mostly on customer satisfaction. Fixed costs and total purchases are presented as modules in figure 11.

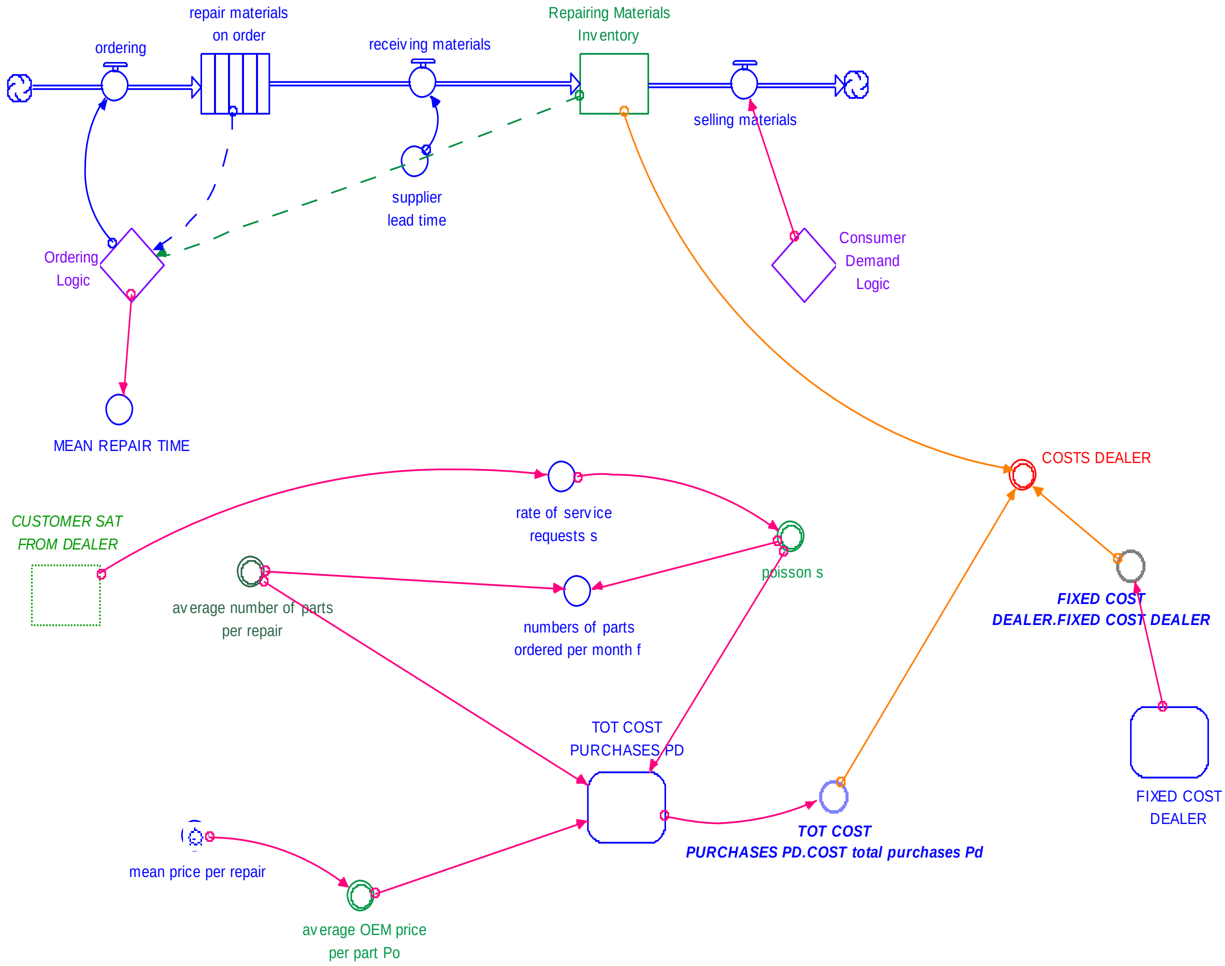

Figure 10 – Costs of the Dealer

Dealer's Value

A dealer obtains value from its relationship with its customers, and this is expressed, in the after-sales market, is due to the expectation of future sales of parts and services (essentially fixing car problems or adding new accessories). An estimate of this expectation can be made by looking at past sales and the customer satisfaction index.

Dealer's total value from its participation in the service system during a month is given by: $V_d = R_d - C_d + Ep$, where *Ep* are the expected profits that the dealer expects to receive, due to the relationship that it has developed with its customers. In order to measure this expectation we look at the revenues and the costs accrue by the relationship between the dealer and its customers. It is obvious that we emphasize the recent past more than the remote past (μ_i). We note that a declining satisfaction index lowers profit expectations and therefore the expected value, while an increasing satisfaction index raises revenue expectations and therefore the relationship value. Again we measure a long term trend for satisfaction emphasizing the recent past (Figure 12).

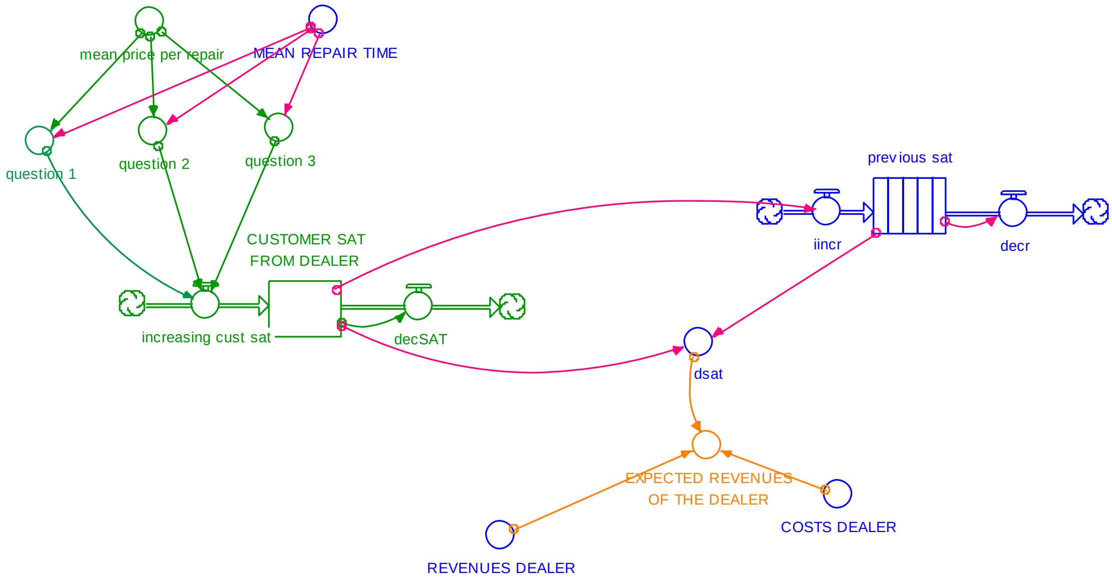

Figure 11- Dealer's expected revenues

6.3.2 OEM

OEM's Revenues

OEM offers advice for repairs to the dealers' technicians for free and sell's certified high-quality parts to dealers at a rate of a*f parts per month at a mean price p_0 per month where a is the percentage of repairing materials that dealer orders from him. OEM's monthly revenues are given by $R_o = \overline{p_o} af$. All variables that are used to calculate R_0 are shown in Figure 13.

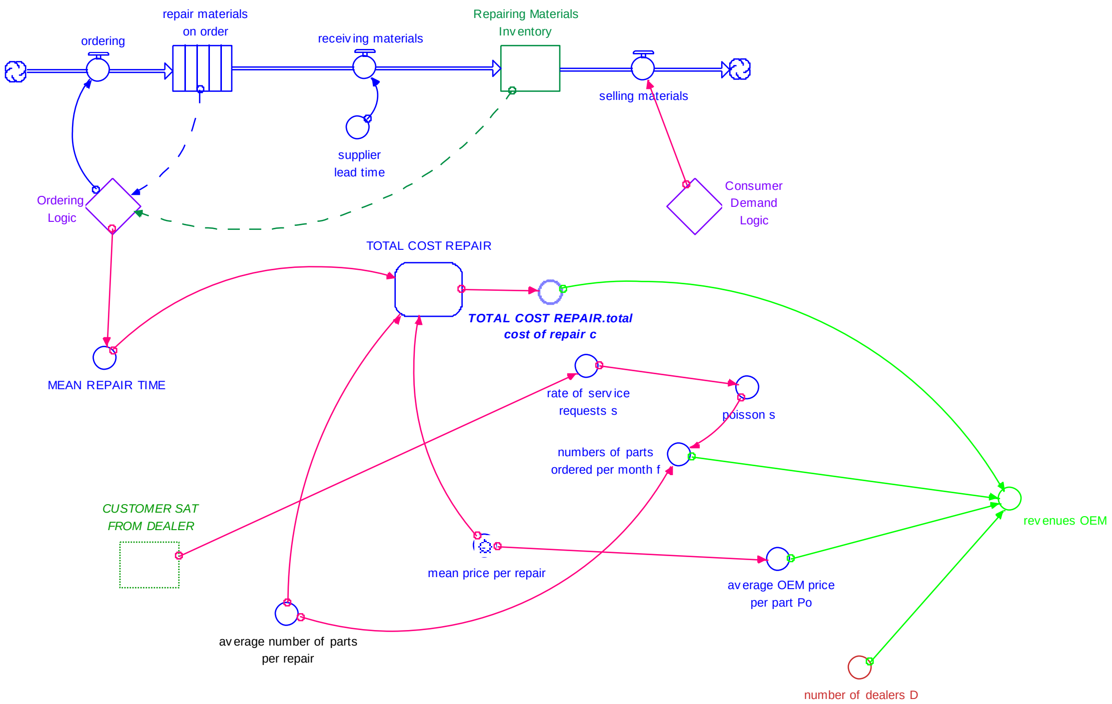

Figure 12- OEM's Revenues

OEM's Costs

Furthermore the OEM purchases the following offerings: (Figure 14)

- Parts from the SCSs at a rate equal to fD, where D is the total number of dealers. The OEM pays $p_c afD$ per month, where p_c is the average price per part that the SCS charges.
- Warranty repairs and defective parts replacements from the dealers at a rate of waf per month, for which the OEM pays $wafc$ per month per dealer, where w is the percentage of defective parts per month that are in warranty from OEM.
- Parts catalog content preparation and mailing at a rate of P per month, and mailing at a rate of M per month.
- Help desk experts' labor at three distinct labor rates (l_1, l_2, l_3) per month corresponding to the first-, second, and third-level (expert-level) help desk support of N_1, N_2 and N_3 experts.

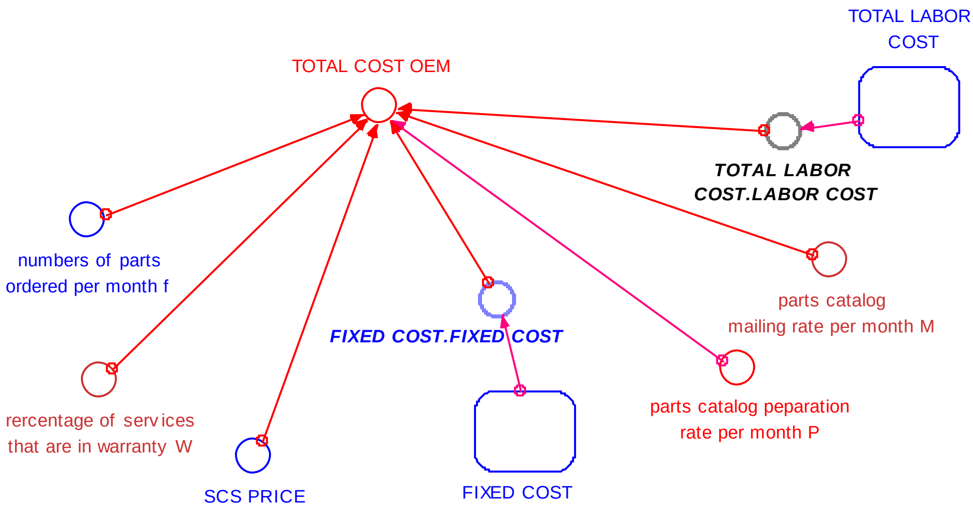

Figure 13 - OEM's Cost

Again satisfaction index is a very important variable to estimate value of OEM. SAT_o is the satisfaction of dealers for ordering parts from OEM. A low satisfaction index decreases the expectations for sales of parts by the OEM, signaling that the dealers will shift the purchasing of parts to the TPSs.

To sum up the value that the OEM receives from the service system during a month is the sum of revenues and expected profits minus costs (figure 15). This given by the formula is $V_O = D(af(p_o - p_c) - wafc - M) - 12P - (N_1 l_1 + N_2 l_2 + N_3 l_3) + Ep_o$

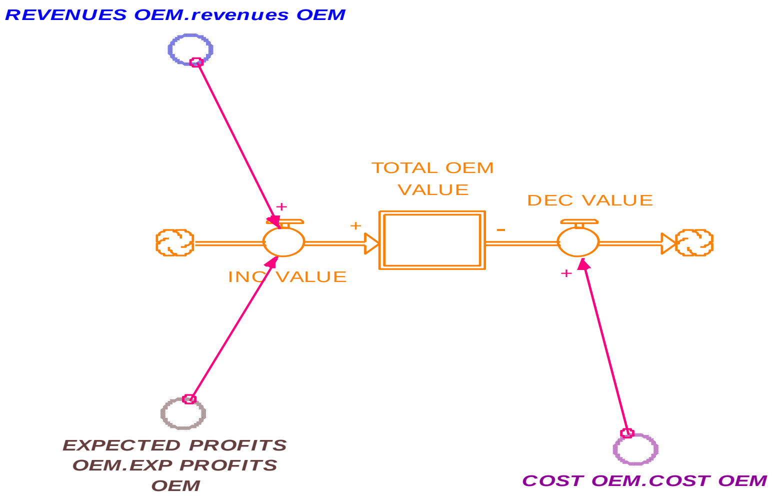

Figure 14- Total value OEM

We calculated the expected profits of OEM (*Ep*$_O$) in a similar way we did for the dealer, replacing the customer satisfaction with dealer satisfaction for the services he receives from OEM. Dealer's satisfaction is calculated using the methodology proposed in American customer satisfaction index.

6.3.3 SUPPLIERS

Suppliers (Figure 5) are an important part of the car OEM service network [59] because they provide the appropriate services to the OEM in order to offer its own services. In figure 5 we see how we estimate their value using the methodology we have already described. In our model (as in the most car OEM service networks) there are 2 types of suppliers, the SCS and the TPS. The value of SCS is directly connected with car OEM because OEM orders from the SCS any service he needs in order to offer its services. On the other hand TPS is interacting with the dealer and is competing SCS. Of course, there are a lot of questions about the behavior of the suppliers inside the service network. In order to simplify the case study in this master thesis, we most occupied with the car OEM and the dealer who are usually the most important participants in a service network and the stability of the network based most on them. The reason for this choice is that the suppliers very often offer their services in more than one (competitive) service networks. The obvious question is if a firm that uses the same suppliers for its inputs as its competitors can achieve higher productivity than that of its competitors in [67] there is a worth remarkable approach on this question. The case study used on this paper is that of Toyota against the US automakers such as GM, Ford and Chrysler. The results shown that if car OEM spends more time with the suppliers exchanging knowledge about the services offered the supplier will have better performance on his network. Furthermore research shown that there are some conditions which prevent the supplier from using these "secrets" to the other competitive networks. That's why service networks that on a first sight look quite similar have different profitability.

The simulation results show, that suppliers are not directly influenced by the end customer satisfaction because they do not interact directly with them. However the price they charge their services influences the final repair price therefore they are directly influenced by the decisions of the dealer or OEM. Consequently their main interest is to sell their services for the highest price they can to maximize their profits. That's why their action tends to increase the final price of the service and compress the profits of OEM or the dealer. Suppliers are directly influenced from the satisfaction of the dealer or OEM but the degree of these effects will be left as a future work. Furthermore in our service network the contribution of SCS to the total value is higher than TPS. The reason for this is that OEM (the most important participant of the network) chooses to cooperate only with them. TPS join the network only after the dealer's decision to cooperate with them. Further study of their behavior and their possible strategic decisions is left for future work.

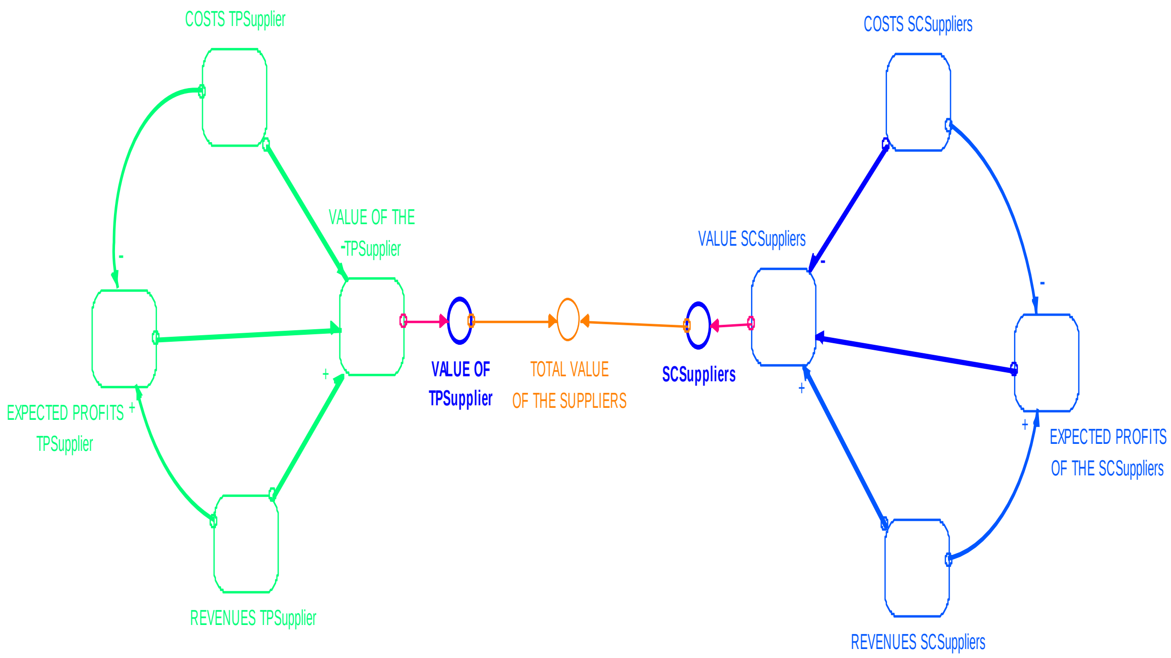

Figure 15-Total value of the Supplier

Finally, the total value of the service network is the sum of the value of all the participants (Figure 16).

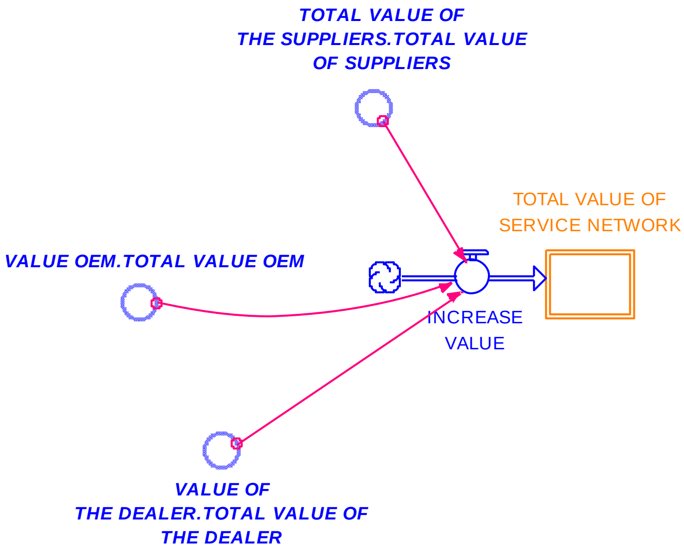

Figure 16– total value of the network

6.4 First transformation of the basic model

When transforming the repair service system, the strategic question for analysts is what to do in order to increase the value of the service system. There are obviously various ways to accomplish this, as will become apparent from the following computations. Two of them are used to increase customer satisfaction, which would eventually lead to more sales, and to cut costs. Another way is to reduce repairs that have to be covered by warranty by improving parts quality. Quality improvement processes are an extensive topic by themselves and will not be addressed here.

The first repair service system transformation that we did is the one in which a solution provider achieves interoperability between the partners' information systems through a central portal operated by the OEM. The portal allows everyone to have access to up-to-date information about parts at any time, as soon as this information becomes available to the portal. The obvious way to increase value by upgrading the IT infrastructure is to eliminate mailing costs. We now examine the changes to the values of the partners. The dealer continues to buy and offer the same services, but the repair time is now reduced because of the time saved by both the parts manager and the technicians in identifying and ordering parts. This decreases revenues (since the labor charged is reduced) but at the same time, the customer satisfaction index goes up. This leads to an increased sales volume for the dealer. This constitutes a trade-off that could increase or decrease the value of the dealer depending on the parameters involved. This, in turn, will influence the value of the service system. There are several changes in the value of the OEM:

- For the first year after the OEM applies the solution, he pays a relatively high price (Cs) to the solution provider. Maintenance is paid out to the solution provider the following years (another offering of the solution provider) at rate Ms.
- The offerings of the content packager are modified, since there is no need for mailings anymore, so the OEM has some savings from this.
- The portal is made available as a free offering to the dealers and the SCSs, but access to it is given for a charge to the TPSs at the rate la, thus producing some additional revenue.
- The capacity of the stock that dealer keeps, decreases in the transformed network. Because the dealer due to the decrease of the mean repair time he needs, to order the repairing parts from OEM, he doesn't have to stock many repairing parts. Consequently he decreases the storing cost. The dealer now is forced to order materials more often than the dealer of the basic network network. However that doesn't cost him so much because the increase in mean repair time is not so high.

The total value of OEM after this transformation is given by:

$$V_O = 12D(af(p_0 - p_c) - wafc) + 12Tl_a - 12P - 12(N_1l_1 + N_2l_2 + N_3l_3) - 12M_s - C_sI_{(n=1)} + Ep_o$$

where $I_{(n=1)}$ takes the value 1 if year n is 1, or 0 otherwise Ep_o are the expected profits of OEM. In figures 17-18 the changes to the revenues and the costs of OEM comparing to the first service net are depicted. In this model total value of the network is the sum of the values of the dealer, the OEM and the Supplier added by the value of the solution provider. We consider that due to his cooperation with OEM, the solution provider is part of the service network and not an external partner

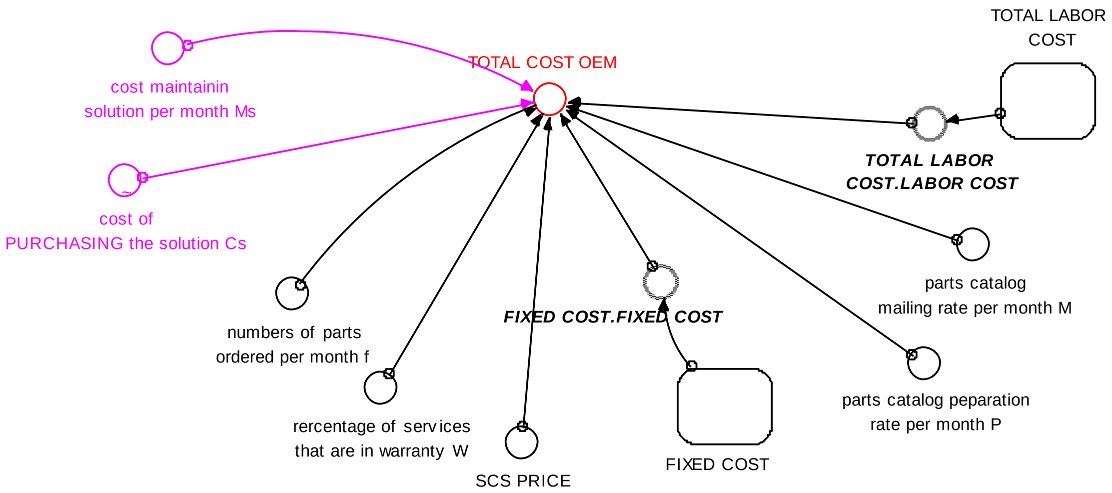

Figure 17- Total cost OEM second service network

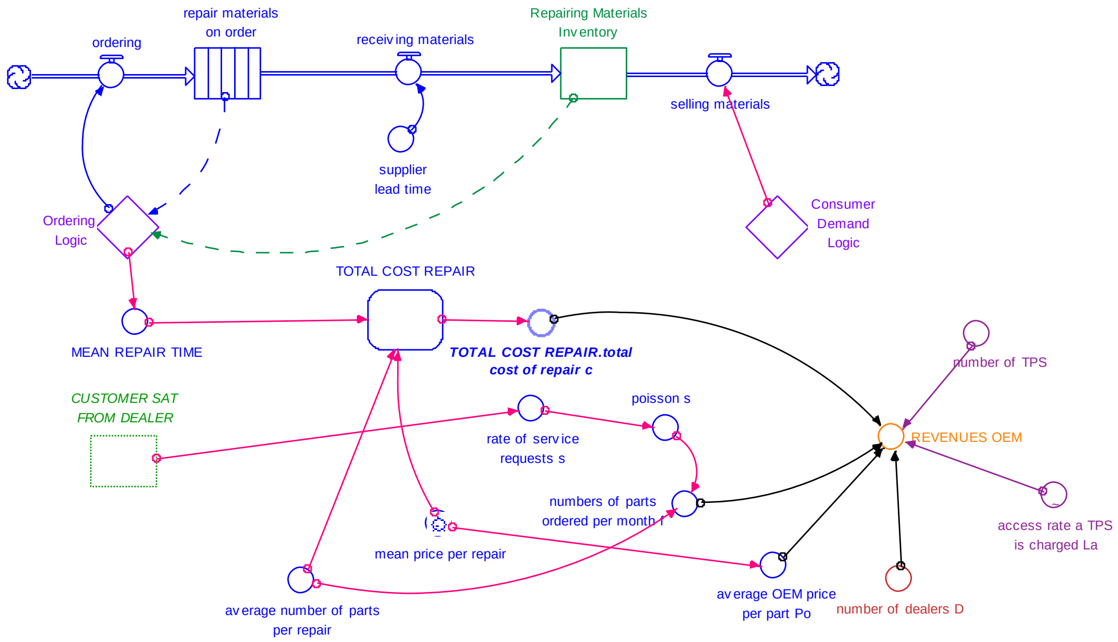

Figure 18- Revenues OEM 2nd service network

6.5 SECOND TRANSFORMATION OF THE BASIC MODEL.

The second transformation proposed by [24] is a variation of the previous solution: the solution provider is replaced by an outsourcer who provides the electronic catalog system and its maintenance as a service and is considered to be an external partner. The only change we observe in the calculation of values concerns the relationship between the OEM and the outsourcer:

- The high price for the purchase of the solution and maintenance costs paid by the OEM is eliminated.
- The OEM pays the outsourcer for the offering of the portal as a service, on a yearly basis.
- The outsourcer undertakes the labor of help desk experts' levels 1 and 2.

In comparison to the previous business model, the value of the OEM may increase or decrease in this model, depending on the specific negotiations that take place between the OEM and the solution provider or the outsourcer, respectively. Again the total value of the service network includes the value of the outsourcer.

6.4 THE ARIVAL OF A NEW PARTICIPANT

Finally we consider a model in which a new team of dealers appears in the market and it is willing to join in the second service network. New dealers offer more complementarities to the end customers of the service network without increasing the mean repair price. This action seems to be profitable due to the increase of the satisfaction of the end customers of the service network. However new dealers have higher costs that may affect service network's value. We examine the value of these dealers and the value of the entire service network provided that OEM chooses to cooperate with them. This allows us to decide whether it is better for the network to be transformed and cooperate with these dealers or not.

CHAPTER 7 - RESULTS

In this chapter we present the simulation results from our analysis. We used the Microsoft Excel solver, the Mathematica and Ithink tools for simulation and optimization. We performed three types of experiments. First we compare the initial model described in section 5 with the second model (first transformation). Second we compared the second model with the third model (second transformation). Third we examined the relationships developed in the second model and how the OEM and the dealer influence the profit maximization of their partners in the service network

7.1 COMPARISON BETWEEN THE FIRST AND SECOND SERVICE NETWORK

In this subsection we compare the initial service network and the transformed service network (with the solution provider). We determine the optimal mean repair price that maximizes the dealers' and OEM's value. We present only the results that came from the Ithink sensitivity analysis because they are more precise and catch the dynamic changes that happen inside the network during the simulation. In table 1 we see the optimal mean repair price for the dealer and for the OEM. We have the following results

	Initial Service network		**Service network 2**	
Optimal mean repair price (*ithink 29 time periods)*	**111(Dealer)**	**225(OEM)**	**116(Dealer)**	**218(OEM)**
Value Of the dealer (*ithink 29 time periods)*	51.469.012	34.700.000	46.874.332	34.985.000
Value Of the OEM(*ithink 29 time periods)*	8.500.000.000	26.793.000.000	9.100.000.000	29.990.000.000

Table 1 - Comparison **between 1st and 2nd service network**

- The optimal mean repair price of the dealer in the initial service network is higher than its value in the second service network. This is explained due to the fact that the mean repair time (that effects value) decreases, so the dealer charges his customers less. Furthermore, as the mean repair price increases, the value of the dealer decreases implying that the customer satisfaction has decreased as well.
- OEM's value is much higher in the second network than in the first one. This is explained by the fact that the mean repair time decreases and the customers are more satisfied. In addition, OEM in the second network has much lower labor costs.

- In both networks OEM's value at dealer's optimal mean repair price (111 and 116 respectively) is very low compared to OEM's value at his optimal mean repair price. This means that OEM will never be satisfied the service network he participates to offer its services at prices that reach dealer's optimal level.
- Dealer's value at OEM's optimal mean repair price is higher in the second service network because the optimal level of mean repair price for OEM is lower. That means that the customer satisfaction will be higher. Consequently, the service requests for the dealer will increase, and this will have a positive effect on the value of the dealer

7.2 OTHER SIMULATION RESULTS

1. As the mean repair price increases, the difference between the value of the dealer in the initial service network and the value of the dealer in the second service network is smaller. This can be justified due to the fact that although the service requests decrease the mean repair price increases resulting decrease of the total value.

MEAN REPAIR PRICE	Difference between dealer1 and dealer2	MEAN REPAIR PRICE	Difference between dealer1 and dealer2
111	13.684.314,52	116	12.407.585,32
112	13.389.894,33	117	12.235.521,63
113	13.126.171,41	118	12.036.228,74
114	12.851.962,76	119	11.708.826,91
115	12.658.804,55	120	11.560.582,04

Table 2 - **Difference between dealer1 and dealer2**

2. The simulation results show that, OEM's value in the second network is not higher than the initial service network from the beginning. It dominates after 10-12 time periods, when both networks offer their final services in their optimal mean repair price. When both service networks offer their services at equal prices the second service network needs to dominate the initial service network varies from 8 to 17. As the common mean repair price increases, the dominance of the second network appears too since the optimal mean repair price in the second network is lower than the optimal meant repair price of the initial one (See figures 19,20, 21).
3. In addition, it is shown by the from simulation and optimization results that the total value of the second network is higher than that of the initial network (see tables 3,4). Moreover, the optimal mean repair price for both service networks is very close to the optimal mean repair price of the car OEM. This was is an expected result since OEM contributes the largest part of the total value of the network than the dealer. Consequently the optimal price is expected to be closer to the optimal price of OEM. The network's optimal mean repair price is very important especially when we want to

compare and analyze competing networks or test if a proposed transformation has positive effect to the service network.

Total value of the initial service network	Total value Second service network
28.593.400.000	32.190.040.300

Table 3 - **Total value**

Optimal mean repair price of the initial Service Network	Optimal mean repair price of the second Service Network
223	216

Table 4 - **Optimal mean repair price**

The results for OEM can be justified because OEM is influenced indirectly from the customer satisfaction that is why he is focused more on the price related to the sales of repairing parts. The dealer is influenced directly from the fluctuation of the price that's why he wants to sell at lower prices. In addition the optimal mean repair price of OEM is lower in the second network because the network transformation helped him to cut his costs giving him the opportunity to reduce the price he sells his services without losing his profitability. This reduction increases his customers and further increases his profitability. On the other hand the dealer's optimal mean repair price is higher in the second service network. OEM is influenced directly from the satisfaction of the dealer. His behavior inside the network may dissatisfy some dealers who choose to abandon the network. The impact of dealer's satisfaction from OEM on the network has been left for future work.

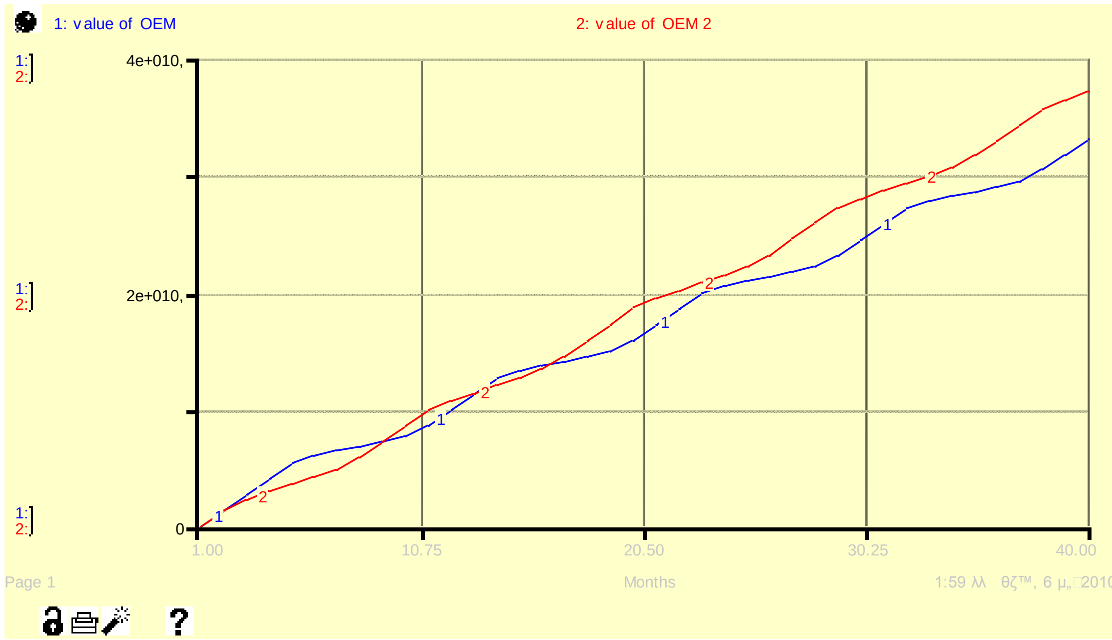

Figure 19 - Total value of the OEM when mean repair price for both networks is 200

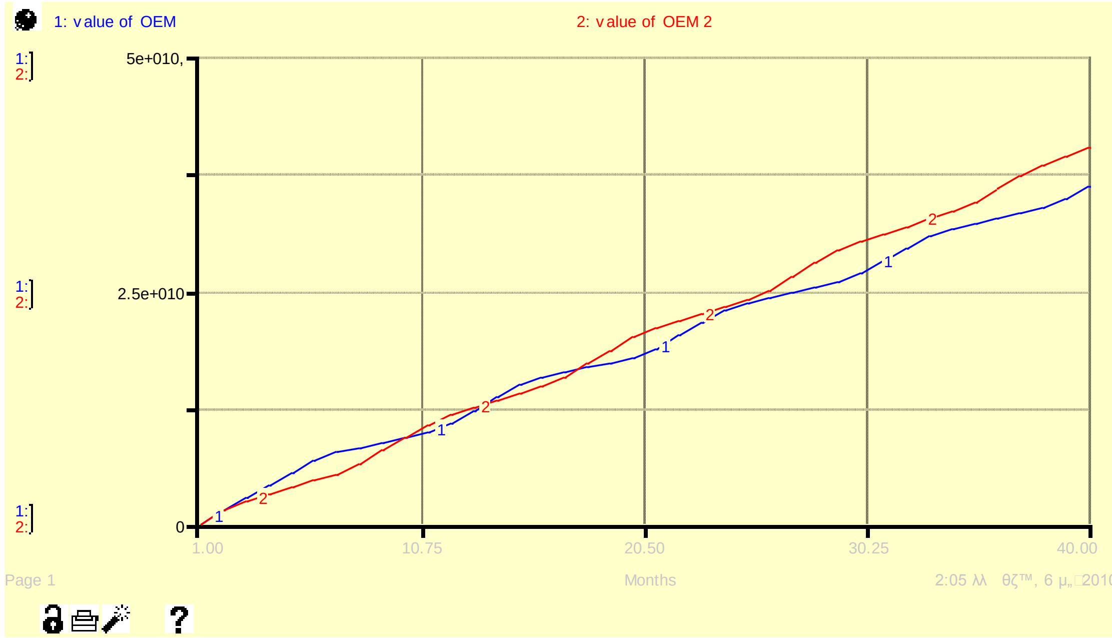

Figure 20 – both networks run on their optimal price

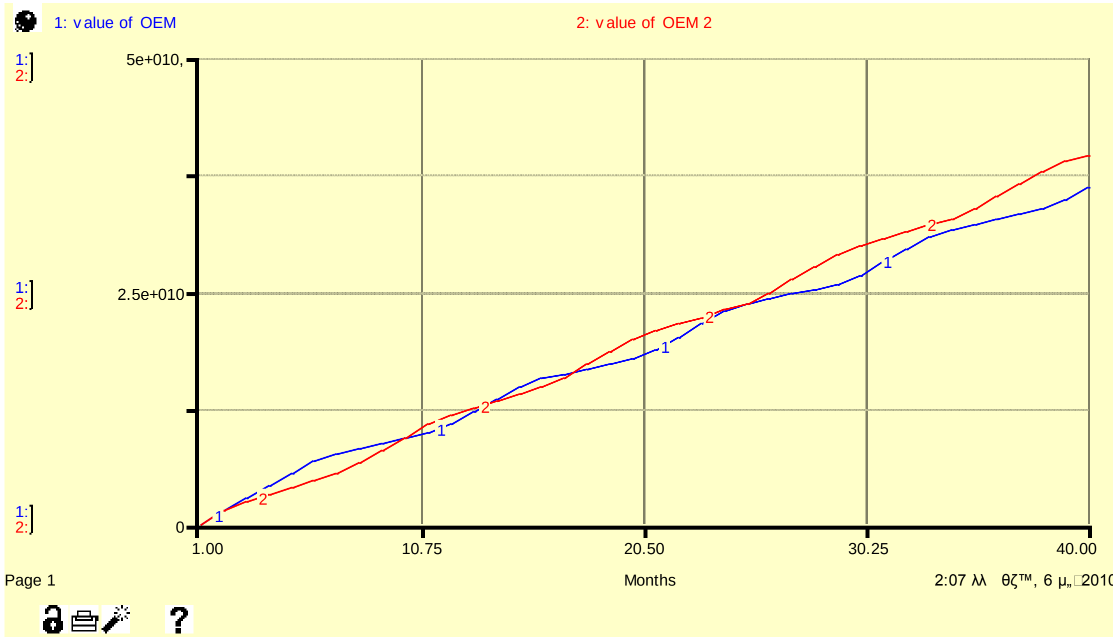

Figure 21 – Total value of the OEM when mean repair price for both networks 230

7.3 Comparison between second and third service network

In this sub section we provide the results from the comparison between the second and the third service network. In table 2 we show the results of the optimization for the second and the third network.

	Service network 2		**Service network 3**	
Optimal mean repair price (i*think* *29 time periods)*	**116(Dealer)**	**225(OEM)**	**116(Dealer)**	**223(OEM)**

Value Of the dealer (ithink 29 time periods)	46.874.332	34.700.000	46.874.332	34.985.000
Value Of the OEM(ithink 29 time periods)	9.100.000.000	26.793.000.000	9.100.000.000	29.990.000.000

Table 5- Comparison between 2nd and 3rd service network

The dealer is not affected by the second transformation, since the changes influence only the relationship between OEM and outsourcer. Consequently the dealer's optimal price and the optimal value are the same for both networks.

We observe that the changes we did in the third model do not affect the value of OEM and the total value of the service network so much. In practice the optimal price tends to be lower for OEM in the third service network and the total value of the third network seems to be higher in most of the cases (figure 22). Consequently, the simulation results and the comparison between the two service networks cannot show us which of the two is more profitable. However the change of parameters such as customer satisfaction, mean repair price or service requests per month may result in the dominance of the second service network. The results confirm our previous consideration that outsourcing is not always a profitable choice for a firm.

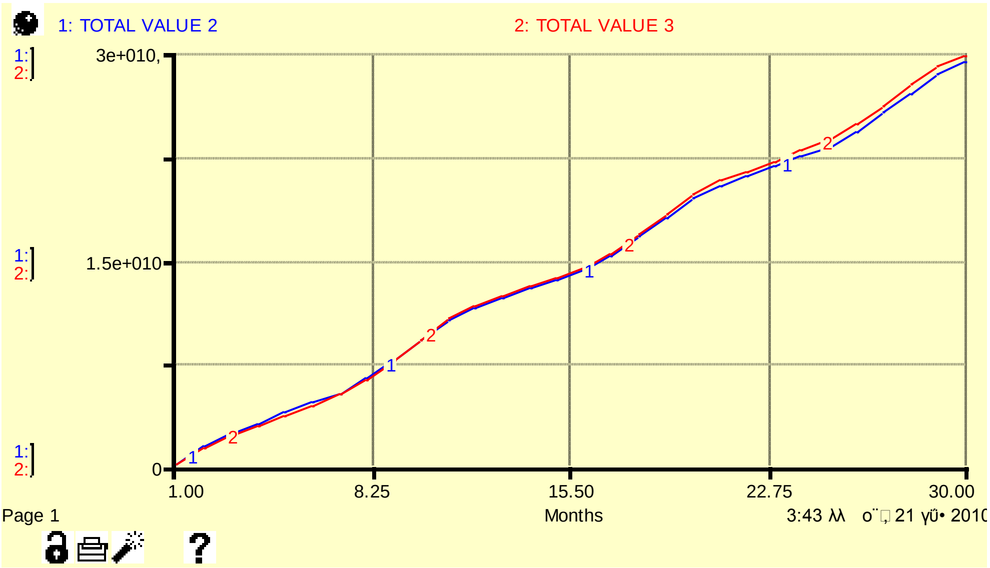

Figure 22– Total value of both networks

7.4 Sensitivity analysis of mean repair price

We examine the behavior of the participants inside the second service network. We want to investigate what is the maximum profit for a participant if the other has a fixed profit. We assume that there is a relationship between the mean repair price that end customer pays to the dealer and the price that the dealer pays to OEM to buy its services. Let *a* be the percentage of the final mean price per repair that the dealer pays to OEM to buy its services. We calculate the optimal mean repair price and the optimal value for three different values of *a* (80%, 90%, 70%). We present the results in table 6. The results confirm in that case that the dealer is not willing to increase his profits very much, because the final price would rise and the customers would be dissatisfied. For example if *a* equals to 90% the obvious outcome will be that the value of OEM will rise and the value of the dealer will decrease because his profits are only 10%. On the other hand the results show that OEM maximizes his profits in lower prices than before. The percentage of the final price that goes to OEM is higher.

SERVICE NETWORK 2						
	a = 80%		a= 90%		a = 70%	
	DEALER	OEM	DEALER	OEM	DEALER	OEM
OPTIMAL PRICE	116	218	111,39	195,60	118,93	241,47
VALUE	46.874.332	29.990.000.000	42.341.983	34.371.080.000	50.824.832	219.732.795.000

Table 6 – Values according to the percentage of mean price per part on the final mean repair price

It is worth mentioning that in the third case (where *a* is 70% the OEM will not be profitable provided that the dealer sets his services at its optimal point. It is obvious that the total value of the network increases when the value of OEM increases and the optimal mean repair price is close to the optimal mean repair price for the dealer. Finally we observe that the fluctuation of OEM's optimal mean repair price is higher than the fluctuation of dealer's optimal mean repair price. When its profits decreases OEM's optimal mean repair price increases in order to maximize its value

7.5 THE IMPACT OF THE NEW TEAM OF DEALERS

In this subsection we analyze the impact of the arrival of a new team of dealers that are willing to join the network. For our experiments we use the second service network. We assume that the new dealers offer complementary services that increase customer satisfaction. We also assume that the mean repair price remains the same for both teams of dealers. Since the cost of the new team of dealers increase (because of the complementarities) simulations show that their total value is lower than the value of the dealers in the second network. In addition OEM's value increases due to the increase of the service requests. The total value of the network increases too because it is influenced from OEM's value more than the value of the dealer (Figure 23, tables 7-9).

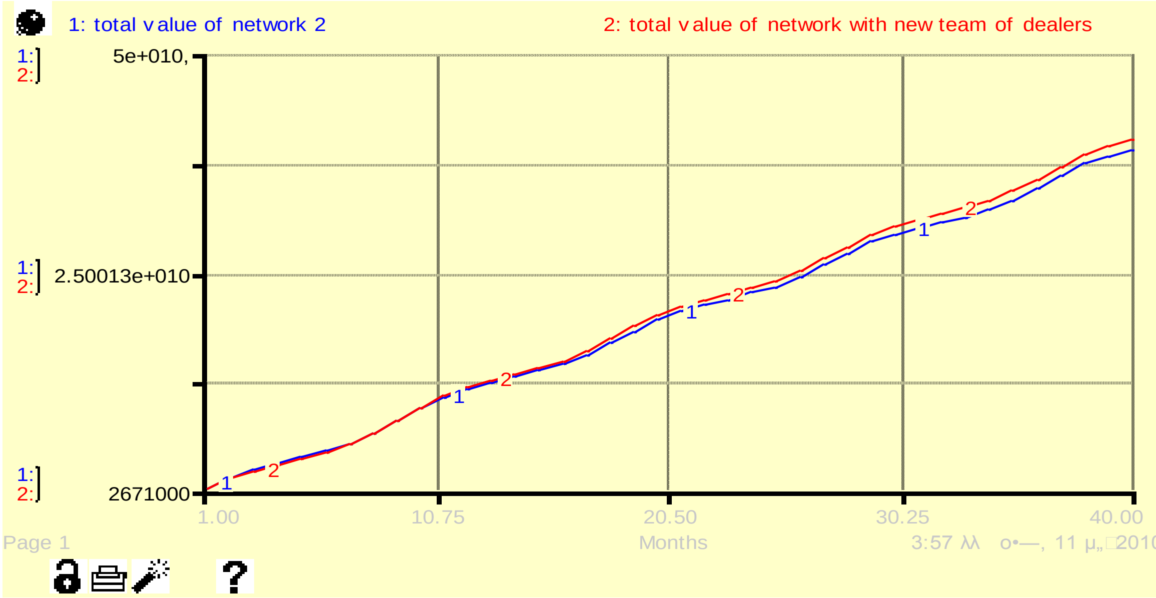

Figure 23 - comparison between the value of the 2nd service network and the service network with the new team of dealers

Total Value of the dealer of the second service network	Total Value of the new team of dealers if they join the second service network
35.481.031	31.527.812

Table 7- Total Value Dealer

Total value of OEM of the second Service Network	Total value of OEM of if he cooperates with the new team of dealers
29.793.000.000	31.713.504.020

Table 8 - Total Value of the OEM

Total Value of the Network	Total Value of the service network with the new team of dealers
32.190.040.300	32.792.529.000

Table 9 – Total value of the service network

A general observation is that it is not necessary for any participant in the service network to increase its value in order to achieve optimality of the total value of the service network. Some participants may be "sacrificed" for the sake of the whole service network. Usually the most important participant takes these decisions. It is obvious that the "sacrificed" participants may become dissatisfied and decide to abandon the network looking for a better one for them, causing instability to their old network. But that depends on a lot of parameters and needs further investigation.

7.6 PARTICIPANTS EQUILIBRIOUM STRATEGIES

In this subsection we describe the internal relationships that are develop among the participants inside the service network. We investigate strategies between OEM and the dealer. We define as a strategy for the dealer and the OEM the profit rate of the margin of profit for each of them. We examine the existence of equilibrium strategies considering that the rest of the network participants (apart from OEM and the dealer) do not affect their decisions. In order to determine the optimal strategies for the OEM and the dealer we propose the following mechanism. First we calculate the cost per repair, for each participant. Then considering the profits that each participant wants to have for each part he sells, this mechanism determines the mean price per repair.

According to the model the car OEM buys repairing parts from his certified suppliers. Suppliers sell these materials at a specific price. Then OEM estimates the cost per part and sells these materials to the dealer at a higher price in order to have profits for its self. We calculate the cost per part by dividing the total cost of OEM by the number of parts he orders. Finally in a similar the dealer calculates in the same way its own cost per part, adds its own margin of profit to this price and offers the service to the end customer (Figure 24). An important characteristic of this mechanism is that the mean repair price is different for time interval. Since the number of ordered parts is different. Consequently, the cost per part is changing dynamically and the same happens to the final price that the end customer pays.

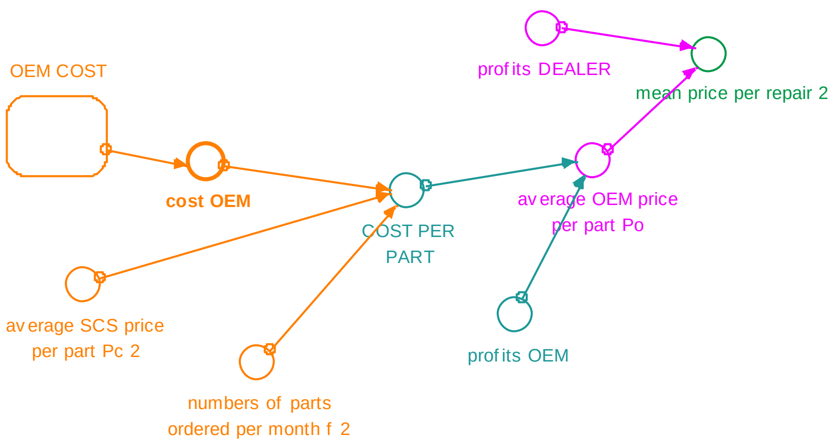

Figure 24- Pricing Mechanism

We want to determine the maximum profit rate for each participant when the other has a fixed profit rate. In the simulations we used the Ithink tool to perform two experiments. In the first experiment we calculate a set of equilibrium strategies that is: we keep constant the OEM's profits to 14% upon the cost per part and figure out that the dealers optimal profit rate equals to 10%. Consequently, if the dealer raises his profits to 10%, OEM optimally chooses a profit rate of 21%. In the second experiment we examine hoe the change of the profit rate of a participant a ffects the profit rate of the other. In table 10 we see that if the dealer raises its profit rate from 6% to 10%, OEM decreases its profit rate from 24% to 21%. The fluctuation of

dealer’s margin of profit influences directly the mean repair price and the satisfaction of the end customer because he is the last ring in the chain before the customer. If he increases this percentage the price that the customer pays will increase too, decreasing its satisfaction and the service requests. In addition when OEM raises his profit rate the dealer has no other choice but decrease his own percentage of profits in order to receive optimal value (Table 10). The simulations show that in if the dealer chooses to offer his services to the end customer with higher profits than the optimal for him the OEM will be negatively influenced too. The value of both the dealer and the OEM will decrease.
As it was expected in the second case the optimal value of the car OEM is lower than in the first case. Again, the optimal profit percentage for OEM is not only for him but also for the dealer. If he raises the percentage of his profits both participants will lose.–It is obvious that the above results depend on the structure of the service network and the specific data given to the experiments. The conflicts of interests between the participants, may lead to unexpected behaviors, putting in danger the stability and the profitability of the network. In case the participants fail to find equilibrium, the network will collapse.

SERVICE NETWORK 2				
	Dealers profit 6%	Dealers profit 10%	OEM profit 14%	OEM profit 21%
Optimal profit percentage	OEM 24%	OEM 21%	Dealer 15%	Dealer 10%

Table 10 - Strategies

CHAPTER 8 - FUTURE WORK

In this master thesis we proposed a methodology that estimates value in service systems. We applied this methodology to a car repair service network. We run simulation experiments to maximize the value of each participant and the total value of the network. In addition, we studied the internal relationships that are develop inside the service network and examine the interactions between the participants. However, except of the efforts to model a service network, optimize its value and simulate its behavior in the future if we want to be realistic in our predictions we have to study the effects of competitive service networks. These networks try to influence negatively the profitability of our service network. Consequently a mistake or a successful decision of these networks can have significant impacts to the network. We propose as future work the study how competitive service networks influence the profitability of our service network and the loyalty of our customers and our partners. Additionally an interesting issue that emerges is what happens when two competitive service networks decide to co operate creating oligopolies. It would be interesting to examine how their decision influences their value and the value of their end customers. In addition we have to examine a larger service network with more participants, were more services are exchanged and the system is more dynamic. Furthermore additional work is needed on the estimation of intangible assets (services) that exchanged among participants inside the network (knowledge, sense of community etc). These services are difficult to be evaluated even though they affect the profitability of service systems to great extend. The satisfaction of the dealer for OEM's services, has to be further studied. We need to investigate, how a dissatisfied dealer can influence the OEM's revenues of the by decreasing the percentage of its orders from OEM. The relationship between the OEM and his suppliers has to be further studied too. How much a supplier that joins competitive service networks influences their value. Finally this work has to be applied in a real service network in order to be tested in more realistic conditions.

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APPENDIX 1

Percentage of parts the dealer buys from OEM α	0.80
Average OEM price per part p_O	0.8P
Labor rate for parts manager l_{pm}	2000.00
Number of technicians N	5.00
Technician's labour rate per month IT	900.00
Labor rate paid by customer le	50.00
Average number of parts per repair n	2.00
Parts catalogue preparation rate per month P	85000.00
Number of TPSs T	100.00
Number of dealers D	10000.00
Average SCS price per part p_c	
Percentage of services that are in warranty w	0.10
Parts catalogue mailing rate per month M	10.00
First-level employees	100
Second-level employees	30
Third-level employees	10
The cost of the stock.	0.5 per unit

Table 1 – constant rates for the 1st network

access rate a TPS is charged la	5000,00
cost purchasing solution	2000000
annual cost maintaining solution	10000
First-level employees	80
Second-level employees	25
Third-level employees	5

Table 2 – rates that changed for the 2nd network due to the transformation

Access rate a TPS is charged	5.000
Annual rate for purchasing the service of solution	500000
First-level employees	100
Second-level employees	30
Third-level employees	10

Table 3 – rates that changed for the 3^{d} network due to
The second transformation