A System Dynamics Approach to Modelling Business-to-Business Markets – Case of Siemens

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Abstract

This study focuses on estimating the size of the electrical and electronical market, i.e. electromarket of Siemens Turkey using system dynamics modelling. Corporate management has recognized the need of a comprehensive model of the electromarket in Turkey, due to the dynamics of the Turkish market, consolidating the data of nine operating groups in different business areas. The backbone of the model resides in the dynamic relationship between served, unserved and inaccessible segments of each electromarket. Nine models have been constructed for groups that operate in energy, telecommunications, medicals, transportation, and automation industries. Each model is converted to a management flight simulator giving each operating group manager the chance to simulate the results of their governance of the group's electromarket. The final deliverable is a consolidated management flight simulator, which will be a support tool for exercising different market approaches and strategic options for corporate management.

Keywords: System dynamics, modelling, flight simulator, business-to-business, market size

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1. Introduction / Project Background

In their work, Leibold et. al indicate that the task of strategic management is not to foresee the future or to implement organization wide change programs; rather such managers establish and modify the direction and boundaries within which effective, self-organized solutions can evolve. Non-linear social-cultural systems react to direction in ways that are difficult to predict and control. However, managers can guide the evolution of a self-organizing enterprise more effectively if they gain more knowledge of the dynamics of the organization's business system [4].

Siemens AG, the parent company of Siemens Turkey, produces a variety of products from mobile phones to gas turbine generators to light bulbs, has always had skillful workforce bent on high quality. In recent years, corporate managers have recognized the fact that competing with rivals takes more than quality- it also requires speed to market, relentless innovation, and attention to costs [1]. This new direction necessitates Siemens Turkey to make use of comprehensive tools for corporate management.

System Dynamics Modeling is a simulation tool that aims to support decision processes in business, social and economic systems. The models operate by simulating the behavior of variables by forecasting the rate of changes [7]. At Siemens Turkey, successful implementations of several System Dynamics models in recent years have ensured the help of such models as a decision support tool. Prior to the current efforts, System Dynamics models have been built for modeling the delivery delay of Medical Solutions group [5] and for modeling energy capacity supply and demand for Power Generation group of Siemens Turkey [6].

Corporate management of Siemens Turkey has recognized the necessity of a comprehensive model of the electrical and electronical market; i.e. electromarket, which consolidates the relevant market data of different operating groups. In our study, we separately built models of nine operating groups within certain time frame. The study has started on August 10, 2003, and the consolidated model has been completed on March 20, 2004.

The aim of the study is to create a consolidated model in which the electromarket data of nine operating groups are present. As a final deliverable, a consolidated management flight simulator, which will be a support tool for exercising different market approaches and strategic options has been constructed.

Following sections are organized as follows: In Section 2 the dynamic problem is defined. The market segment concept is explained and visualized in Section 3. A brief insight is given to the model development methodology in Section 4. A generic causal loop diagram with major stock-flow variables are introduced and models are explained in Section 5. In Section 6, validation and simulation results are discussed. Concluding remarks are given in Section 7.

2. Problem Definition

Siemens AG, the parent company of Siemens Turkey has certain operating standards and definitions. Among these, the definition of markets that are being operated in, is unique for Siemens. The total electromarket for each operating group that is for concern is divided into three main segments: These are inaccessible, unserved, and served markets. The definition of these segments is standard, although each operating group can have their own view, according to their definition.

Siemens Turkey corporate managers want to be in hold of market size movements within their operating groups. It is not hard to guess that the conversion of market segments to each other are highly dynamic and are of particular interest to System Dynamics problem solving. A concrete model was crucial for Siemens Turkey that guides the managers on what the size of inaccessible, unserved and served markets would be in the upcoming years, in conjunction with the internal and external developments.

3. Conceptual Approach to Business-to-Business Markets

The total market of the operating group comprises of the total business field market in one country. This sum includes all the possible customers regardless whether they are accessible or not. For market share calculations purposes this amount is used. In Figure 1, the division of the total market to inaccessible, unserved and served segments is visualized.
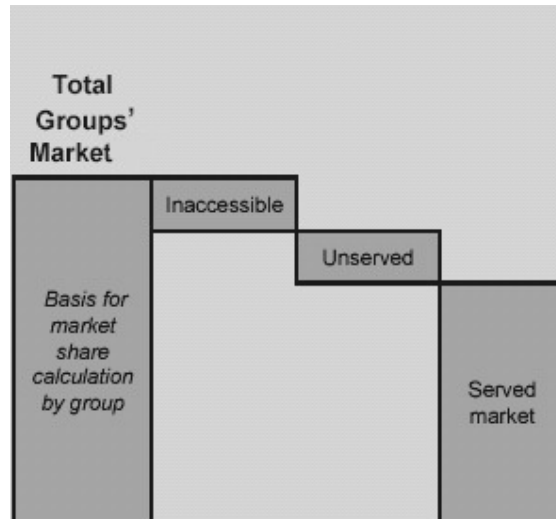

Figure 1. Division of Total Groups' Market (Adapted from Kohlöffel (2002) [3])

3.1 The Inaccessible Market

Some customers within the total market can be inaccessible due to in-house supplies, legal restrictions and state monopolies. There are no possible ways to reach this part of the market. Hence, this portion is named as the "Inaccessible Market" for the operating group. Inaccessible market can be reduced with deregulations and liberalization. The remaining of the market is thus called "Accessible Market"

3.2 The Unserved Market

Still, a part of the accessible market may be unserved due to lack of profitability, absence of suitable products (probably due to different standards), lack of appropriate know-how, high competitiveness, or the buyers' preference for national manufacturers. Therefore, this segment is named as the "Unserved Market" for the operating group.

3.3 The Served Market

The rest of the market, that Siemens groups operate in are the "Served Market". Served market consists of the segment that is tried to be served with Siemens offerings.

4. Development Methodology

We have launched the System Dynamics Modelling Project of Siemens Electromarket on August 10, 2003. We initially held interviews with the strategic planning partners that are officers of each operating group. These partners are the representatives of Corporate Strategies and Consulting Department in their operating group. In some cases, these interviews were converted to workshops, in which more officers were involved. After the development of the basic conceptual model for the operating group, the first presentation was given to operating group directors and officers of the group. Feedbacks were collected and the model was fine-tuned. Afterwards the final presentations and implementation of the software has been completed. The timetable of the project is as below:

Operating Group	Completion Date
1. Medical Solutions (MED)	31.08.03
2. Power Generation (PG)	20.09.03
3. Power Transmission and Distribution (PTD)	10.10.03
4. Automation and Drives (A&D)	31.10.03
5. Industrial Solutions and Services (I&S)	20.11.03
Interim Report	15.12.03
6. Information and Communication (IC)	10.01.04
7. IC Mobile Devices (ICMD)	31.01.04
8. Transportation Systems (TS)	20.02.04
9. Integrated Building Services (IBS)	10.03.04
10. Consolidation of All Models	20.03.04

Table 1. Timetable of Electromarket Modelling Project in Siemens Turkey

At the end, on March 2004, all the models have been consolidated to reach a model for Siemens Turkey. This model has been then presented to CEO and CFO.

5. Model Development

5.1 Generic Causal Loop Diagram

The operating groups of Siemens Turkey are independent from each other considering their operations. The structural differences of the operating groups' necessitated us to build separate models for each. The causal loop diagram in Figure 2 is an example from Medical Solutions group.
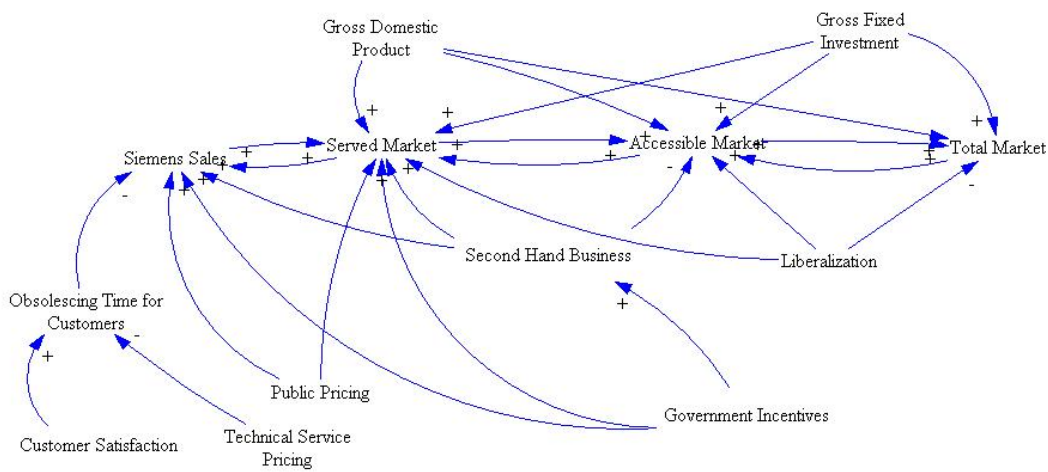

Figure 2. Causal Loop Diagram for Medical Solutions Group

5.2 Stock and Flow Structure

The main stock variables that we would like to observe their level in time are Siemens sales, served market, unserved Market and Inaccessible Market sizes of the operating groups in Million Euros. Each model of an individual operating group has this classification of stocks. Thus the consolidated model has 9×4= 36 stocks.

The dynamic behavior of the model arises from the conversion of the stocks to each other. The assumption is that the total market is a sum of Siemens sales, the portion of served market that is not Siemens customer, i.e. Served-not-Customer, unserved market and inaccessible market. It is noteworthy to mention that served market is not itself a stock, since it simply comprises of the Siemens customers (Siemens sales stock) and the Siemens non-customers (served-not-customer stock).

It is thus important to consider the flows between Siemens sales and Served-not-customer stocks as adopting and quitting to be Siemens customer. Once the client quits being Siemens customer, its market data resides in the flow from

Siemens sales to served-not-customer stock. In Figure 3, the backbone of the model with the major stock flow relationships can be found.
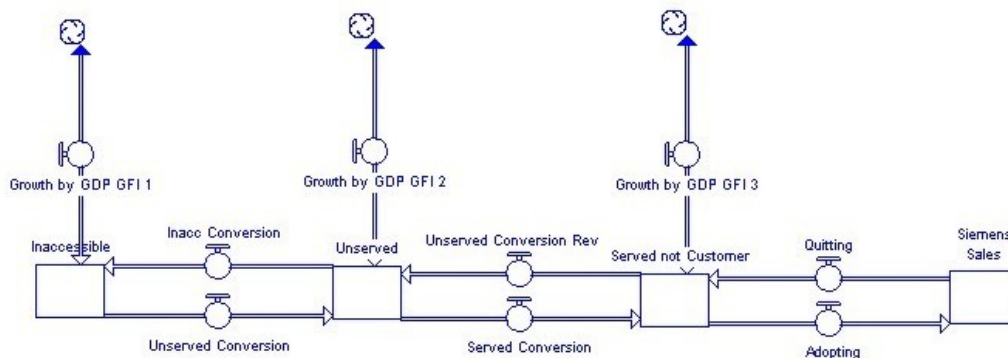

Figure 3. The Generic Model of Major Stock and Flow Variables

With certain effects, an inaccessible amount can be converted to sales after certain flows occur. Another major flow effect is by the expanding and shrinking effect of Gross Domestic Product (GDP) and Gross Fixed Investment (GFI). In Figure 3, direct inflows and outflows can be observed to market stocks by the GDP and GFI effects.

The above template is valid for all models of different operating groups. However, the auxiliary variables and converters are different, so are the functions that are inherent in them. In the next part we would like to define important variables group by group.

5.3 Models of Operating Groups

The nine operating groups of Siemens Turkey have common variables as well as distinguishing variables that affect their market size. All the variables mentioned in this section are decision variables in the interface of the simulation game for each model.

5.3.1 Medical Solutions Group (MED)

Siemens Medical Solutions Turkey provides complete health-care solutions and support diagnoses and therapy in hospitals. Medical Solutions group is a market leader in the domestic market. MED has a wide range of products from x-ray, angiography, and ultrasound systems to computerized tomography, magnetic resonance, nuclear medicine, echocardiography and radiotherapy [8].

The four stocks (sales, served-not-customer, unserved and inaccessible markets) are the same for each model of groups. An exception to this situation is MED, which does not have an inaccessible market defined for itself. GDP and GFI inflows affect unserved and served-not-customer Markets.

The conversion of sales to served-not-customer by quitting customers and the conversion of served-not-customer market to Siemens sales by adopting customers is modeled by a bi-flow between them. Customer Satisfaction and

Average Obsolescence form Obsolescing Time that affects quitting. Adoption is affected from Market Share and Time to Become Siemens Customer, which is a converter.

Served-not-customer market has also an inflow because of liberalization of government hospitals. Government Incentives and Public Social Security Institution Pricing of medical equipment directly affect the size of served market. The more the government is in favor of medical liberalization, the larger the market is.

The conversion of the unserved market to served market and vice versa is maintained by the effects of auxiliary variables to bi-flow between them. These variables are The Amount of Barriers to Second Hand Business, Volatility in TL Rate, and Absence of Appropriate Product. These are converted to market size in Million Euros with a conversion fraction.

Unserved market has an additional inflow from growth by financing. This flow considers the favorable conditions of Borrowing Interest Rates for leasing purposes. The better the rates are it is easier to find financing and thus the market is larger.

5.3.2 Power Generation (PG)

Power Generation Group offers environmentally compatible power generation systems, and services for power plant projects. Siemens Turkey PG Group in partnership with the PG Group of Siemens AG Germany, provides multi-purpose services and turnkey solutions for steam and gas turbines, and electric and automation systems for all types of power plants. The PG Group in Turkey specializes in engineering, production, erection and commissioning services for the electrical and instrumentation and control systems of thermal and hydroelectric power plants. Projects in power plants range from super efficient gas turbines to computerized control systems [8].

Growth of GDP and GFI are standard among all models. Additional to these two, Energy Demand Increase is another major variable that affects the inflow to unserved and served-not-customer markets.

The served-not-customer market has an additional inflow, which is Capacity Necessity. The two auxiliary variables that affect this inflow are the Coverage Ratio of Installed Capacity of the Demand in MW and GWh. The more the capacity necessity, the higher the served market would be for PG Group.

An inflow to unserved market size else than GDP and GFI Growth is the Effect of Credit Rating. The favorable conditions in the ratings directly affect the market size. The conversion from inaccessible to unserved market is affected from the auxiliary variable Accessing to Bilateral Government Agreements, for which accessing causes unserved market to go up.

5.3.3 Power Transmission and Distribution (PTD)

The transmission and distribution of energy to consumption points safely and efficiently is as important as the generation of the required amount of energy at the highest quality and the lowest cost. PTD Group offers consultancy, engineering, turnkey solutions, and after-sales services for all voltage levels from 0,4 kV up to 400 kV. Private and state-owned power transmission and distribution companies, as well as industrial plants, benefit from Siemens solutions. Siemens conducts the network planning of new systems, and the modernization of existing ones [8].

Except the four standard stocks, PTD model has different auxiliary variables and converters. The GDP and GFI growths affect inaccessible, unserved and served-not-customer markets similar to other models. PTD Group has also the auxiliary variable Energy Demand Increase like PG group which affects inaccessible, unserved and served-not-customer markets.

Sales is affected from the same variables as in MED group, except here there is a Pricing Effect from Export Sales. As export sales revenue grows, the fixed costs are shared between both export and local sales. This ends up in more competitive pricing of local products, which causes higher sales.

Served-not-customer stock of PTD has an extra inflow that is affected from three auxiliary variables. Level of Outsourcing is a determinant of how large the served market size is. The degree of Privatization also affects the served market size. TEDAS (Turkish Electricity Distribution Company) Requirements are also important, since the higher these requirements are the better Siemens have chances to enter the market with high caliber products.

The conversion from inaccessible market to unserved market has one major auxiliary variable which is Accessing to State Owned Companies. The higher the accessing fraction, the greater the unserved market is.

5.3.4 Automation and Drives (A&D)

With the increasing importance of automation techniques in industry, systems, which ensure total compatibility between units, have become a necessity. The Automation and Drives Group offers services to its customers with switchgear and installation technologies, motor and motor speed control systems, and process automation techniques [8].

For A&D Electromarket model, the four stocks are the same as previous models. The GDP and GFI growths affect the stocks except sales stock. Additional to the same variables that affect sales, there is an Euro-Turkish Lira Parity auxiliary variable, which directly affects sales. This variable is introduced to the model since most of the group's products are sold in Euros, and that the strengthening of Euro against TL hurts sales of A&D Group.

Served market is additionally affected from Competitive Pricing and from Presence of Imitations and Low Cost Local Producers. The imitation products are a threat for the market of A&D in Turkey, and therefore this variable is crucial.

Efficiency in Sales Channels is another auxiliary variable and a decision variable in the game interface for the unserved market of A&D. The better the efficiency, the greater the market size is.

5.3.5 Industrial Solutions and Services (I&S)

Industrial Solutions and Services Group is one of the world's leading suppliers of electrical equipment and drives as well as automation and IT solutions for many different industries. It also works on infrastructure projects encompassing drinking and wastewater, marine engineering, airport installations, alternative power solutions, and traffic control and guidance systems [8].

The inaccessible, unserved, served-not-customer and sales stocks are the same for the model. The macroeconomical decision variables in the interface are GDP and GFI Growth same as the previous models. Additional to these a Government Spending and Incentives variable is included in the model that affects the inflow to stocks.

Level of Outsourcing is a crucial auxiliary variable that affects served market size. The higher the tendency to outsource in the market, the larger the market size is. Served market also has an inflow that is affected from Investment Opportunities Abroad.

Unserved market has an inflow that grows its size with a positive feedback loop connected. This inflow is affected from Local Company Competition auxiliary variable.

5.3.6 Information and Communication (IC)

Siemens has three fundamental core competencies in information and communication technologies: next-generation Internet, wireless communications and advanced electronics. This combination enables the company to offer full array of mobile business solutions from a single source,

ranging from innovative voice, data and video communications equipment for end users to complete networks and tailored applications. The networks group also provides comprehensive engineering and consulting services, from network planning to financing and from installation to training [8].

The stocks are standard for IC Group as well. The effects of GDP and GFI Growth are by inflows to market segment stocks. There are several other auxiliary variables that affect the sales and served-not-customer inflows.

The sales stock is specifically affected from Competitive New Product Development, Competitive Sales Force and Competitive Pricing variables. It is noteworthy to mention that these three variables emerge from the basis of Siemens' competitive advantage notion.

The served market segment is additionally affected from, Administrative and Political Environment, Technological Development, Privatization of Turkish Telecommunications Co. (TT), Tariff Indicator of TT and Computer Sales and Internet Connection Growth variables.

5.3.7 IC Mobile Devices (ICM D)

The recent and rapid developments in telecommunications can be evidenced from the increasing uses and functions of mobile telephones. ICM D is actually a subgroup under IC Group. However, because of the fast consumable nature of their products, it has been decided to classify ICM D market as a separate and unique entity [8].

Four stocks are the same as the above models. Additional to GDP and GFI, Euro-Turkish Lira Parity is an additional macroeconomic decision variable that affects sales. The lower the rate is, the more favorable effect there is for sales. The Pricing Level and Weighted Distribution of the distributors are the two other auxiliary variables that affect sales.

Served market has an additional inflow that is affected from auxiliary variables, Marketing Expenditures Level and New Product Launch and Campaigns. The default value of the current level is zero for both variables. On the game interface Marketing Expenditures can vary between an increase of 80% and a decrease of 80%. Similarly, the default value of zero can increase in a scale when new product is launched.

Presence of Operator Subsidy and New Technology Launch affect the unserved market. They both a default value of zero and can be altered as a decision variable in the interface. Parallel Import and Illegal Sales affect the inaccessible market. It is not possible to serve the illegal portion, though this type of sales is included in determining the market size.

5.3.8 Transportation Systems (TS)

The fact that Siemens supplies full scope of requirements for turnkey installation of all kinds of transportation systems, has led to become the world leader in rail systems. TS concentrates on the development, improvement and integration of highway, railway and air transportation. The group also provides and installs the traffic management and control systems [8].

TS Group has not defined unserved and inaccessible markets so this leaves served-not-customer and sales stocks only. However, we have included dummy stocks for unserved and inaccessible segments that have a value of zero, for consolidation purposes.

Additional to GDP and GFI macroeconomic indicators, the Euro-Turkish Lira Parity is also introduced to the model. The lower the parity is, the cheaper the products are, which causes sales to increase.

Competitive Pricing and Public Tenders Law are the two other auxiliary variables that affect sales. The Acceptance of Public Tenders Law is a 3-scale indicator. Zero is the current default value with no progress. The initial progress (scale at 1) concerns the acceptance of the "Limiting the Duties" item. When the scale is at 2, this means the international fortification is accepted. Scale of 3 signals a scope extension.

Favorable Political Environment, Treasury Guarantees, Absence of Product and Presence of Special Credits (such as EIB, Worldbank, and softloans) are additional variables that affect the served market.

5.3.9 Integrated Building Services (IBS)

IBS Group works towards ensuring efficiency at all stages of modern buildings' lifespan from design and construction to utilization. Services cover the full range of buildings and facilities: hotels, hospitals, industrial plants, universities, schools, business centers, airports, harbours, and shopping malls [8].

The four stocks are also present in our last group's model. GDP and GFI Growth affect the market segment stocks separately. An auxiliary variable, the Presence of Competitive Services is defined for IBS, which is a cause for Customer Adopting flow.

Administrative and Legal Conditions, Level of Outsourcing, New Technology Usage, and Privatization are other auxiliary variables that affect served market. Among these the default value of Privatization variable is zero as the current level and is subject to increase as the market is privatized.

5.4 The Consolidated Model

As a final deliverable, nine simulation games for each operating group and a consolidated simulation game for Siemens Turkey have been prepared. Each of the nine games has its separate decision variables; only three of the decision variables are common. Namely, these are

- Gross Domestic Product Growth,
- Gross Fixed Investment Growth,
- Euro-Turkish Lira Parity.

These three are classified under Macroeconomic Indicators in the consolidated model. All the other decision variables have also been consolidated in the Siemens Turkey model. The consolidated model therefore has an interface that can be used as a flight simulator by corporate management.

The Table 2 below summarizes all the decision variables of each model for market segments that are also present in the consolidated model.

	MED	PG	PTD	I&S	A&D	IC	ICM D	TS	IBS
Served Market	- GDP Growth, - GFI Growth, - Public SSK Pricing, - Government Incentives, - Volatility in TL Rate, - Barriers for Second Hand Business Level, - Effect of Risky TL Business	- GDP Growth, - GFI Growth, - Energy Demand Increase, - Coverage Ratio of Installed Capacity of the Demand (i) GWh and (ii) MW	- GDP Growth, - GFI Growth, - Energy Demand Increase, - TEDAS Market Requirements Level, - Level of Outsourcing, - Privatization	- GDP Growth, - GFI Growth, - Level of Outsourcing, - Investment Opportunities Abroad, - Government Spending	- GDP Growth, - GFI Growth, - Presence of Imitations and Low Cost Local Products, - Competitive Pricing	- GDP Growth, - GFI Growth, - Privatization of TT, - Tariffs - Administrative Indicator, and Political Environment, - Technological Developments, - Computer Sales and Internet Connection Growth	- GDP Growth, - GFI Growth, - New Product Launch and Campaigns, - Marketing Expenditure Growth	- GDP Growth, - GFI Growth, - Political Environment, - Absence of Product, - Presence of Credits, - Treasury Guarantees	- GDP Growth, - GFI Growth, - New Technology Usage, - Level of Outsourcing, - Administrative and Legal Conditions, - Privatization
Unserved Market	- GDP Growth, - GFI Growth, - Volatility in TL Rate, - Barriers for Second Hand Business Level, - Effect of Risky TL Business, - Borrowing Interest Rates	- GDP Growth, - GFI Growth, - Energy Demand Increase, - Credit Rating	- GDP Growth, - GFI Growth, - Energy Demand Increase, - Privatization	- GDP Growth, - GFI Growth, - Government Spending, - Local Company Competition	- GDP Growth, - GFI Growth, - Efficiency in Sales Channels	- GDP Growth, - GFI Growth	- GDP Growth, - GFI Growth, - Presence of Operator Subsidy, - New Tecjnology Launch	Unserved Market not present.	- GDP Growth, - GFI Growth, - Competitive Pricing
Inaccessible Market	Inaccessible Market not present.	- GDP Growth, - Energy Demand Increase	- GDP Growth, - GFI Growth, - Access to State Owned Companies	- GDP Growth, - GFI Growth, - Government Spending	- GDP Growth	- GDP Growth, - GFI Growth	- GDP Growth, - GFI Growth, - Parallel Imports and Illegal Sales	Inaccessible Market not present.	- GDP Growth, - GFI Growth

Table 2. Decision variables in the models for market segments

6. Validation and Simulation

Simulations are done for 9 years of which 6 years are to the future. In other words the simulation ends in 2009. Year 2001 is labeled as Year 1 and so on. The simulations are undertaken on a quarterly basis. In the validation phase, the available data for the years 2003 and before have been used as given and the models are constructed accordingly. It was observed that a good simulation fit for the past years are reached.

It is aimed that operating group managers should gain expertise in the simulation games by altering the decision variables. The consolidated game is prepared for the CEO and CFO, and their console consists of all the decision variables both unique and common in nine models.

In Figure 4 and Table 3 below can be found the graph and table for the simulation with the default values of functions. The Gross Domestic Product Growth and the Gross Fixed Investment Growth default values for 2004 and later are obtained as estimates from Chief Economist / Corporate Relations department at the Headquarters of Siemens AG at Münich. The values for years 2001-2003 are used as given. These default values can be found in Figure 5 and 6.
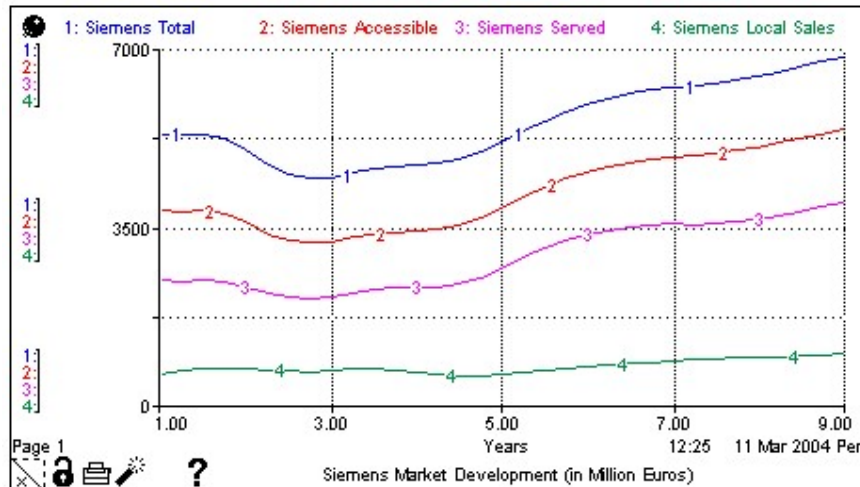

Figure 4. The Growth of Siemens Turkey Market and Sales with Default Values

Years	1	2	3	4	5	6	7	8	Final
MED Total Market	101	103	100	103	107	112	116	121	126
PTD Total Market	535	542	479	526	578	636	697	763	835
PG Total Market	537	507	442	379	451	612	585	566	514
I&S Total Market	1.122	1.097	883	965	1.058	1.159	1.269	1.388	1.518
A&D Total Market	241	256	263	284	307	333	360	389	421
IC Total Market	1.140	876	643	613	679	904	1.097	1.234	1.377
ICMD Total Market	499	504	463	488	515	544	574	607	640
TS Total Market	81	83	175	339	427	575	490	322	337
IBS Total Market	1.071	1.058	1.023	1.028	1.037	1.048	1.062	1.079	1.100
Siemens Total	5.327	5.025	4.470	4.726	5.159	5.923	6.251	6.469	6.868

Table 3. The Growth of Siemens Operating Groups' Market with Default Values

Years	GDP Growth
1.000	7.200
2.000	-7.300
3.000	4.900
4.000	4.100
5.000	4.800
6.000	4.600
7.000	4.600
8.000	4.300
9.000	4.300

Data Points: 9
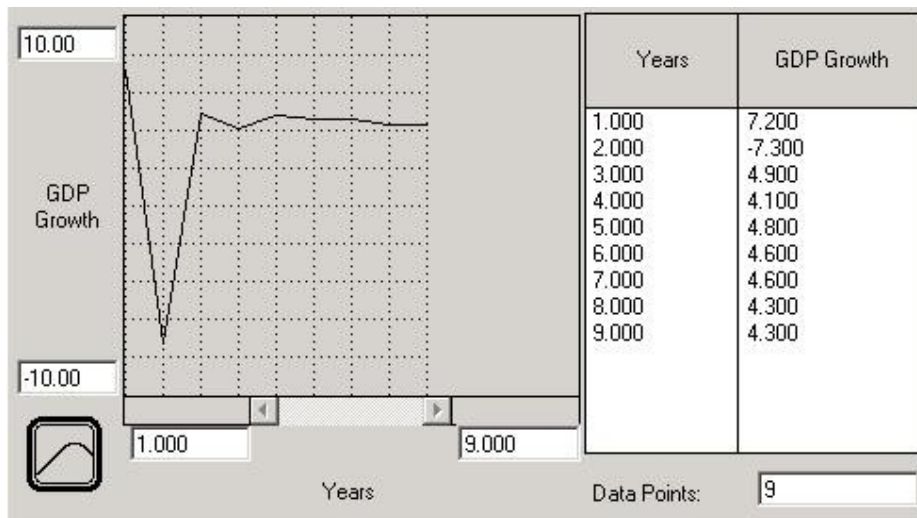
Figure 5. The Default Values of Gross Domestic Product Growth Function

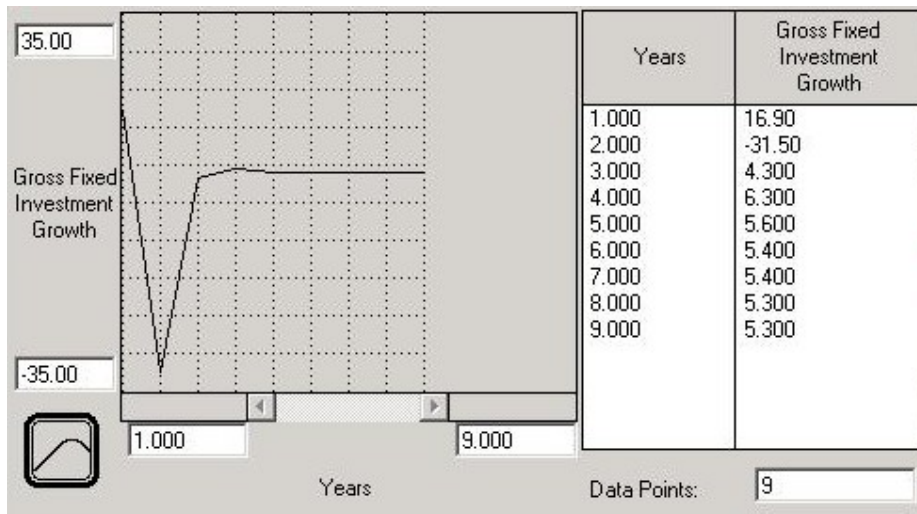| Years	Gross Fixed Investment Growth
1.000	16.90
2.000	-31.50
3.000	4.300
4.000	6.300
5.000	5.600
6.000	5.400
7.000	5.400
8.000	5.300
9.000	5.300

Data Points: 9

Figure 6. The Default Values of Gross Fixed Investment Growth Function

When the two main decision variables, GDP Growth is set to 6.0% and GFI Growth is set to 15.0% constant growth, the values of total market size change accordingly as in Table 4.

Years	1	2	3	4	5	6	7	8	Final
MED Total Market	101	106	111	116	122	128	135	142	150
PTD Total Market	535	612	704	810	932	1.069	1.225	1.406	1.616
PG Total Market	537	519	475	412	492	670	667	665	612
I&S Total Market	1.122	1.268	1.441	1.641	1.869	2.129	2.428	2.773	3.173
A&D Total Market	241	267	296	327	362	401	443	491	543
IC Total Market	1.140	946	857	862	963	1.227	1.466	1.656	1.859
ICMD Total Market	499	545	595	647	702	761	827	898	977
TS Total Market	81	84	180	347	443	605	537	382	410
IBS Total Market	1.071	1.083	1.096	1.113	1.133	1.157	1.186	1.219	1.259
Siemens Total	5.327	5.430	5.754	6.275	7.017	8.147	8.914	9.633	10.598

(Table header: 11:31 15 Mar 2004 Paz — Table (Total Markets of Operating Groups))

Table 4. Siemens Operating Groups' Market with Constant Growth in Economy

Table 5 shows the situation when there is a severe constant economic crisis with a GDP Growth at –6.0% and a GFI Growth at –15%. It should be noted that decision variables could be altered on yearly terms, although in Table 5 a constant crisis is shown.

Years	1	2	3	4	5	6	7	8	Final
MED Total Market	101	96	91	87	83	79	75	71	68
PTD Total Market	535	454	386	328	279	239	206	177	153
PG Total Market	537	493	429	354	383	469	391	327	263
I&S Total Market	1.122	867	690	564	473	405	353	313	282
A&D Total Market	241	244	248	251	254	257	260	264	267
IC Total Market	1.140	759	527	411	407	551	641	671	706
ICMD Total Market	499	449	405	368	336	308	282	259	238
TS Total Market	81	77	169	313	366	457	308	106	100
IBS Total Market	1.071	1.025	983	945	910	880	852	828	807
Siemens Total	5.327	4.465	3.927	3.621	3.491	3.644	3.370	3.017	2.882

(Table header: 11:35 15 Mar 2004 Paz — Table (Total Markets of Operating Groups))

Table 5. Siemens Operating Groups' Market with Constant Crisis in Economy

7. Conclusions and Further Research

Our work is the first to undertake such an empirical study with Siemens data in this area. We aimed to develop a flight simulator for the corporate management that will enable them to expertise their knowledge of market size. It was important to communicate our work to group managers, which are the end-user of our nine simulation games.

It was hard to reach numerical data for some of the variables that are too abstract, so we tried to solidify the concepts and refined the data. Though, we insisted on using the abstract variables by setting them a scale, which can be conceived by the end-users.

This model can be further developed to include other operating groups such as Electronic Components, Programming and Software Engineering, which are not currently included in the consolidated model. Also a horizontal development is possible, which is to develop market size models for other countries that operate under Siemens AG.

Another development possibility lies in the area of introducing competitors as stocks or auxiliary variables to the model. By this approach, the boundaries will be drawn wider and so that the relative market share can be calculated from the output of the model.

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