A Novel Product Development - Key Issues for Success

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Abstract

The purpose of this work is to reduce the risk of investment return in development of new products. One of the problems when developing a new product is a high-risk of investment return that prevents many companies from innovation and development of new products. In order to reduce the risk, a model of innovation diffusion should be included in a new product development. There are few theories in literature that examine diffusion of new products, but they focus on specific segments of diffusion process.

Within the scope of this work, we propose a model of product diffusion in the market based on the concepts of systems thinking and the methodology of system dynamics. The model focuses on comprehensiveness, and it helps the management to understand the diffusion process. Using the model, one can simulate how the market will accept a product depending on its specific characteristics. Based on the predictions, it is possible to choose the optimal characteristics of a product for the predefined market. Furthermore, we discuss an application to the development of a new e-learning product.

Keywords: Innovation diffusion, New product development, System dynamic, System thinking

JEL: C02, O3

1. Introduction

A basic issue in macroeconomics is identification of the factors which determine the annual output rate growth per capita. The context for thinking was provided by Robert Solow (Solow, 1956, 1966). In his research, he identified two growth sources, capital accumulation and technological progress. He claimed that capital itself cannot generate growth eternally due to the law of diminishing returns, and that sustainable growth requires sustainable technological progress. The countries with higher rate of technological progress in long term overhaul others. The developed Western World achieved average output growth of 4% per

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capita annually in the period from 1950 to 1973 (Aghion and Durlauf, 2005). In the period from 1973 to 1980, the average growth rate amounted to 2% (Aghion and Durlauf, 2005). The difference was caused directly by the backlash of technological progress, and growth of the service sector in post-industrial economies and decrease of productiveness of R&D sector are said to be the reason. Above all, the technological progress depends on productiveness and applicability of research, and on inventiveness and innovativeness (Nelson and Pack, 1999; Jones, 1999). The abovementioned has been confirmed by the EU and OECD, which identified innovations as the chief factor of economic growth on the part of few national and international companies (Union, 1995, 2007; OECD, 1999, 2002).

In literature, innovation is understood as the process of developing new products out of new knowledge and technologies, but also as new and improved products themselves (Hauser et al., 2006). Differently from invention, innovation implies commercialization. Porter defined innovation as ”a new way of getting things done which is commercialized” (Watts and Porter, 1997). Utterback believes that it is almost necessary for the companies that wish to survive on the market to innovate, and specifically, to innovate incrementally and radically (Utterback, 1996). Companies ought to create incremental innovations in order to satisfy the present-day needs of the market, but they also ought to ensure a long-term survival by preparing radical innovations which will enhance their business and redefine their market in a positive way. Furthermore, radical innovations can result in temporary domination of an innovator on the market, and, among other things, provide him with a large profit (Sekhar and Dismukes, 2009). Tidd et al. (2005) indicated that even the biggest companies disappear after some time if they do not work on radical innovations for new generations of a product. Furthermore, they noted that almost 40% of the companies which made Fortune Top 500 in 1980’s have vanished today because they did not have radical innovations in their programmes. In his research, Modelski (2001) affirmed that radical innovations are responsible for global economic cycles (Kondratiev waves). Therefore, it is hardly surprising that governments are trying to promote and stimulate innovations in order to solve economic and social problems of their countries, such as, for example, productivity and unemployment rate (Union, 1995). The concept of diffusion, which is defined as the process by which innovation is communicated through certain channels among the members of a social community, is closely related to innovation (Rogers, 2003). According to Rogers (2003), diffusion models are trying to describe the mentioned process. The basic models in innovation diffusion are the Rogers model and the Bass model. Rogers (2003) divided diffusion process into five steps. In the first step, potential users become aware of the existence of the product; in the second step, they form their attitude about the product; in the third and fourth step, they evaluate the product, and, if possible, try it out as well; and in the fifth step, the adaptation to the product follows. On the other hand, Bass (1969) developed a model which was primarily supposed to answer the question of how a product spreads among a set of potential users. The importance of such answer is that it functions well in situations with no startup users, a.k.a. startup problem (Sterman, 2000). In the core of the diffusion processes lies the fact that adaptation of a new consumer depends on the quality of the product or the service usage by the existing consumers (Reichheld, 2003). According to Yeon et al. (2006), models of diffusion of innovations can be divided into: the S-curve diffusion model, Acceptance model, Marketing hype and hype cycles, and Customer satisfaction models. Among the mentioned models, variants of logistic models are most frequently used (Carrillo and Gonzlez, 2002).

It is evident that the importance of the new product development is enormous, for specific companies, as well as for the complete world economy (Krishnan and Ulrich, 2001; Boretos, 2009; Kash and Rycroft, 2002). In spite of that, companies very rarely decide to invest into developing new radical products. The reason for that is that it is very often not of interest to the stockholders, who are generally interested only in short-term profit and who refuse to take such a huge risk that new, unproved technology brings (Galanakis, 2006). To stockholders, the expected investment return and investment risk are the key factors in making business decisions. From this perspective, investing into radical innovations is usually too risky. In order to reduce the aforementioned risk, it is necessary to include, in the very process of the product development, modelling of the diffusion process of that product through the target market. There are few theories in literature that examine diffusion of new products, but all of them focus on certain specific segments of diffusion process (Galanakis, 2006). Bers et al. (2009) examined the issue of the necessity to accelerate the development of radical innovations. The work of Guseo and Guidolin (2008) examined importance of communication channels between set of potential users. Decision-making for new technology is covered by Cunningham and van der Lei (2009), while Giovanis and Skiadas (1999) examined the influence of stochastic elements on diffusion of innovations. In the work of Bonner (2005) the influence of formal controls on customer interactivity in new product development is being covered.

The purpose of this work is to reduce the risk of investment return in development of new products. We propose the model of the diffusion of products throughout the market, which is based on the concepts of systems thinking and the methodology of system dynamics. The developed model includes all aspects which researchers in the field, as well as practical users (companies), should take into consideration when defining the characteristics of a new product for the predefined market. The model focuses on comprehensiveness, and it is useful to the management for a few reasons. First of all, the cause and effect diagram represents the qualitative description of the innovation system, and as such, it makes possible for business professionals to have a clear access to all the important processes which take place when consumers are accepting the product. By transforming the abovementioned diagram into a simulation model, it is possible to examine how a product's diffusion depends on the characteristics of the product, accompanied by the predefined characteristics of the market. Also, the characteristics of the market can be modified, and sensitivity of the product diffusion to them can be identified. The developed model is used for the development of a new e-learning product, with academic community as its market (Pale et al., 2007; Miletic et al., 2007). The product was created to satisfy both the students' demands for interactive and easy-to-use material and the lecturers' time and technological limitations. It is a software package that combines PowerPoint presentation with lecture video capturing. This allows students to re-experience the lecture at any time and anywhere. Product combines two strong elements into one lecturing system. The first one being the addition of variety of content and interactivity to existing PowerPoint presentations in an easy way that does not require much computer knowledge nor lecturer's time. The second one is the video recording of a lecture, which helps students to preserve the lecture in its original form. This reduces the chance for students to miss any part of a lecture. It also significantly augments the potential audience of the lecture. It was shown by simulations that the market will accept the product only if it is extremely easy to use. Also, strategies which could enhance the acceptance of such product on the part of the academic community are identified.

2. Modelling Approach

System dynamic was created at the beginning of 1960 by J. W. Forrester of the Massachusetts Institute of Technology. Although the methodology has its roots in engineering, today it is increasingly used in business administration and generally in modelling of social and economic systems (Galanakis, 2006; Keller and Ledergerber, 1998; Lee and von Tunzelmann, 2005; Cronin et al., 2009). The role of system dynamic in today's world Sterman described by the following words: Effective decision making and learning in a world of growing dynamic complexity requires us to become systems thinkers to expand the boundaries of our mental models and develop tools to understand how the structure of complex systems creates their behaviour. System dynamic is a perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems. System dynamics is also a rigorous modelling method that enables us to build formal computer simulations of complex systems and use them to design more effective policies and organizations (Sterman, 2000). In his book Bussines Dynamic (Sterman, 2000), Sterman explained the methodology of building a model, and he showed how methodology can be used to understand business and economic processes. Besides that, he showed how, on the basis of the models already built, different business strategies can be examined, and, accordingly, how an optimal strategy in the given conditions can be chosen.

System dynamic focuses on interaction between variables with the goal of understanding how the whole system behaves. The main assumption is that the positive and negative feedbacks, which exist in the system, are the key generators of dynamic and patterns of behaviour which we notice on the macro level (Senge, 2006). The main models that we meet in the methodology are as follows: casual-loop diagram, stock-flow diagram and simulation model (Sterman, 2000). Until today, there have been many different computer tools developed for simulation, for example, Stella, Vensim, Ithink, and Powersim. In this work, Vensim was used as such tool. Although a mathematical apparatus lies in the background of the system dynamic modelling, much information accessible to the modeller is not numerical in nature, but qualitative. There exist a considerable number of papers on working with qualitative data within the system dynamic (Luna-Reyes and Andersen, 2003; Coyle, 1999; Sterman, 2000). The importance of qualitative description of the system is that it improves the understanding of the processes which go on in the system, even when the quantitative description is not possible.

With models based on system dynamic the emphasis is not on precise short-term predictions; instead, efforts are usually made to predict trends, that is, long-term behaviour of the system. Finally, it is important to point out that the conclusions drawn out of simulations are just as trustworthy as the assumptions the model was built on. Great criticisms at the beginning of the system dynamic's existence, which were levelled against its ineffectiveness, appeared exactly because of bad prediction results which were obtained on grounds of negative starting assumptions (Meadows et al., 1972).

3. Model Foundations

Based on the insights from the works aforementioned we can summarize the prior research as follows: The probability of a new user adopting the product depends on (1) the quality of the product, (2) the experience of the users (people with higher knowledge about the product) and (3) advertising. The probability of a new user adopting the product is referred as the affinity and assume that in the given time every potential adopter has certain affinity toward adopting the product.

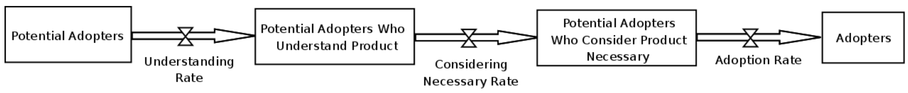

Figure 1: A stock-flow diagram of a model

Starting from the stock-flow model of the Roger's theory and the customer choice model, and using the definition of the product and the adopters given in Appendix A, the population of the potential adopters is divided in four bins, with three steps of the diffusion process. In this model the first step is denoted as understanding. For the sake of simplicity and easier model understanding the second step in the model is denoted considering necessary instead evaluation (Rogers, 2003). This is done to be more clear whether the potential adopter evaluated the product as a necessary or an unnecessary. This is equivalent to say that the potential adopter has moved from one population to the another only if she has reached the certain affinity. Since we define the Adopters as people who used the product (see Appendix A), we may the last two steps from Roger's theory (trial and adoption) observe as adoption only. The resulting three steps stock-flow diagram is shown in Figure 1. Each stock in the Figure 1 contain population with certain affinity toward product. Number of potential product adopter in a given time, heavily depends on the flow between stocks which is controlled by the "valve" (flow rate) between each pair of stocks. The discussion about product diffusion is the discussion about the parameters affect the flow rate and (directly) increase the number of adopters. In our case the "valves" under debate are the control variables that are named Understanding Rate, Considering Necessary Rate and Adoption Rate.

The variables Understanding From Advertising and Understanding From Personal Influence as well as Considering Necessary From Advertising and

Considering Necessary From Personal Influence tell us how strong influence on certain step in the model (understanding and considering necessary) has each part (advertising and personal influence). The causal loops for these variables are discussed in previous works (Bass (1969) and Rogers (2003) in the first place) and are directly incorporated into the diffusion model (see Figure 9). In the third step, named adoption, we a priori assumed that personal influence and advertising do not have direct influence, since each potential adopter needs to decide by herself whether she will try and accept the product. Such assumption is based on belief that humans are beings with its own free will and that they establish their decisions independently, however, the number of Potential Adopters Who Consider Product Necessary is assumed to have impact on the Adoption Rate, since they may interact with each other and discuss product adoption (similar to Rogers (2003)).

The variables in the first step of our diffusion innovation model may be formalized as follows: ”To understand the product a potential adopter has to be in an opportunity to understand product (to be exposed to commercial or personal influence).” On the other hand, to consider product necessary the potential adopter apart from exposure to external influence[1] needs to notice ”something” (on this product) which marks this product as necessary. Without this ”something” any commercial or personal influence is vainly. This ”something” are the product features. This adds another variable to the model, called Product perception which incorporates both the features that potential adopter first sees on the product and the impressions consumer has before she comes in direct contact with the product. The relation between Product perception and Considering Necessary Rate can be formalized as follows: ”To see whether the product is necessary for the consumer, the overall consumers’ perception of the product needs to be considered (along the product features).” For this reason we discuss consumer’s impressions (of the product), believes, and needs; coupled with product features.

Up until now, the variables which act upon most significant segment for manufacturer - product adoption itself were not discussed. Generally, we can notice that, to become an adopter, potential adopter has to pass through the decision process in which she can notice that having this product brings her more pleasure while the investment needed for product adoption is below certain threshold. This as a consequence has two additional variables in model shown in Figure 9, named Investment and Gain which represent causal variables for variable Adoption Rate.

The discussion about variable Gain is the discussion about consumer’s attitude towards the product after she is informed about the product. Yet we can see that this variable is somehow connected to Product Perception, because Gain presents final impression with the product, while Product Perception presents first impression. Latter we will get back to this correlation between variables Product Perception and Gain as well as their cause.

4. Variable Discussion and Integration

In this section further and more detailed discussion about the variables and

[1] advertising and word of mouth

causal loops is presented. To summarize the work so far we can say that the product diffusion process consists out of three steps: understanding, considering necessary and adopting. In order to fortify the adoption rate, apart from advertising and word of mouth, the consumer must have specific needs which product can satisfy. Therefore one can conclude that product features and potential adopters needs are complimentary and that in decision process involved in product diffusion same importance goes to the consumer as to the product. Potential adopter’s attitude is formed both by adopters’ perception of the product and by the product features. This attitude is based on arguments (whether they are subjective or objective), and we’ll refer to them with equal respect. Gain describes all things consumer gains with the product. But not all ”things” gained with the product are wanted. For example, product can have consequences or side effects which potential adopter didn’t want, as well as many which she did hope for. For this reason we have forked variable Gain in two main sub-variables: Arguments Pro and Arguments Contra. Arguments Pro contains all the attractive product features, while all unattractive or repulsive features are placed under name Arguments Contra.

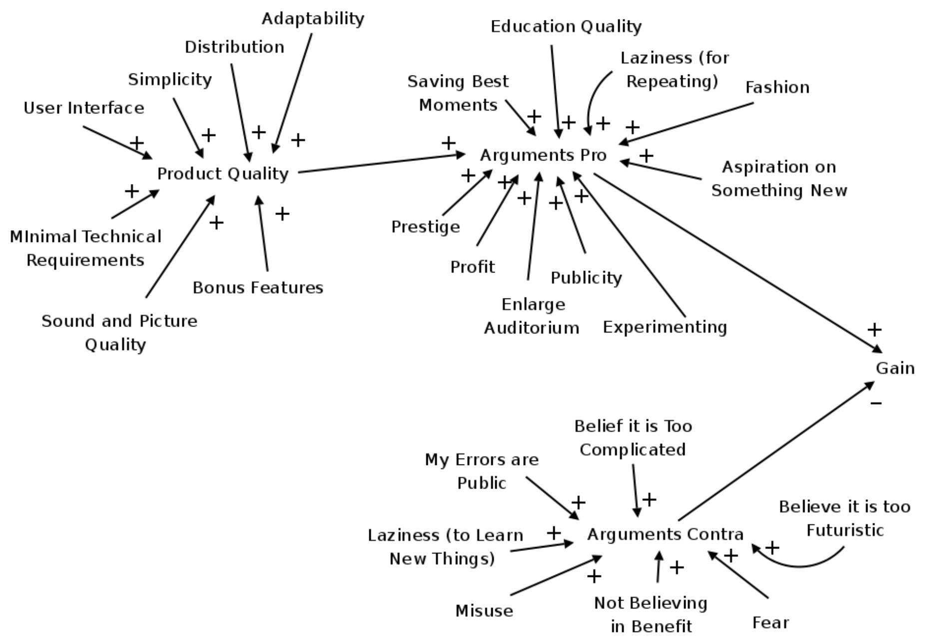

Figure 2: The causal tree for the variable Gain.

The whole causal tree of variable Gain is shown in Figure 2, where all arguments are segregated in Arguments Pro and Arguments Contra. In Figure 2 the product specific variables (such as Sound and Picture Quality) are also presented, which should be replaced with its equivalents, if the model is used for a different product. The assumption formalized in the Figure 2 can be summarized as follows: ”If the Product Quality is good it increases the Arguments Pro and shows to the

Potential Adopters that they Gain more when using the product.” Therefore, the Product Quality, Arguments Pro, and Arguments Contra are the variables that are elaborated in more details in the rest of this section.

Product Quality usually implies important product’s features. We underline important, to point out that we’re speaking about features that help product to fulfill its purpose (i.e. satisfy consumer). Additionally, we can say that the Product Quality represents agglomerate of features which represents the product, i.e. which potential adopter has in mind when she thinks about product. The features reflecting the product quality were identified and are already shown in the Figure 2.

During modeling process we came to the conclusion that for such a product, the features like Simplicity and User Interface usually have higher transitions and impact on user than minimal technical requirements, adaptability, distribution or any additional ”eye-candy” features, and especially features related to sound and picture quality and minimal technical requirements if assumed that they are consistent to the state of art. To detect the causal loop in this section, we ask ourselves what affects the Simplicity and User Interface. If these variables are so important, it can be expected that manufacturer already invested in these variables to make their influence as highest as possible before entering the market. But, even if manufacturer has done that, there is still much room for improvement, due to information received from products Adopters. Therefore we’ll say that these variables simply depend of number of adopters, or that their causal variable is variable Adopters. This can be expressed as: ”If we have more adopters, more feedback the manufacturer has, therefore, the product can have better user interface, and became even simpler”. One should have in mind that this is more difficult to achieve for larger total population, since then more variety within this population exist. Apart form a manufacturer who receives information about product (and therefore makes product simpler), product becomes simpler due to larger number of people who use this product, since the knowledge for using the product becomes the state of the art within that population. Along with that, as the number of people who use the product increases, each new potential adopter has more people to consult about how to use this product. Finally, notice that this forms the closed loop between Gain, Adopters, and Product Quality. These causal loops are all shown in Figure 3.

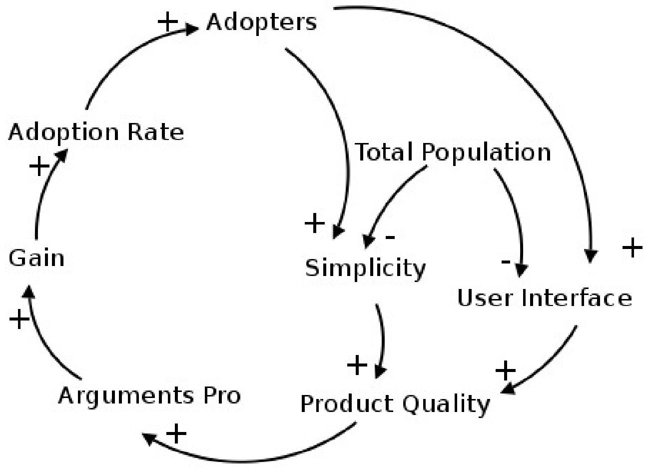

Figure 3: Lower scale causal loop for Arguments Pro.

Arguments Pro is a set of variables which represents advantages because of which potential adopter may choose to adopt the product (see Figure 2). The variable are named as reasons why potential adopter may want to use this product. In this way they represent how much can this product satisfy specific adopters' needs.

Among Arguments Pro, beside from variable Product Quality, greatest change shows variable Fashion. Variable Fashion is based, in the first place, on the perception of a product. For this reason, number of adopters affects the potential adopters' opinion on how fashionable this product is. Therefore, one can say that Adopters are casual variable to variable Fashion. For this reason it is expected that variable Fashion shows the greatest change through time and brings most contribution to the modeling process. Therefore, on a larger scale modeling, we will point out just variable Fashion. Figure 4 shows causal loops from this discussion.

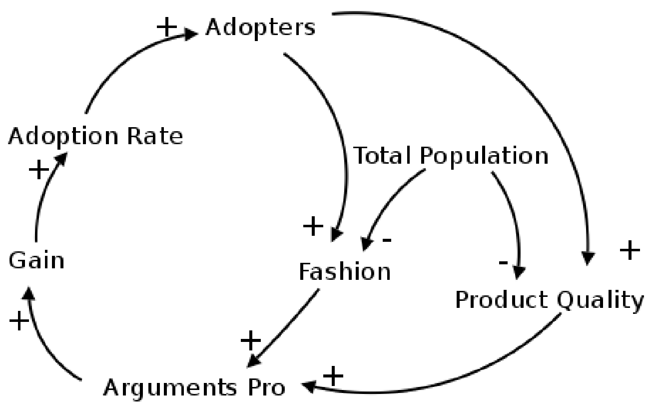

Figure 4: Higher scale causal loop for Arguments Pro.

Arguments Contra are defined as a set of variables which represents disadvantages because of which potential adopter may choose not to adopt the product. We can notice that ”Belief”-variables (Not Believing in Benefit, Belief that it is too Futuristic and Belief that it is Too Complicated) will increase above what they would otherwise have been if the variable Adopters increases. We fortify this statement in same line of arguments as for variable Fashion. We assume that ”Belief”-variables are variables which represent perception of the product and that they will ooze as number of adopters increases and convince skeptics who still may hold on to some of these arguments (believes). The rest of the variables are not expected to change as much. Therefore, effect which Adopters have on Arguments Pro and Arguments Contra, and at the end on variable Gain, can be presented as positive causal loop as in Figure 5. It is essential to have in mind that here we will also have a negative causal link from a Total Population, since it is expected that actually the portion of Adopters in Total Population describes the chance that an adopter make an impact on the ”beliefs” of a potential adopter.

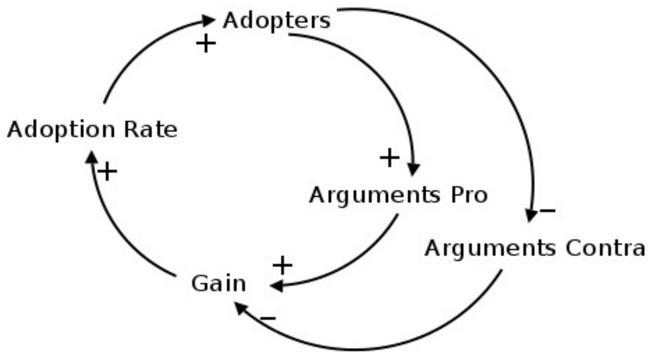

Figure 5: Arguments Pro and Arguments Contra incorporated in causal loop of the variable Gain on a higher scale. See text for details.

Notice that in the model, as usual in system dynamic modeling, we observe only average values. This has for consequence that the potential adopter observed in our model is actually an average potential adopter. Therefore, the average ”potential adopter who understands product” and average ”potential adopter who considers product necessary” are not the same because they are in different populations due to their characteristics (Rogers (2003) also claims that potential users can be separated in different population due to their characteristic). With average (Potential) Adopters in mind, it is easy to notice that that potential adopter is a time dependent variable. This becomes clear if we know that an average consumer is calculated as population average in a certain stock. Therefore follows, as stock value changes, average consumer changes. This happens because non-average consumers diffuse from one stock to another. To show that our consumer, who diffuses from one stock to another, is non-average consumer, let’s look at one example. Consumer that passes from population of Potential Adopters Who Consider Product Necessary to population of Adopters is not an average consumer of any population. Consumer passes from one population to another if she (her characteristics) is more alike this other population. It is natural to assume assume that the consumer, who passes from one population to another, is a consumer who has more characteristics alike consumers in the second the population than any other consumer in this first population. Because of that, consumer who passes from population of Potential Adopters Who Consider Product Necessary to population of Adopters is the best consumer from the first population (not average). At the same time she is the worst consumer in the second population (again, not average). In this example we used adjectives best and worst to describe how close a consumer is to adopting the product (or how high her affinity is). From the presented example we can see that the strength of the arguments pro will decline as more people adopt product, while the arguments contra will grow stronger. This is due to fact that average consumer from the population has for a fraction lower affinity with each new adopter gained. The causality may be stated in the following form: ”As the number of Adopters grows, the Adopters Quality declines” - and use variable Adopters Quality to govern the change in the Arguments Pro and Arguments Contra. The former discussion leads to the causal loop shown in Figure 6.

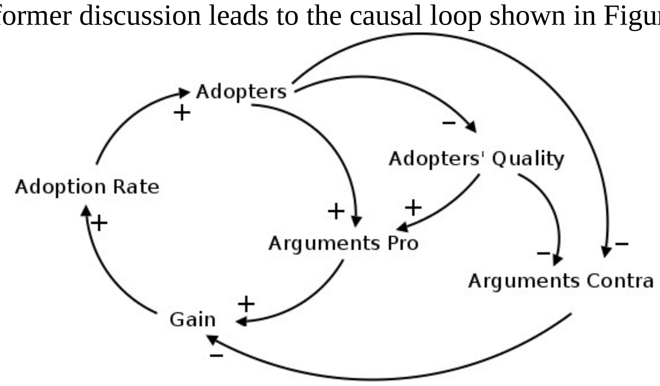

Figure 6: Incorporation of the Adopters Quality in the loop from Figure 5

As we have already noted the variable Product Perception is correlated to the variable Gain. The reason for this lies in the fact that the variable Product Perception follows same reasoning as variable Gain. The main difference is that in Product Perception we count in only the arguments which potential adopter notices first (at first glance). If we denote this fist impression of the product as Prime Arguments, we can divide them again in Prime Arguments Pro and Prime Arguments Contra. The Prime Arguments Pro are then the overall idea of product quality, and how fashionable the product is, while the Prime Arguments Contra are ”Belief”-variables similar to the variables from Argument Contra.

Similar reasoning as for Arguments Pro and Arguments Contra can be deducted on the Prime Arguments Pro and Prime Arguments Contra. Through time, as the number of Adopters and Potential Adopters Who Consider Product Necessary grows, the same effect of weakening of the arguments pro and strengthening of the arguments contra is going to happen as before. The difference is that this arguments belong to the different population, i.e. the Prime Arguments Pro describes the average potential adopter between Potential Adopters Who Understand Product and Potential Adopters Who Consider Product Necessary, while in the previous discussion the average potential adopter between Potential Adopters Who Consider Product Necessary and the Adopters has been observed. Same as before, we use new variable called Potential Adopters Quality to describe the change in the prime arguments. The distinction between arguments and prime arguments is done to express more clearly that each of these sets belongs to a different population. The result of this discussion is the causal loop in Figure 7.

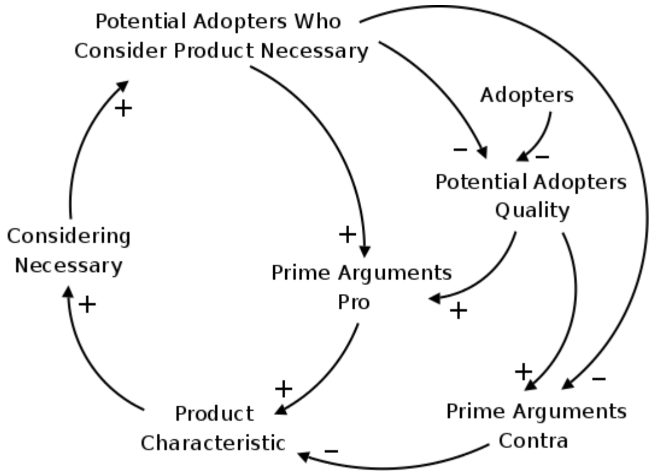

Figure 7: The influence of the Prime Arguments Pro on the Potential Adopters Who Consider Product Necessary and the associated loop. See text for details on difference between Arguments Pro and Prime Arguments Pro.

The variable Investment represents resources which potential adopter needs to invest so that she can become an adopter. These resources are: Time, Money and Knowledge. Variable Time presents time necessary to learn how to use this product. Knowledge is a variable that represents how much additional knowledge potential adopter has to have, to be able to learn how to use this product. Variable Money represents the amount of money that potential adopter needs to invest to adopt this product. These variables have positive causal link toward variable Investment, as shown in Figure 8. Causal variable for Time and Knowledge is variable Adopters. This can be stated as: ”Time needed to learn how to use the product will be shortened as product Simplicity increases and manufacturer improves its User Interface (see Arguments Pro) and these variables will increase above what they would otherwise have been if (the number of) Adopters increases”. Besides, potential adopter will need less time to learn how to use the product as she has more acquaintances who use this product and with whom can she consult. Alike that, additional knowledge user has to have decreases as some specific knowledge for using this product become common knowledge due to the increased number of adopters. All these negative causal links from variable Adopters to variables Time and Knowledge will have weaker and weaker effects as the adopters population increases, due to lowering of the Adopters Quality, same as shown before with the variable Arguments Pro. Even if this negative link prevails in the beginning, during longer simulation positive link will have the strongest influence. These causal loops are shown in Figure 8.

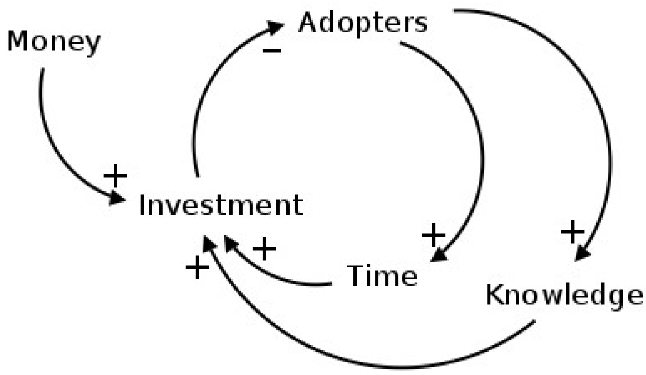

Figure 8: The causal loop for the variable Investment.

Integration of the causal loops discussed so far leads to a larger-scale model which is presented in Figure 9. Negative causal links from Adopters to Gain and from Adopters to Product Perception as well as the negative link from Potential Adopters Considering Necessary to Product Perception we owe to causal loops depicted in Figures 5 and 6.

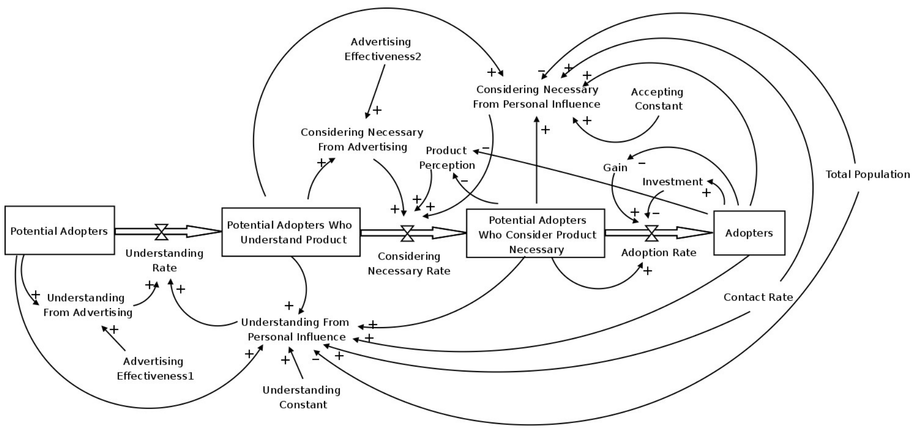

Figure 9: The final model.

5. Simulation Results and Strategy Discussion

The model described in this paper is simulated for the estimated total population of 3000 potential adopters. The model sensitivity tests was conducted on the larger scale and showed that the most important variables (such as Gain, Investment or Product Quality) do not affect the stability of the model. For instance, the simulations showed that if a larger investment of time and knowledge is needed to learn how to use product the total amount of the adopter will decline. An instance of the simulation results is shown in Figure 8, where the total amount of the investment is reduced by 20%. Simplicity and user interface of the product have the highest effect on the variable Investment. Also notice that the same effect can be achieved if the quality of the population is increased, i.e. if the workshops or education about use of the product are organized.

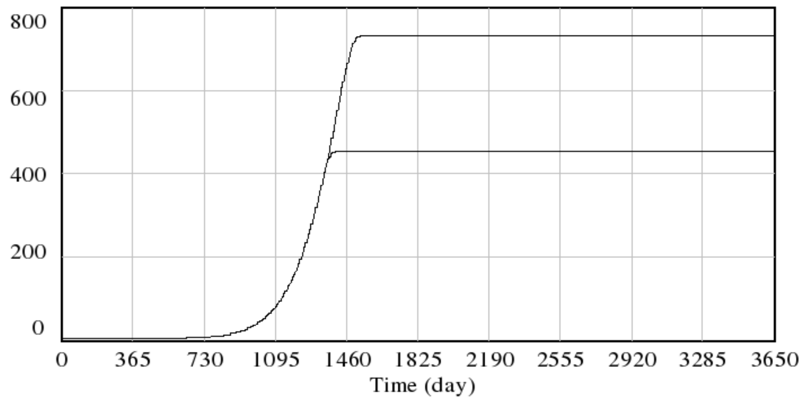

Figure 10: The graphs in the figure show the change of the Adopters trough time. The difference between the total number of adopters in the stationary state for the two simulations shown within figure, are due to reduction of the variable Investment by 20%.

Additionally the model was simulated with three different advertising strategies. In the first case the model was simulated with the aggressive advertising within the first half of the first year, while in the second case a moderate advertising for longer period of time (five years) was simulated. In the third simulation the aggressive advertising was implemented later in the diffusion process (within the first half of the third year). All the signals were constructed so that they have the same energy, i.e. the total amount of capital invested in the advertising is the same in all three simulations. This is depicted in Figure 11, where it can be noticed that the integrals of all three functions are the same. The simulation results shows that different advertising strategies do not affect the total number of the Adopters. However, the aggressive marketing in the early stage of the product diffusion can significantly shorten the time necessary to reach the total number of adopters. The simulation results are shown in Figure 12.

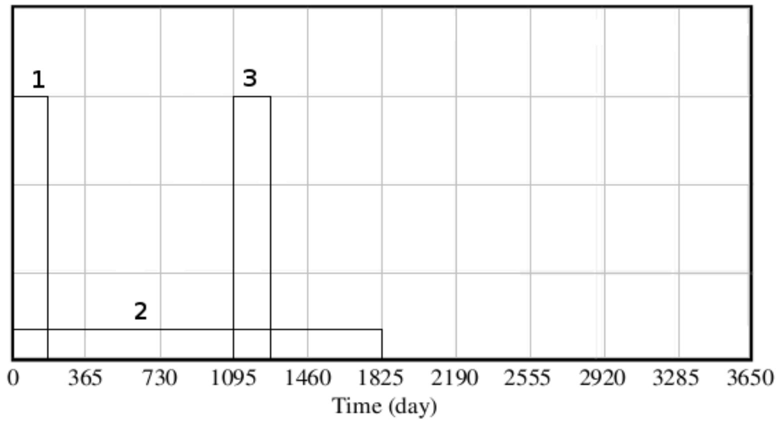

Figure 11: The graphs shows the relative amount of capital invested in the marketing. The numbers 1, 2 and 3 are used to denote: (1) aggressive marketing in the early stage of product diffusion, (2) moderate marketing, and (3) aggressive marketing later in the diffusion process. Notice that the integrals of all three functions are the same.

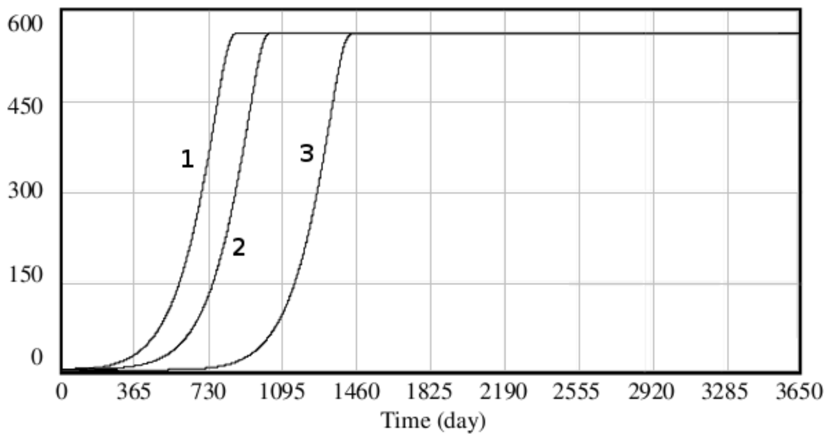

Figure 12: The graph shows the result of three simulations (from left to right): (1) aggressive marketing in the early stage of product diffusion, (2) moderate marketing, and (3) aggressive marketing later in the diffusion process. The aggressive marketing in the early stage of the diffusion process reduces the product diffusion time.

There are several implications that can be drawn from this model. (1) A lot of variables concerning product and potential adopters are interdependent. (2) The customer attitude or ”belief” may heavily affect product diffusion. (3) The total possible amount of adopters is heavily dependent on the product simplicity in our case, and in general on the gain/investment ratio. (4) The time needed to saturate the market (reach the maximum number of possible adopters) can be reduced with aggressive marketing in the early stage of the diffusion process.

6. Conclusion

In this work the model of innovation diffusion on the market is presented by the use of systems thinking and methodology of system dynamic. The model focuses on comprehensiveness, and it is useful to the management because of several reasons: firstly, the cause and effect diagram enables full view of all the important processes which go on in the process of accepting a product on the part of a customer. On the qualitative level, it is easy to see what will happen if some things in the product, or in its promotion, change. Secondly, it is possible to predict by simulations how diffusion of the product through the defined market depends on the characteristics of the product. In line with it, it is possible to define optimal characteristics of the product and optimal marketing strategy for the predefined market. Thirdly, due to the nature of the model, it is easy to try out different scenarios that can happen, and see how the diffusion of the product will develop in such conditions. The model is applied to defining the characteristics of a new e-learning product, with academic community as its market. It is shown that the simplicity in usage is the key characteristic for accepting the above mentioned product.

The results of this work should help business professionals to better understand the role of the innovation diffusion when developing new products. This should help to lower the investors return risk and, accordingly, should stimulate investment in new products development.

Appendix A

- Potential Adopters - population that does not know anything about the product
- Potential Adopters Who Understand - population that understands the purpose of this product (which needs does the product satisfy)
- Potential Adopters Who Consider Product Necessary - population that considers product necessary
- Adopters - the total number of people who used the product
- Total population - population of our market
- Contact rate - average number of social contacts made in a time step
- Understanding Rate - when we say that Potential adopter understands the product we consider that she knows what need the product satisfies or which problem it solves.
- Considering Necessary Rate - we say that Potential adopter considers product necessary if she has certain demand on which the product can

answer, or a problem that the product can solve. For product to be able to do so, it needs to have certain characteristics on which adopter can decide if the product is able to answer her needs.

- Adoption Rate - we assume that potential adopter becomes adopter in case her gain with the product is more valuable than investments she needs to invest in the product.
- Understanding Constant - probability that Potential adopter will understand the product when in contact with someone more familiar with the product.
- Accepting Constant - probability that Potential adopter will accept the product as necessary when in contact with someone more familiar with the product.
- Understanding From Personal Influence - number of people who (in certain amount time) understand product as a result of personal influence.
- Considering Necessary From Personal Influence - number of people who (in certain amount of time) find product necessary as a result of personal influence.
- Understanding From Advertising - number of people who (in certain amount time) understand product as a result of advertising.
- Considering Necessary From Advertising - number of people who (in certain amount time) find product necessary as a result of advertising.
- Advertising Effectiveness1 - probability for Potential adopter to understand the product because of information about the product from the media.
- Advertising Effectiveness2 - probability for Potential Adopters Who Understand to consider product necessary because of information about the product from the media.

The last two variables incorporate probability for potential adopter to receive information sent by media, same as probability for information to have enough quality to be able to help potential adopter to understand the product, or to persuade her that shes really in need of that product. Although advertising in purpose of understanding the product, and advertising in purpose to
convince potential adopters that they really need that product, may have the same value, the same effectiveness, they are not the same variables. Although they may be highly correlated, they are not identical. To distinguish this we named them Advertising Effectiveness1 and Advertising Effectiveness2, where number 1 and 2 refer to the first step of diffusion process or understanding, and to the second step or evaluating (considering necessary).

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