TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 64, Issue III, September, 2021

TRIZ FOR DEVELOPING INNOVATIVE BUSINESSES AND RELATED STRATEGIES

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Abstract: *An integrated model of product, company and market lifecycles is analyzed in this paper. This model reveals new angles to see innovation. It is shown that the success of a new product onto the market strongly depends on the synchronization of various stages of the three lifecycles. From this perspective, this research indicates which are the successful combinations and which combinations lead to failures. TRIZ is used to define a novel framework for leading innovation from the paradigm of aggregated model product-company-market.*

Key words: *TRIZ, innovation, systems approach, system evolution laws, non-standard problem-solving method, resources, technology transfer.*

1. INTRODUCTION

Innovation is a complex topic that increases in importance year-by-year because of the evolution of global markets. Competitiveness of companies is strongly influenced by the technological progress in communication and mobility. This facilitates rapid formation of business partnerships in the value chains, with less barriers dictated by geography. Market uncertainties is nowadays a game changer in the innovation models.

From traditional approaches of innovation management, we are preferring today modern concepts for innovation management, such as open innovation [1], and lean innovation [2]. Agility is crucial for mastering uncertainty in the framework of innovation processes, too [3].

Nevertheless, for new markets creation, the most powerful concept is disruptive innovation [4]. It exists since the '50s, being successfully implemented by Japanese and South Korean companies, but it was coined for the first time by prof. Christensen from Harvard Business School in the '90s, who was the most prominent observer of this phenomenon [4]. Nowadays, China and India are important players in disruptive innovation, whereas Western countries are trying to catch it up in order to be successfully present on emerging markets, because it is foreseen that these markets will grasp about 80% of the economic growth in the next decade.

A systematic approach to promoting a product to the market is based on the works of Bernstein [5] and Petrov [6]. Methods of obtaining ideas for innovation are based on the works on TRIZ by Altshuller [7][8], and Petrov [9][10][11].

This paper considers the unification principle from TRIZ and explores the space of innovation by tackling the three dimensions (product, organization, and market) in an integrated manner with the attempt to create a novel framework that is capable to materialize a systemic effect for innovative business success.

The major focus of the framework is on disruptive product innovation, which creates structural transformations in the market and in the equation of economic competitiveness.

2. SYSTEMS APPROACH FOR PRODUCT INNOVATION

2.1 Systems approach

A systems approach to creating innovations should consider not only the product itself, but also the company that develops and

Received: 30.07.21; **Similarities**: 10.08.21: **Reviewed**: 02.09.21: **Accepted**:16.09.21.

manufactures the product and the market that distributes this product. By product, in the context of this paper we understand both the product itself and its related services.

System synthesis of the product

The created product must satisfy some *need(s)*, performing some *function(s)* with the help of some *principle(s) of action*.

A product can satisfy an existing or new need, perform a known or new function, use a known or new principle of action. According to empirical researches, there are about eight options for creating a new product [11].

An ideal systemic synthesis is the creation of a *self-organizing system* that leads to its balance. Such a system adapts to changes and resists to unbalanced changes.

System synthesis of the company

The system synthesis of a company is similar to the system synthesis of a product. However, the company has only one main need and that is to make profit.

The company must satisfy this need through a function - increasing profits. This function can be performed using various principles of action. Under the principle of action in this case we mean ways to increase the company's profits.

System synthesis of the market

System synthesis of the market is similar to the system synthesis of a company. The market has only one need - to increase the number of sales and only one main function - to be an intermediary between the producer and the consumer.

This function can be carried out in different ways. Under the principle of action in this case, we mean the ways of mediation between the manufacturer and the consumer.

System synthesis of a product, company, and market as a whole

By combining patterns of new products with different cases of companies and markets, we can define more product options in terms of strategic development.

2.2 Lifecycle concept

The success of an innovation largely depends on the synchronization of various stages of the lifecycles of the product, of the company that develops and manufactures the product and of the market targeted for product distribution.

Systems approach considers interdependence of the stages between the lifecycles of product (service), company and market.

Different sources indicate a different number of stages. In this paper we will consider four stages of the lifecycle, which relate both to the development of a product (service) and to the development of the company and the market.

1. Development and introduction.
2. Growth.
3. Maturity.
4. Decline, and “dying” or stagnation.

Most often, the stages of the lifecycle are presented in the form of an S-curve.

In this paper we propose to represent the stages of the lifecycle in the form of a graph (Fig. 1), which we conditionally called a hat-shaped curve.

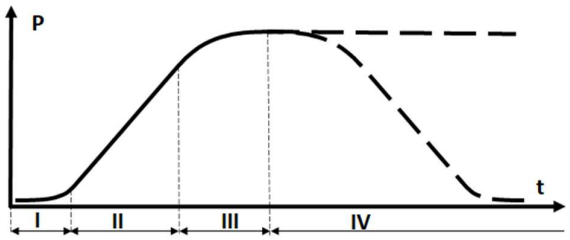

Fig. 1. Lifecycle stages

In Fig. 1, “P” is the symbol for parameter, and “t” for time. The parameter "P" can be, first of all, the main characteristic of the system. At the beginning, a product (service), company or market develops slowly (stage I), upon reaching a certain level, then its development accelerates (stage II) and after reaching a certain level of growth rate it decreases and, ultimately, the growth of the parameter stops (stage III), which means the appearance of some contradictions in the system.

In stage IV, the parameter of the system may not change (stagnation) – see the dotted line, parallel to the time axis (t) – or decreases, and to the end the system “dies”. The IV-th stage is not typical for all products (services), companies and

markets, and some remain at the III-rd stage (stagnation).
At each stage of the lifecycle of a product (service), company and market (system), there are certain patterns that must be considered. These patterns are described in [7].

2.3 Integrated product innovation

Life cycle summary chart
The overall perspective of the concurrent joint development of the triple helix "product, company and market" is illustrated in the graph from Fig. 2.

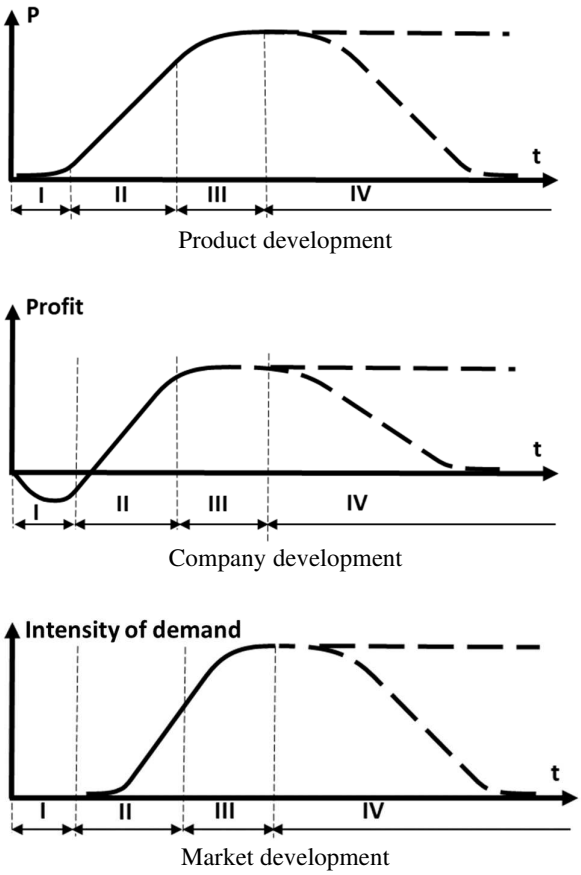

Fig. 2. The three perspectives of the lifecycle

The main parameter (P) of the product in Fig. 2 could be any key technical performance, for example, speed, reliability, power, accuracy, weight, etc. For services, it could be, for example, productivity, number of customers, customer satisfaction, etc.

For company, we will consider profit as the main parameter (P). At stage I and the first part of stage II (introduction phase), the profit is negative. The product has not yet been produced, so there is still nothing to sell and only costs occur.
For market, the main parameter (P) can be considered the number of sales. Sales begin in stage II.
Considering the three generic perspectives of the lifecycle, the number of options increases even more. Here is a matrix of possible combinations of various products, companies, and markets (Table 1). Let us designate the product with the letter "P", the company with the letter "C" and the market with the letter "M".

Table 1

Matrix of possible combinations

Development Objects	**Development stages**			
Product	P1	P2	P3	P4
Company	C1	C2	C3	C4
Market	M1	M2	M3	M4

Numbers in Table 1 indicate the stages of the lifecycle, which are symbolized in the graph from Fig. 1 with Roman numerals (I-IV). A total of 64 combinations are possible. Of them[1]:

- The best combinations: P1C1M2, P1C2M1, P2C2M2, P3C3M3, P3C3M4, P4C3M4.
- Real situations: P2C1M1, P2C2M1, P3C2M3, P3C2M2, P3C2M1.
- Unreal (undesirable) situations: P3C1M3, P3C1M2, P1C2M2, P1C2M3.

In the event of undesirable combinations, such businesses do not need to be neither started nor stopped, because they lead to fail, excepting the case when a non-standard, out-of-the-box way is found to fix the situation. In the latter case, it is advisable to use TRIZ tools to solve the problem. Let us consider several situations.
First-stage companies work effectively with first-stage products. The activity of such a company, as a rule, is to develop a new product. Second-stage companies can work with both first and second-stage products. These companies bring the prototype to mass production.

[1] Data from the book [4] and the authors' experience.

Third-stage companies are great at working with products in stage three or in the middle of stage two.
Third-stage companies cannot work with first-stage products, and third-stage companies cannot work with third-stage products.
The companies of the second and third-stages enter the markets of the first-stage, but the most successful are the second-stage companies. The structure and management style of a third-stage company is not compatible with first-stage product development. This contradiction is resolved by creating a subsidiary, which is a second-stage company created by a third-stage company.
It is interesting to note that a first-stage company may release a first-stage product for a third-stage market.
For example, a new food product is being developed. The food market has long been at the third-stage. In this case, most often, investments in marketing are significantly reduced to create a need and demand for this product.
According to the logic above described, it is absurd to invest in a new first-stage product for a fourth-stage market. But the TRIZ elements can help to come up with a product that will support the fourth-stage market or even transfer it back to the third-stage. In other formulation, it is necessary to reborn the demand by identifying new characteristics of the market due to evolutions in the system, characteristics that are not yet made aware by that target market.

Example: Software company X
Let us give an example of how the software company X resolves the contradictions related to the mismatch of the product stage and the market stage. Company X develops a new product (first stage) that has not yet been fully tested and releases it onto a market positioned in the second stage. The market is informed about the fact that the product is only an intermediate version (alpha or beta version), therefore the company X sells it at a lower price. Buyers test the product and inform back the company about the noticed errors. Thus, the company saves significant funds for testing the program and advertises a new product at the expense of customers. Another case is when the company X launches the third-stage product on a market positioned only on the second-stage. According to traditional business rules, a third-stage product must be released onto a third-stage market. How does the company X do to succeed by launching the product for a second-stage market? In principle, a third-stage software product should not contain errors (bugs). This requires a significant investment of time and money for testing and bug fixing. This is reflected in the price. But the company X, instead of investing too much in testing and bug fixing releases a product which is not fully tested, therefore it might contain errors. However, a special module is built into the software product that notices errors and allows users to report this error to the company.

3. INNOVATION STRATEGY

The development of any company is associated with its ability to create and adopt innovations of any kind, from product, to process, marketing, organizational and business model-related. It is very important to know how to properly run this process for a given market sector.

3.1 Generic clustering of markets

The market is created when the needs of a given consumer group are met. The market can be roughly divided into two conceptual clusters:

1. The top-level cluster for consumers capable to afford and use the full potential or a significant part of the potential embedded in the product. This is a market for highly mature products (usually also higher price products). This market category is called “high-end consumers”.
2. The bottom-level cluster for undemanding consumers. This market finds acceptable lower performance products because simply it does not need higher performances and/or it cannot afford to buy the professional technology and/or it is not capable to valorize the full capability of the professional technology. This is a market for low-cost products.

There are certainly mid-market categories. Companies are looking for strategies capable to master one of the market categories or all categories and distribute their products among

them. Table 2 illustrates market clustering for the case of steel-made raw products.

Table 2

Distribution of various product categories manufactured in steel mills[2]

Steel quality	Types of steel	% of total production	% profit
Top-level	Sheet steel	55	25-30
Upper intermediate level	Structural steel	22	18
Intermediate level	Corner iron, rods, and beams	8	12
Bottom-level	Reinforcing iron	4	7

In the example from Table 2, the top-level sector is the production and distribution of metal sheet steel, and the lower level is reinforcing iron. Specialized steel category is not included in Table 2.

3.2 Types of innovations

There are over 70 types of innovations according to the recent surveys done by the consulting company Creax [12]. However, from the perspective of job creation, Clayton M. Christensen formulated the following types of innovations [4]:

1. Disruptive innovation, which creates new job opportunities.
2. Supporting innovation, which maintains current jobs.
3. Productivity-driven innovation, which eliminates jobs.

Further, we will comment only on the first two types of innovation, the last one being non-social oriented and more focused on capital.

Disruptive innovation

There are two major types of disruptive innovations. The first one is directed on creating a fundamentally new product. The second one searches for significantly reducing the cost of products already available onto the market or creates simpler and more convenient product handling.

Disruptive product innovation often creates a new market, and usually addresses in its early stages of the lifecycle mid and low-end consumers, whereas radical product innovation meets new needs. The last one is merely designed for consumers who love everything new. They agree to buy at high prices products that do new jobs. Thus, such a product creates a new market that did not exist before. In its first version(s) such a product is often not of high performance. Disruptive innovation deals with products that are already onto the market but making them much cheaper and easier to use. Such products may be less functional and / or of lower quality, but they target non-consumers to transform them into consumers (low-end). It is about consumers who previously could not afford to buy such products.

Example: Transistors

In the early 50s of the last century, there was still no market for transistors. Texas Instruments began shipping transistors in November 1953 in the attempt to create a new market. Texas Instruments started by signing a contract in October 1953 to supply 7,500 transistors for hearing aids, but this technology created interest for the general public, too. In this created context, Patrick Haggerty, the head of Texas Instruments at that time, came with the idea of designing and producing a pocket-sized transistor radio to create a market for transistors. Because in that moment Texas Instruments lacked own facilities to produce receivers, Haggerty invited manufacturers such as RCA, Philco, or Emerson, to produce receivers, but he was refused. They did not want to get involved with new, low predictable technologies and did not see a big future for handheld devices[3]. This is an example of creating a fundamentally new product, also called radical innovation.

In October 1954, Texas Instruments announced the launch of the first transistorized receiver under the Regency trademark. Production of the Regency TR-1 began on October 25th and sales on November 1st.

Later, a wide import of much cheaper Japanese products began in the United States, and in 1960 the Regency trademark, under the pressure of

[2] Data from the book [4].

[3] https://ru.wikipedia.org/wiki/Regency_TR-1

such competition, left the market of transistor receivers.
In 1955, Sony released its first transistorized compact radio, the Sony TR-63, which kicked off the company's success. The receiver, although it was called a pocket receiver and was really small, did not fit into the pocket of an ordinary men's shirt. For the traveling salesmen, the company made special shirts with enlarged pockets so that they could demonstrate at the time of sale how easy the receiver is to take with you. This receiver was much cheaper than the Regency TR-1 receiver, and therefore ousted it from the market even in the USA.
This is an example of a company and its product that has successfully conquered the market with a disruptive innovation.

Supporting innovation
Supporting innovation aims to produce more expensive, improved products for its main consumers. Improvements come from the competition with other companies. These products embed some properties that are superior to anything else onto the market. These products are mostly designed for high-end consumers. This kind of innovation sometimes allows companies to make a breakthrough and get far ahead of the rest of the competition. As a rule, in such cases the leader always wins.

3.3 Driving competitors out of the market

Let us describe how disruptive innovations win the competition against established industry leaders and drive them out of the market.

First way: new companies create disruptive technologies
Start-ups, using “disruptive” innovations, drive out leaders from the low-end consumer business sector; the sector that is less attractive by the leading companies in terms of income and profitability. As a rule, leading companies do not pay too much attention to concede this market sector if new entrants move ahead with disruptive offers. Most often this happens because “disruptive” innovations make the product cheaper, but its quality is also rather low. That is why such a product is intended only for the lower market sector.
However, in the next phases of its lifecycle, even disruptive innovation increases in performance, leading to better products. Since this technology is cheaper than the traditional one produced by the leading companies, it becomes more competitive and traditional players are pushed out of the market step-by-step.
If the “disruptive” technology is being further improved in performance while keeping the price lower than traditional technology, at a certain point in time the “demolitionist” company (the disruptor) will eliminate the old technology from the market. By this time, the "demolitionist" company having accumulated experience and technological groundwork, will put the leaders in the situation of not being able to be competitive at none of the product categories.

Example: Steel industry
A very illustrative example of how disruptive innovation works is given by prof. Clayton M. Christensen from Harvard University. The industrial sector is steel production [4]. In the past, steel mills covered the entire steel making process: blast and open-hearth furnaces, rolling mills and other equipment for steel production. They produced all kinds of styles from the lowest grade steel to rebar, angle iron, rods and beams, high quality grades of steel (structural and rolled steel). Such plants occupied a very large land area, and the investment were very high, with attractive returns on investment only over a long-time horizon. Due to the huge investment, these plants are forced to produce products for what they were designed, at the productivity rate for which they were designed. They are not at all agile and flexible. This means, they were captive and forced to keep the same product portfolio and the same production processes.
At a certain moment in time, mini-mill factories have been invented. Mini-mill factories produce steel using electric arc furnaces. They take up a much smaller area and production costs 20% less than traditional production. In their early phases of lifecycle, electric arc furnaces were not perfect and could only produce the lowest-quality types of steel - rebar. Since the production of reinforcing steel was 20% cheaper in the mini-mills, they began to compete with

steel mills and soon forced them to step out from this market sector. Since for steel mills this market sector accounted for only 4% of their total production and gave only 7% of the profit, they did not fight for this market sector and abandoned it.

Further, electric arc furnaces were merged to improve and started to produce corner iron, rods, and beams. Since these types of products were 20% cheaper in the mini-plants, they started to compete with steel mills in this market sector, too. As one can see from Table 2, this market sector accounted for only 8% of the total market and gave only 12% of the profit for the large steel plants; thus, after some time, they abandoned this market sector.

The technology of electric arc furnaces was being constantly improved and after a while it was possible to produce structural steel with this technology, too. Since it was possible to produce structural steel with 20% less costs, mini-mills pushed steel mills out of this market sector, as well. Steel mills felt the threat of mini-factories' competition, but they could no longer do anything.

When the technology of steel production using electric-arc furnaces reached a level that could produce any kind of steel and cheaper with 20%, the mini-mills gained a competitive advantage and completely moved steel mills from the market.

The only exceptions were the Japanese and South Korean steel mills. They introduced electric arc furnaces in time. They have the best and largest electric arc furnaces today.

Second way: disruptive technologies are first developed in mature companies

Typically, mature companies have all the resources to develop a disruptive product. They have highly qualified developers, an experienced base, and the means to acquire the necessary materials and equipment. Engineers of such companies can develop and test prototypes and choose the best one. Results are transferred to the marketing department, which investigates the demand for a newly developed product. The marketing service addresses its main consumers, i.e., consumers of the upper sector, who have very high expectations and very specific needs.

In most of the cases, a new development does not have the best characteristics at its early lifecycle phases, therefore high-end consumers will not adopt the new innovation. Thus, a new market must be created, most often for the low-end consumers. Most often, technology from the mature company is transferred to a spin-off to address the new market. Developing a new product by mature companies with the involvement of a traditional marketing service is often futile.

Example: Floppy disks

Seagate Technology was the leading manufacturer of 5.25-inch floppy disks. In 1985, the R&D department invented the 3.5-inch floppy disks. The company created about 80 prototypes and having selected the best among them, applied for the project to senior management.

The management of this company wanted to know if there might be a market for these small floppy disks. These floppy disks were cheaper, but still of inferior quality, with less memory. It sent this request to the marketing department.

Marketers showed prototypes to the main consumers of their products and asked for feedback on this type of floppy disk. The main consumers of their products were IBM and manufacturers of desktop personal computers of the XT and AT classes. The capacity of these floppy disks was much less than what this mainstream desktop market needed. As a result, these companies showed no interest in Seagate 3.5-inch floppy disks. Few years later, other companies introduced this product onto the market.

Third way: disruptive technologies are developed in mature companies

This is the case of mature companies, which were leaders in innovation since their foundation and have a culture for innovating continuously and disruptively. This is a special category of companies, led by visionary managers.

Example: Apple

In the mid-1970s, Steve Jobs, Ronald Wayne and Steve Wozniak assembled their first personal computer based on the MOS Technology 6502 processor. On April 1, 1976,

they incorporated Apple Computer, Inc. with the money raised from the sale of several dozens of these computers.

In 1977, the Apple II personal computer was released in mass circulation. In total, more than 5 million of them were sold. In 1984, Apple introduced a new 32-bit Macintosh computer. This changed the entire computer industry.

In 2001, the company introduced the iPod audio player. It didn't just change the way we listen to music, but the entire music industry.

In 2007, the iPhone was launched into the market. It brought together three groundbreaking projects: a widescreen with touch control, a revolutionary mobile phone and a new portable internet device. This device has not only changed several industries, but also our lives. In 2010, the iPad was launched onto the market. Macintosh, iPod, iTunes Store and iPhone are examples of disruptive products.

3.3 Successful business growth strategy

In order to maintain growth, a third stage company, in our opinion, should adhere to the following strategy[4]:

1. Company **A** distributes its main product (service) **α**.
2. Company **A** creates:

a. A branch $\mathbf{A_1}$ that develops new technologies ($\boldsymbol{\alpha_1}$ products or services) to **support** this market.
b. A branch $\mathbf{A_2}$ that **brings** the $\boldsymbol{\alpha_1}$ product (service) to the market.
c. A branch $\mathbf{A_3}$ that develops a **disruptive product** (service) $\boldsymbol{\alpha_2}$ dedicated to the low-end consumer sector.
d. A branch $\mathbf{A_4}$ that finds a market for the $\boldsymbol{\alpha_2}$ product (service) and **distributes** that product.

Note. There may be one single department that performs the functions of departments A_1 - A_4.

3. Company **A** sets up a **subsidiary company B** to create a **disruptive technology** (product or service **β**).

a. A branch $\mathbf{B_1}$ of the company **B** is engaged in the development of the product (service) **β**.
b. A branch $\mathbf{B_2}$ of the company **B** looks for a new market for product (service) **β** and distributes this product.
c. A branch $\mathbf{B_3}$ of company **B** is engaged in the improvement of the product (service) **β** to bring the product to the upper market sectors, independently or in conjunction with branch $\mathbf{A_1}$ and / or with **A**.
d. Company **B** merges with company **A** when the product becomes successful onto the market.

Note. There can be a single department performing the functions of departments B_1 -B_3, i.e., all functions are performed by B.

It is also possible that company **A** creates a department to search for start-ups engaged in the development of disruptive technologies in the business field of company **A**, supports them financially and / or with resources and monitors the results of their growth and helps them searching for new markets. Further, the path is similar to 3 c, d.

The strategy of transition of the company from the first stage company to the second stage one largely depends on company's strategy. First of all, it is a matter of capacity to restructure and lead the second stage company or to sell the company.

4. WAYS TO CREATE INNOVATIONS[5]

4.1 TRIZ tools for creating innovations

To create supportive and disruptive innovations the following TRIZ paradigms can help [10]:

1. Systems approach.
2. Laws and patterns of systems development.
3. Methods for non-standard problem solving.
4. Resources.
5. Transfer of technologies.

[4] These are theoretical representations of the authors, based on the analysis of Christensen's work and data that are available on Internet.

[5] Examples of creating a product are partially given in the presentation, and completely in the book [11].

4.2 TRIZ roadmap to create a fundamentally new disruptive product

Systems approach to creating a fundamentally new product should include the following steps:

1. Identify needs.
2. Develop a concept.
3. Analyze the position on the lifecycle curve for company and market.
4. Plan product, company, and market development.
5. Develop product strategy.

Need identification is carried out in the following sequence: analysis of the existing *product (service)*, determination of the *principle of operation* of the product (service), identification of the *main function* of the product (service) and the *need* that this product (service) satisfies.

Alternative products (services) that use the same operating principle, or alternative products (services) that perform the same function, or alternative products (services) that satisfy this need can be selected and developed.

When developing a new product, it is desirable to obtain the widest possible range of alternatives. For this purpose, it is desirable to have a wide set of operating principles, functions and needs.

Alternative operating principles can be obtained using physical, chemical, biological and geometric effects, or technology transfer.

To obtain alternative functions and needs, one can use the patterns of changes in functions and development of needs. These are the most general patterns of systems development [9]:

- The pattern of idealization.
- The pattern of controllability and dynamism.
- The pattern of the transition to the supersystem and subsystem.
- The pattern of coordination.

We will use these patterns to obtain new functions, new needs and forecast new products (services). For the old operating principle, one can select or develop alternative products (services). To obtain more alternative products (services), one can use the morphological approach.

All possible combinations of principles of action, functions and needs are determined. Another way is to build a tree-like graph of needs, functions, principles of actions and products. At each stage, the most appropriate need, the main function, the best operating principle, and the best product (service) are selected.

To reduce the cost of products or make them easier and more convenient to use, the pattern of increasing the degree of ideality is used in the form of the trimming method.

5. CONCLUDING REMARKS

The major contribution of this paper is to highlight the importance of analyzing product innovation in close conjunction with the lifecycle stages of the company responsible for production and sales of that product, as well as in close relation with the market maturity to adopt the innovation. The right combination of the lifecycle stages of the three agents (product, company, market) determines the success or failure of new innovations. This aspect is not tackled in a structured way by most of the entrepreneurs. From here we see the high rate of failures of many product innovation initiatives.

Based on empirical researches, in the paper are proposed desirable combinations of the three key agents in the framework of new product innovation. From the analysis of disruptive innovation phenomenon, it was possible to identify successful business growth strategies based on product innovation. The pattern is not linear and can follow several branches. To assist this process, TRIZ tools can be considered. They are briefly highlighted in the end part of the paper. It is proposed a novel scheme to strategize product innovation in relation to needs, functions, and operating principles.

It is opened a window for further researches by using structured innovation (e.g., TRIZ) to perform disruptive product innovation to increase the rate of success.

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TRIZ pentru dezvoltarea de afaceri inovative și strategii asociate

Rezumat: Un model integrat al ciclurilor de viață ale produsului, companiei și pieței este analizat în această lucrare. Acest model dezvăluie noi unghiuri pentru a vedea inovația. Se arată că succesul unui nou produs pe piață depinde în mare măsură de sincronizarea diferitelor etape ale celor trei cicluri de viață. Din această perspectivă, această cercetare indică care sunt combinațiile de succes și care combinații duc la eșecuri. TRIZ este utilizat pentru a defini un cadru nou pentru conducerea inovației din paradigma modelului agregat produs-companie-piață.

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