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DECISION SUPPORT SYSTEM FOR IDEA SELECTION

M. Stevanović, D. Marjanović and M. Štorga

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1. Introduction

New product development is a process during which the organization uses the available ideas, capabilities and resources to create new or transform existing products [Feyzioglu and Buyukozkan 2005].The creation of new ideas, both by individuals and by a larger number of participants and teams, is a process which provides the key component of product development. Highly innovative companies realize more than 75% of their revenue from sales of products and services which have not been in their production programs five years ago [Howard et al. 2008].Therefore, the participants in the product development process are actively encouraged in various ways to generate new ideas [Glassman 2009]. The fact is that organizations do not come to new ideas just from own environment. Their ability to develop new products based on new ideas indicates their ability to interact with their environment: customers, suppliers, development institutions and canters, and public organizations [Carson 2007].

Once the basis of market value of a company was the value of its products and the ability to produce the required quantity of certain products. Today, the value of a company is greatly affected by the ability to adapt to new conditions, the number of patents it holds, available knowledge and innovations, licenses, databases, data access, new products, innovation and ability to implement changes. The dominant influence of value switched the focus from static internal values to dynamic values of the interaction with the environment. Products are no longer defined by the abilities of producers but by their acquired knowledge, available technology and customer needs.

In the last twenty years, the rapid development of information technology has led to the point where majority of information and knowledge became accessible to everyone, and it became a platform for the development of IT services. Parallel to the development of the Internet, the revolution in communications was also happening; for the first time after the invention of the phone it gained a new platform for dual communication with customers. Thus, the communication and information technology influenced the creation of social factors that have begun to significantly determine the acceptance of new products. Permanent availability of all information affects how fast the product is available and how quick the responses to competition are. A key factor for market success of a product becomes its identity based on quality, functionality and diversity from those of the competition. Once the market success of products used to be represented by quality management, time management and management of efficiency, but now it includes new expectations through management of innovation.

New product development process is often time cosuming and expensive. Some data suggest that the early stages of a new product development determine up to 70% of the costs incurred during the lifetime of the product [Asiedu and Gu 1998].According to research [Cooper and Kleinschmidt 2004], [Herstatt and Verworn 2001] big differences between winners and losers in the market are usually due to differences in the quality of analysis implementation in the early stages of product development.

The earliest stage of product development essentially determines the final realization of products in almost all aspects. Studies show that only about 6% of the cost and about 16% of the time accounts for the initial phase of product development [Cooper and Kleinschmidt 2004], [Herstatt and Verworn 2001] while damage due to poorly conducted analysis and wrong decisions are more pronounced in the later stages of development.
Therefore, the process of developing a new product sets a condition that all changes related to the product being developed must be made as early as possible, in order to shorten the development process and make it cheaper. Therefore, the need arose for the preparation process of developing a new product, a process which precedes the formal process of developing new products, to be singled out and viewed as a separate phase. The above has been recognized by several authors [Koen et al. 2001], [Kim and Wilemon 2002], who dubbed it Fuzzy Front-End or Front-End of Innovation.
The earliest phase of new product development is characterized by three inter-dependent and conditioned units [Koen et al. 2001], [Stevanović and Marjanović 2011]:

- analysis and validation of opportunities
- analysis and validation of ideas
- creation and testing of a concepts

which result in a new product concept as the basis for the development and commercialization of the product itself.
Analysis and validation of a business opportunity indicates what products the organization can offer on the market on the basis of adopted technologies and available knowledge, i.e. which products can be accepted on the market that the organization would be able to offer. Analysis of business opportunities is a constant evaluation of supply opportunities and the feasibility of the proposed, based on which we get the directions for new product development. Management of ideas primarily assumes the organization of requirements for generating of ideas, gathering of ideas, basic validation of ideas, classification of ideas according to predefined criteria, the determination of attributes for describing the ideas, storage of ideas in the appropriate databases, improving the ideas in communication of reviewers and creators, and the selection of those ideas that can contribute to the success of the product [Glassman 2009] according to predefined criteria.
The creation of a product concept and testing of the concept is the final part of the early stages of product development [Koen et.al. 2001], [Stevanović and Marjanović 2011], and a platform for further development of products based on the best ideas according to defined criteria. The creation, evaluation and selection of ideas are the most important activities during the preparation of new product development, and according to [Koen et.al. 2001] "*the most important activity is the selection of those ideas that can provide the highest value of products*."
In this paper, a methodology for managing of ideas, especially in the selection of ideas, will be discussed. Particular attention will be devoted to the presentation of certain results of research in defining the attributes of collected ideas, categorization, and evaluation and validation according to certain criteria in order to select the best ideas for product development.

2. Background

The starting point of any development process is based on an idea. The idea is nothing more than a presentation of new thoughts, concepts, understandings or attitudes, which occurred as a result of certain mental activities based on the available skills and knowledge. Creativity is a unique, new and unexpected display of an idea or a combination of several ideas. The idea becomes the main factor that leads some products to success. But in the multitude of ideas there are only a small number of those, which on their own or together with other ideas, can result in successful products, and only a few that are revolutionary and lead, through innovation, to exceptional results.
The creation of new ideas is a process that begins with the definition of desires based on recognized opportunities and possibilities. The basic ideas are produced through various activities: basic research, market trends, customer trends, internal R&D, competitors, focus groups, employees, sales, corporate spies, trade shows, ethnographics. To generate new ideas all available resources are used, both internal and external, including the use of capacities based on a mass approach.

Numerous models and methods for generating of ideas have been developed, as well as certain models of management of ideas [Glassman 2009].It is often pointed out that a common problem for the creation of ideas is not the lack of creativity, but the lack of incentives that would influence the involvement of creative potentials. It is particularly important for organizations in the process of collection of ideas to ensure their employees, but also all interested parties, the possibility to present ideas. Employees may have superior ideas, but often have no means or motivation to present them appropriately.The lack of a formal idea gathering process will often mean that a significant number of ideas will remain unnoticed. Formal models can be very simple: all employees have the opportunity to write down their ideas and, at the end of the day, submit them to their superiors; but can also be very sophisticated. Internet as a platform, has opened up new possibilities for open systems of idea collection, innovation competition, idea competition and collection of ideas through the Internet community. Common to these processes is the use of widespread knowledge of a large number of participants related to each other thematically and motivated correspondingly [Toubia 2006].
After a successful completion of the collection of ideas, the quality and value of collected ideas is inspected. Collected ideas represent guidelines on how the current situation characterized by available resources (technology, knowledge, human potential) can be best utilized for the desired new product. There are a large number of methods that in some ways more or less cover the process of idea management. Recently, some studies deal with this problem [Glassman 2009].The process of idea management, as opposed to the process of idea creation, is often an internal process for the organization that collects ideas and is characterized by some basic stages: collection of ideas, an overview of the collected ideas, labeling and defining of attributes of collected ideas, categorizing of ideas and their archiving in a database, and the use of collected ideas for development.
As we already mentioned, the biggest problem is definitely the problem of selection of the ideas that contain the greatest potential for a given product that we intend to develop. The structure or definition of the problem is the most important characteristic with regard to the possible methods and procedures for decision support. Simply put, the level of structuring is the answer to the question whether the problem is known and whether it is known what to do to fix the problem. In order for the problem to be well structured, it is necessary to have all the components of the solution known [Simon 1960], i.e. to determine the exact problem, precisely define the input data, alternatives and strategies of possible solutions, and the process of analysis and selection of the final solution. Based on the structuring, problems range from completely specified (well structured) to completely unspecified (poorly structured). Well-structured problems are successfully solved by optimization methods; however, for partially or poorly structured problems it is necessary to apply multi-criteria decision making methods. Since the decision maker in this case is presented with numerous unknowns, both in terms of selecting the most important attributes of ideas and the valuation of attributes of ideas, as well as product features and/or product life cycle (PLM) that will be affected more or less by the applied idea, the idea selection process can be said to belong to a group of programmed unstructured or poorly structured problems.
According to the latter, it is necessary to define a decision support system (DSS) which should include several methods that allow multi-criteria analysis of ideas for specific product requirements and offer a subset of ideas that are complementary and offer the greatest development potential to the product.

3. Related work - idea management and idea selection

Collecting and categorizing the multitude of ideas does not represent any benefit if the ideas are not used to their full potential in the product development process (or processes).To recognize the usefulness of collected ideas for potential deployment in a product, it is necessary to ensure proper evaluation and thus create conditions for the proposal of ideas that will be selected for implementation in the development process. There is a large number of methods of evaluation of collected ideas presented in the literature [Rebernik and Bradac 2009]. In the first phase of implementation of open systems for collecting of ideas much attention was given to the process of collecting and managing of ideas. In recent years, there are significant trends in the inceasing number of papers from the area of evaluation of ideas and concepts based on the product development ideas. To apply the methods of multi-criteria decision making, it is necessary to carry out the procedure of identification of the key

values of the collected ideas, to define the values of corresponding attributes of ideas, and to define criteria for the implementation of selection with these methods and by using the method of ranking of alternatives.

For the implementation of ideas for product development, it is not enough just to collect the ideas and pass them as such to the decision makers to choose from. In a large number of collected ideas we often have those that process the same problem with varying degrees of quality. There are frequent cases in which several ideas deal with the same problem in part or completely. In order to choose from the multitude of ideas contained in the collected set the ones that will best contribute to our development process it is necessary to conduct the process of selection of ideas.

We have not found an appropriate model for such a procedure in our literature, the one which would be satisfactory in our research, therefore, the following figure shows the model we are using.

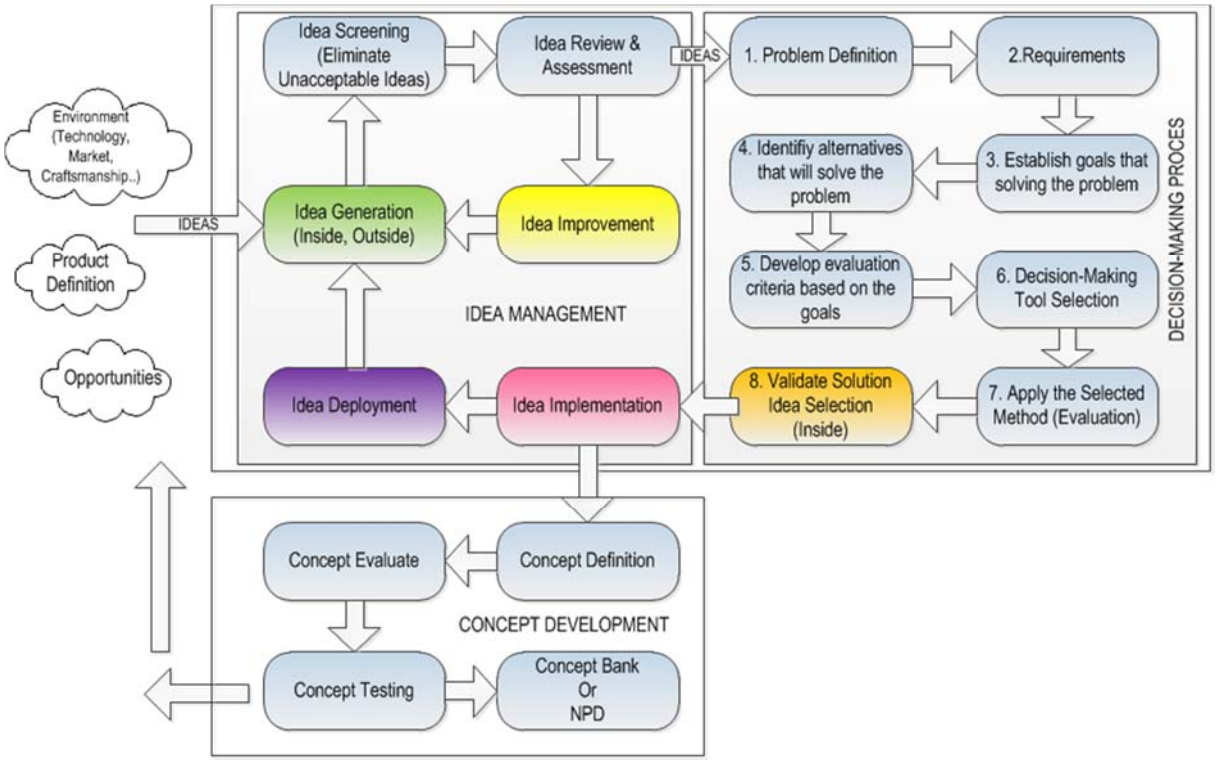

Figure 1. A model of the idea management process, the idea selection process and the process of concept creation

As can be seen, three processes are integrated into a common model: the process of idea management, decision-making process (selection of ideas) and the process of developing a product concept. In this way, complete early phases of product development are covered (fuzzy front end). The idea management model also includes the idea generation process, which is not shown in detail in this model. More on the model of idea generation and idea management can be found in some works, especially in [Glassman 2009].The thing we are concerned with, and what we particularly process, is how to identify from the collected ideas those that have the greatest potential for future products, and how to implement the selection of ideas.

For a start, immediately after the procedure of idea generation and collection, it is necessary to implement the first stage of idea validation (screening) to determine if collected ideas are at all suitable for further consideration, and immediately thereafter, the categorization of ideas, especially those we could not automatically categorize during the creation process. The categorization of ideas is carried out according to defined attributes of categorization which will be discussed in the next chapter. After the categorization of ideas, an iterative process of improvement of ideas is implemented if needed, through communication between the reviewer and the author of the idea. Only after the

reviewer confirms the idea, it is ready to participate equally in the decision-making process and the selection of ideas, thereby becoming an integral part of the concept of the future product.
To select the ideas that will be used in the product development process we use a defined decision support system [Baker et al. 2001]. As the previous figure shows, the method consists of eight steps, and is structured and well organized. In short, the implementation of the decision support system takes place through:

1. **Step 1, Define the Problem** – is the crucial first step in making a good decision. The goal is to express the issue in a clear, one-sentence problem statement that describes both the initial conditions and the desired conditions. In our case the problem is a selection of an idea or set of ideas to meet general or specific needs of a particular product
2. **Step 2, Determine Requirements** – that are conditions that any acceptable solution to the problem must meet. The requirements are the constraints and some ideas can fulfil them or not (it has a value of 0 or 1 if viewed mathematically)
3. **Step 3, Establish Goals** – defining of required properties that the idea should possess to a greater or lesser extent during the realization of the product. This value is usually more easily measurable with fuzzy logic.
4. **Step 4, Identify Alternatives** - defining from a subset of the set of ideas that we have, which we will consider in the selection of ideas
5. **Step 5, Define Criteria** - defining the rules for the implementation of ranking of the values for each of the ideas, in order to have as small deviations in determining the partial value of the idea as possible. Usually no one alternative will be the best for all goals, requiring alternatives to be compared with each one. Each criterion should measure something important, and not depend on another criterion.
6. **Step 6, Select a Decision-Making Tool** for the implementation of selection - select one or more methods from a group of multi-criteria methods and/or other methods. From a large number of methods, we will mention only some which can be applied:
   - Pros and Cons Analysis (PCA)
   - Kepner-Tregoe (KT) Decision Analysis
   - Analytic Hierarchy Process (AHP)
   - Multi-Attribute Utility Theory (MAUT)
   - Simple Multi Attribute Rating Technique (SMART)
   - Cost-Benefit Analysis (CBA)
   - Custom Tailored Tools (CTT)

   Some of this method can be complicated and difficult to apply. The method selection needs to be based on the complexity of the problem and the experience of the team. Generylly, the simpler the method, the better. More complex analisys can be added later if needed.
7. **Step 7, Evaluate Alternatives against Criteria** – Alternative can be evaluated with quantitative methods, qualitative methods, or any combination. Criteria can be weighted and used to rank the alternatives. Both sensitivity and uncertainty analysis can be used to improve the quality of the selection process.
8. **Step 8, Validate Solution(s) against Problem Statement** – After the evaluation process has selected a preferred alternative, the solution should be checked to ensure that it truly solves the problem identified. Compare the original problem statement to the goals and requirements. A final solution should fulfil the desired state, meet requirements and best achieve the goals within the values of the decision makers.

After the selection process of idea/ideas, we approach the definition of the concept of a future product, i.e. after the evaluation and testing of the concept of eventual product development. It is important to note that in the selection of ideas it is not necessary to choose one idea or one set of ideas. Often it may happen that we have two or more competing ideas and it is, at this stage, difficult to decide which would give better future results. In such cases it is reasonable to start with the development of a concept based on all groups of ideas, and only then evaluate with what to proceed into the final implementation.

4. Defining the attributes for describing the collected ideas

In order to carry out the process of validation of collected ideas, it is necessary to define the attributes of the very idea. Defining attributes is often a simple procedure, but in the case of ideas, which are themselves something that normally could not be previously imagined, this is a complex task.

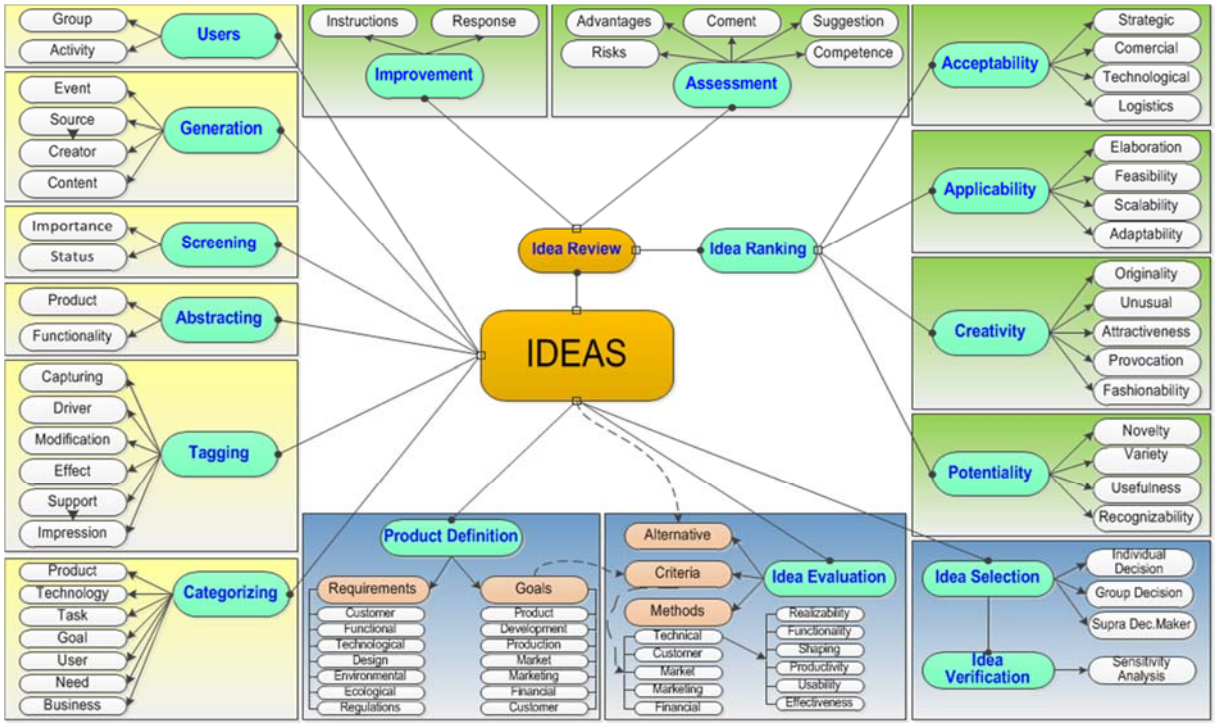

Figure 2. Schema of the concept included in the ACP ontology for idea selection system

This is also evident by the small number of papers in the reviewed literature dealing with these areas, and the results described therein generally only partially deal with the current problem. We therefore attempted to define general attributes for describing of ideas that can be used in various cases of categorization and validation of the evry idea, and even in the process of evaluation of ideas (Figure 2). In determining of attributes for the description, validation and evaluation of ideas, we have decided to first define a glossary of terms that are commonly used for these purposes. After that we started grouping and defining relations. As the figure shows, there are three areas that are functionally distinct:

- **Collection** and **categorization** of ideas (left)
- **Reviewing** and **ranking** of ideas (top and right)
- **Evaluation** and **selection** of ideas (down)

The attributes for **collecting** and **categorizing** of ideas following groups:

- **Generation** of ideas (event, source, creator, content)
- **Screening** of ideas (the importance, status)
- **Abstracting of** ideas (product, functionality)
- **Tagging** of ideas (capturing, driver, modification, effect, support, impression)
- **Categorizing** of ideas (product, technology, task, goal, users, needs, business)

A significant number of attributes are determined automatically during the collection of ideas, while some need to be determined subsequently during screening, reviews, audits and improvement.

The attributes for the **review** and **ranking** of ideas are organized in the following groups:

- **Acceptability** of ideas (A)
- **Applicability** of ideas (A)
- **Creativity** of ideas (C)
- **Potentiality** of ideas (P)

In the area of **acceptability** of ideas the value of the idea is estimated in the context of business determinants including:

- **Strategic** eligibility (whether the realization of the idea fits into the strategic plan of the company)
- **Commercial** eligibility (whether the realization of an idea commercially acceptable)
- **Technological** eligibility (whether the realization of the idea is technologically acceptable in relation to the existing technological capabilities or technological features that may soon be adopted)
- **Logistic** eligibility (whether we have enough resources for the realization of the idea - human, material, etc.)

In the area of **applicability** of ideas the value of each of the ideas is estimated on the basis of:

- **Elaboration** (the development of all features of the idea, detailed descriptions, drawings, ...)
- **Feasibility** (evaluation of the extent to which we are able to realize the idea)
- **Scalability** (assessment of how the idea may be improved and the time it would take to improve)
- **Adaptability** (estimate how many ideas are compatible with other expectations)

In the area of **creativity** of ideas the usable value of each of the ideas is evaluated on the basis of:

- **Originality** (estimate the originality of an idea)
- **Unusual** (assessing the extent to which a particular idea is unexpected)
- **Attractiveness** (estimate the extent to which a certain idea is attractive)
- **Provocation** (assessing the extent to which some idea is provocative)
- **Fashionability** (estimate the extent to which an ideas can influence the creation of trends)

In the area of the **potentiality** of the idea the estimated value of the idea is calculated on the basis of:

- **Novelty** (new things the idea brings in relation to the existing situation and other ideas)
- **Diversity** (diversity in relation to other ideas and existing solutions)
- **Usefulness** (usefulness in the field of needs, expectations, desirability, ...)
- **Recognizability** (the recognizability that the idea brings to the product)

For the determination of the above mentioned attributes, it is desirable for the review procedure to be conducted with a highest possible number of reviewers, using some of the methods for decision support in determining the values of attributes. The main objective of this review is, on one hand, to reduce the need for experts (but not abolish it) in the phase of the ranking of ideas and provide needed improvements to the idea, and on the other, perform the ranking of the idea in order to form values for the subsequent implementation of the evaluation and selection of ideas.

It should be noted that the values of attributes of an exclusive group of acceptability are mutually exclusive, ie an idea that has some of the attributes of acceptability marked as unacceptable is absolutely unacceptable.

This above mentioned procedure of ranking (we have called an **ACP** procedure), according to the initial letters of attribute groups.The attributes for selection of ideas for product development can be decomposed to the following subgroups:

- **Technical** - examines the technical aspects of the idea on the potential product, primarily of: realizability, functionality, design, productivity, usability, efficiency, safety, reliability and environmental attributes (esthetics, ecology and recyclability).
- **Customers** - considers the relationship between users and products in terms of usefulness and usability, but also in terms of importance, superiority, affordability, profitability, trends).
- **Marketability** - which examines the possibility of acceptance in the market for products such as size, growth, competition
- **Marketing** - which considers marketing potentials to support the product, such as strategies, resources, distribution and service channels,...
- **Financial** - to analyze the financial effects of products such as the time it takes for the return of the investment

5. Idea evaluation and selection

Process of the selection of ideas for product development is based on multiple evaluation criteria for the selection of ideas. The procedure is divided into two parts: the first part estimates the **basic value** of the collected ideas: Acceptability, Applicability, Creativity and Potentiality. The second part implements the **evaluation and selection** attributes of ideas according to the criteria of a product being developed.

The estimates of the values of the ideas are primarily used to rank the ideas as a starting point for the subsequent process of evaluation and selection of ideas. It is important to emphasize that the criteria for the evaluation of the idea is not dependent, in principle, on any specific product, but on the content of the idea and on the features and capabilities of the company. The process of ranking of the ideas according to these indicators (**ACP** ranking) is implemented using the Analytic Hierarchy Process (AHP) method with the MakeITRational program. In this procedure, we ranked the collected ideas according to the utility for the listed criteria.In order to better assess the relationships of individual attribute values, as part of the research titled "Development of products based on ideas", which we conducted at the end of 2011. in 123 manufacturing companies in Croatia, we asked questions of mutual evaluation of mentioned attributes (value of the score in the range 1-5).

Table 1. Results of research into the mutual evaluation criteria

Acceptability	Value	Normalized
Strategic	4,0	0,255
Comercial	4,0	0,255
Technological	3,8	0,242
Logistic	3,9	0,248

Applicability	Value	Normalized
Elaboration	3,7	0,236
Feasibility	4,3	0,274
Scalability	3,8	0,242
Adaptability	4,0	0,255

Creativity	Value	Normalized
Originality	3,9	0,248
Unusual	3,2	0,204
Attraciveness	3,6	0,229
Provocation	2,6	0,166
Trendy	2,7	0,172

Potentiality	Value	Normalized
Novelty	4,1	0,261
Variety	3,7	0,236
Usefulness	3,9	0,248
Recognisability	3,5	0,223

	Value	Normalized
Acceptability	3,8	0,242
Applicability	4,4	0,280
Creativity	3,5	0,223
Potentiality	3,3	0,210

The afore mentioned values were used as the orientation for the comparison of criteria for idea ranking. The following figure (Figure 3) shows ranked usefulness of the five sets of ideas using these criteria and the AHP method, criteria weights for ranking ideas (Figure 4) and sensitivity analysis (Figure 5). In the ranking process the eligibility criteria was deliberately omitted given that it is exclusive, and that after the assessment it can only have a value of 0 or 1.

After the ranking of the idea, according to the product's needs and requirements for ideas, we approach the selection of ideas for product development. For the implementation of the evaluation we use the methodology for the decision support system (Figure 1) and the methodology for the valuation of ideas according to the criteria defined for a specific product.

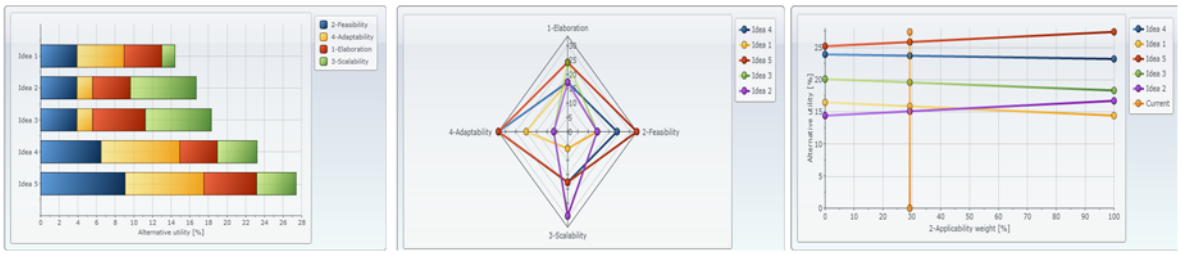

Figure 3. Ideas ranking usefulness of the five sets of ideas by the AHP method

Figure 4. Subcriteria weights for ranking

Figure 5. Sensitivity analysis

In the general model the evaluation is conducted for a group of technical criteria that is relevant to the product development process and criteria relevant for the commercial success of the product as the ultimate goal of process innovation. The technical group of criteria includes:

- **Technical-Development** criteria (V_{TD}) – Functionality (V_{TDF}), Realizability (V_{TDR}), Design (V_{TDD}), Productivity (V_{TDP}), Usability (V_{TDU}), Efficiency (V_{TDE})
- **Technical-Standards** (V_{TS}) – Safety (V_{TSS}), Reliability (V_{TSR})
- **Technical-Environment** criteria (V_{TE}) – Esthetics(V_{TEES}), Ecology(V_{TEEC}), Recyclability(V_{TER})

Criteria relevant to the commercial success of the product are:

- **Customer** criteria (V_{CC})
- **Market** criteria (V_{MC})
- **Marketing** criteria (V_{RC})
- **Financial** criteria (V_{FC})

The methodology provides the evaluation of four values for each of the technical criteria from the first group (V_{TD}) :

- The **usability** of the ideas in relation to the criterion (V_{U})
- The **cost** of implementation of the idea in relation to the criterion (V_C)
- The **time** of the implementation of the idea in relation to the criterion (V_T)
- The **risk** of implementing the idea in relation to the criterion (V_R)

The following figure (Figure 6) shows the scheme of the assessment of the technical value of the idea for product development in its full form.

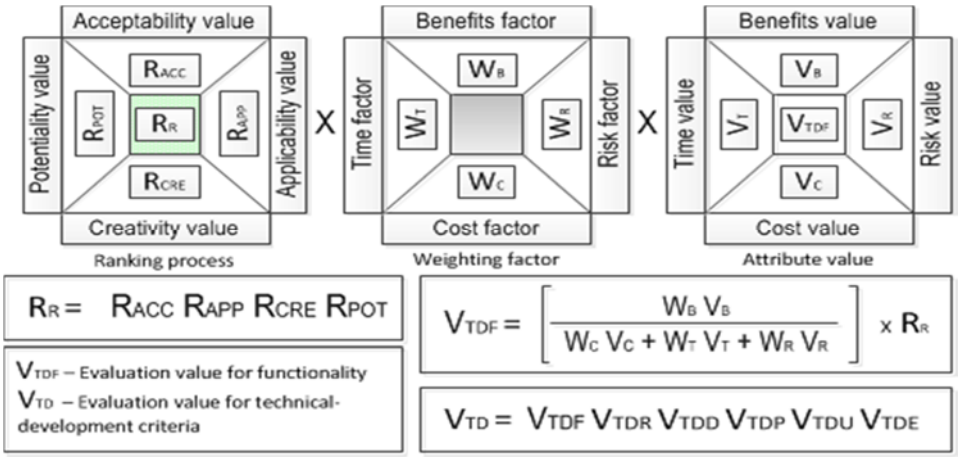

Figure 6. An example of assessment in the evaluation process

While the technical criteria of the other two groups (V_{TS} and V_{TE}) are valued just as satisfied or unsatisfied (1/0). The criteria relevant to the commercial success of products are not considered at this stage of the implemented research.

It is important to note that only a few ideas have all the grades. In many cases the idea has only one score: functionality, realizability, shape, productivity, usability, efficiency. After the evaluation of the entire set of ideas selected as eligible for the development of a product, a set of ideas from which to approach the concept of product development is chosen. It is important to note that the process of evaluation of ideas does not have to be implemented in this way, it can be carried out with any other multi-criterion decision method.

6. Conclusion

The paper shows the importance of ideas to develop and market successful products in significantly shortened development cycles. Starting from the assumption based on existing research that indicates the importance of a higher degree of compliance in the early stages of product development, in order to shorten and simplify the development process, the importance of choices and ideas for product

development is illustrated. The above showed the model of decision support system (DSS) in the case of selection of ideas. All steps are explained in the decision support system, from defining the problem to the validation of the proposal. Particular attention was paid to defining the attributes for the identification and validation of ideas. As part of this, we proposed a taxonomy of ideas for product development. In addition, we presented a model to define the criteria and briefly pointed to the implementation of the selection of ideas. The proposed model of decision support system can be relatively easy to implement, which would allow for a process that is still in the stage of product development and is not considered systematically enough to be of significantly higher quality and to increase the competitiveness of the products.

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MSc Milan Stevanović, dipl.ing.
Markot.tel, Trg K.Cosica 11, Zagreb, Croatia
Telephone: +38513035913
Email: MStevanovic@fsb.hr