

THE IMPACT OF MANAGEMENT ON CREATIVITY AND KNOWLEDGE TRANSFER IN AN ACADEMIC VIRTUAL ENTERPRISE

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Preliminary notes

In a competitive knowledge-based environment the role of creativity in new product development (NPD) has increased. The university as the provider of scientific and technological knowledge has become a key player in NPD, as a supplier of knowledge and human capital and as the physical space for new enterprises. The boundaries between science and technology, university and industry are in flux. This article therefore examines the environmental, strategic and organizational factors influencing innovation in NPD process on an example of an Academic Virtual Enterprise (AVE) that was applied in a design course called European Global Product Realization. AVE represents a creative working environment for students, where they act as real professionals in solving a real-life design problem.

Keywords: *Academic Virtual Enterprise, creativity, innovation, Knowledge-based economy, NPD process*

Utjecaj upravljanja na kreativnost i transfer znanja u akademskom virtualnom poduzeću

Prethodno priopćenje

U konkurentnom okruženju utemeljenom na znanju povećana je uloga kreativnosti u razvoju novog proizvoda (RNP). Sveučilište kao pružatelj znanstvenog i tehnološkog znanja postalo je ključni igrač u RNP, kao dobavljač znanja i ljudskog kapitala i kao fizički prostor za nova poduzeća. Granice između znanosti i tehnologije, sveučilišta i industrije su fluidne. Ovaj članak istražuje stoga okolišne, strateške i organizacijske faktore koji utječu na inovacije u RNP procesu na primjeru akademskog virtualnog poduzeća (VP) koje je primijenjeno u oblikovanju kolegija Realizacija europskog globalnog proizvoda. VP predstavlja kreativnu radnu okolinu za studente, gdje oni djeluju kao pravi profesionalci u rješavanju stvarnog problema oblikovanja (konstruiranja).

Ključne riječi: *akademsko virtualno poduzeće, kreativnost, inovativnost, gospodarstvo zasnovano na znanju, RNP proces*

1 Introduction Uvod

To succeed in the market it is necessary for the companies to fully research customer needs and generate solutions which can best satisfy them. Creativity plays a crucial role in this process. If it is correctly implemented into the innovation process, it can mean a decisive competitive advantage for the company. It is connected to the idea generation phase within the overall NPD process. Innovation is the implementation of the results of creativity [1].

A NPD can be defined as an innovative process whereby the inputs into the process are creative ideas and the final result is a definition of the final product. The chain of four loops is introduced, representing a possibility of iteration in any phase of NPD [2]. The first loop guides the developer from abstraction to goal definition. The result of the first loop in NPD, where idea generation plays the primary role, is a research goal or task that needs to be further specified in the process. Further three loops guide the developer through the planning process from the definition of the design process through the specification of the design requirements, evaluation of design requirements, iteration between function and shape, presentation and expert assessment and finally to the use of particular results after each step of design process. We chose this model to represent the NPD process due to the fact that it recognizes several important factors of the NPD that were presented in other models (i.e. VDI 2222) and also introduces the importance of idea generation and the formation of a research goal which are both highly influenced by creativity.

In a highly competitive global environment a company needs to use external sources of knowledge and technology

to define its research goals effectively.

Companies increasingly consider universities, as well as other companies and government laboratories, to be a potential source of useful knowledge and technology. Industries, which have materials and know-how close to the chain of production, may still require the input of university experts to help them solve certain problems beyond their capacities. The networks of academic and industrial researchers are a fundamental instrument of collaboration between the institutions of university and industry and seem to be effective in enhancing productivity in terms of discoveries and inventions. They are also the crucial relations within a knowledge-based economy.

The key question raised in this paper is how creativity is enhanced within knowledge-based economy and how it influences the definition of the research goal in the first phases of the NPD process. Which factors in the activities of a company influence the process of creativity and idea generation in the first loop of the NPD process?

A review of the literature in this field reveals that the main concern of most authors has been the influence of organizational culture on creativity and consequently on innovation. Little, however, has been written on the way management influences creativity in the NPD process on any level – macro or micro. Our contribution is therefore based on illuminating the topic of idea generation in the first loop of the NPD process from the strategic management point of view.

2 Strategic management factors affecting creativity Strateški čimbenici upravljanja koji utječu na kreativnost

A company is a social system composed of interdependent subsystems [3]. Coordination within these subsystems is accomplished through management policies

which interact with the environment to help to achieve a set of goals or objectives. In the field of strategic management we have identified three levels of influence, which in their coexistence and co-dependency affect research goal definition: the environment, the strategy and the organizational structure (Fig. 1).

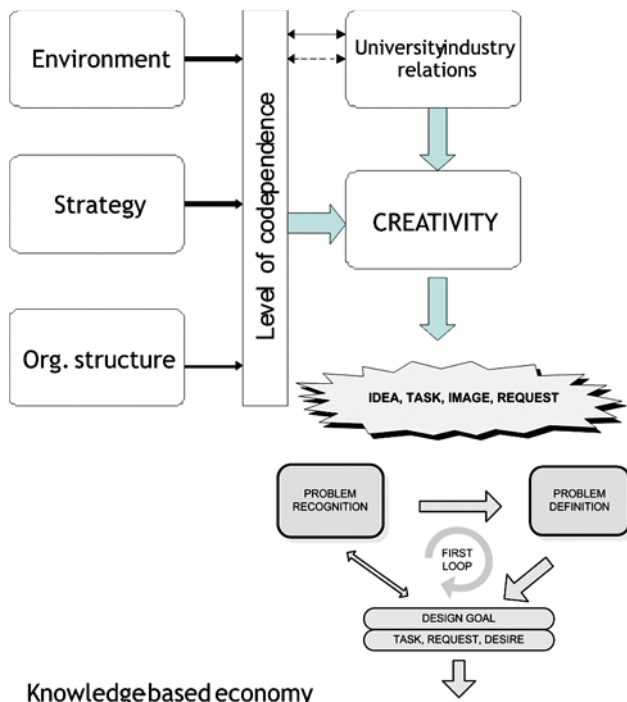


Figure 1 Theoretical framework for studying the factors affecting creativity in the first loop of NPD process within a knowledge-based economy

Slika 1. Teorijski okvir za proučavanje čimbenika koji utječu na kreativnost prvoj petlji procesa RNP unutar na znanju utemeljenog gospodarstva

2.1

Influence of the external environment on creativity

Utjecaj vanjskog okruženja na kreativnost

The survival of a company heavily depends on its capability of satisfying customer needs and overcoming the pressures of competitors [4]. For that reason we define the influences of the external environment on creativity based firstly on customer and competitor orientation. They are most commonly structured in relation to dynamics, complexity and available resources in the specified environment.

A dynamic environment is unpredictable and forces companies to constantly adapt to new customer needs, deal with the competitors' activities and recognize and adapt to new manufacturing and service technologies. Therefore, innovation and market differentiation are more important in dynamic environments [5], and consequently a greater level of creativity is essential.

The company can enter and exit several environments, but when it has entered one, the environment sets the conditions under which the company can act effectively.

These conditions set social, economic, technological and legal dimensions within which the company must work [6]. Future trends must not be neglected either.

2.2

Strategy and creativity in a company

Strategija i kreativnost u poduzeću

Over time, successful companies develop a systematic approach to adapting to the environment. At the same time, strategies also integrate the company internally, as they define the systematic adaptation of the company to all influences [7]. Miles and Snow [8] have defined three different strategy types which differ mainly in strategic choices made in the product continuum of the market:

Prospectors act proactively and constantly search for new market opportunities and possibilities for new product development [9]. Most often they experiment with reactions to current market trends and compete aggressively by innovating [7].

The defenders' focus is on maintaining a safe position in existing markets, and opportunity searching is not a part of their strategy [9]. They look for competitive advantages in quality improvements and lower prices of products investing little in innovation [7].

Analyzers are a combination of both previously defined strategies. In their activities they search for a balance between assuring their position in existing markets and searching for their share in new markets. Their competitive advantage is based on differentiation and operational performance [7].

2.3

Organizational structure and creative cooperation

Organizacijska struktura i kreativna suradnja

The company adopts internal structures that best satisfy the unique demands of the company in the market. These structures are created to assure the coordination within the company, so it can best follow its planned strategy. They can be distinguished by means of centralization, formalization and specialization [3], [7], but successful integration of all three levels is needed to assure a company's success:

Centralization refers to the level of authority single business units have within a company. In centralized structures the communication paths and decision-making processes are well defined, which leaves little or no possibility for deviation. A decentralized organization will be more productive in non-routine tasks in complex environments, because the employees have a higher level of decision-making authority. This leads to faster implementation of goals and consequently gives the company a greater possibility of gaining competitive advantages through creativity. The need for decentralization is mostly reinforced by complex environments and changes in NPD processes [5].

Formalization is the degree to which formal rules and procedures define decisions and working relationships within a company [7]. The rules and procedures define acceptable behavior in specific situations and enable people to structure their work into routine operations, thus leading to better performance and reduction of costs; however, they limit the creativity and flexibility of the company. On the contrary, if the informal cooperation of units within the company is efficient and well established, it can lead to a higher level of idea generation and creativity.

Specialization refers to the degree to which tasks, activities and authorities are divided among employees in a company [3]. In NPD, the cooperation of specialists from

different units within a company is essential [5]. Specialization in the company can effect creativity in either of two ways. If the level of specialization is too high, it can inhibit the specialist in the process of lateral thinking outside a given area, but on the other hand it gives a better guideline in finding and analyzing customer needs and competitor activities.

3

Academic Virtual Enterprise and EGPR

Akademsko virtualno poduzeće i realizacija europskog globalnog proizvoda

Universities take a key role in providing companies with broader view of knowledge and they also go one step further as they ensure the human capital needed for more creative innovation processes. Etzkowitz claims [10] that the key elements of an emerging entrepreneurial university include: (1) the organization of group research; (2) the creation of a research base with commercial potential; (3) the development of organizational mechanisms to move research out of the university as protected intellectual property; (4) the capacity to organize companies within university; and (5) the integration of academic and business elements into new formats such as university-industry research centers. All proposed formations help enhance creativity within NPD as entrepreneurial universities have an active role in implementing innovation policies and commercializing research findings [11].

To involve students into this process and to establish a stimulating learning and working environment the concept of an academic virtual enterprise (AVE) has been invented [12]. It is a project oriented educational agreement, which is based on alliance of industrial and academic partners for mutual advantages. The industrial partner provides a problem to be solved by the international teams of students. They communicate through a video-conferencing system and other internet communication channels. The AVE connects academic and practical knowledge by solving a real-life NPD problem. Its main characteristic is the formation of virtual teams of students that only know each other through the video-conferencing meetings. All the communication and work in such an enterprise is done with the help of internet technologies, as the participants are located in different parts of the world.

The result of cooperation between several European Universities (In the year 2009: University of Zagreb, Ecole Polytechnique Federale de Lausanne, University of Ljubljana, City University London, Technological University Budapest and Delft University of Technology) is an international AVE called European Global Product Realization (EGPR) design course with a different industrial partner involved each year. The industrial partners define product specifications for the products to be developed and provide the information about the existing models in the comparable families of products.

The goal of EGPR courses is to enable students to develop capabilities that are needed to solve complex real-life NPD problems, to generate product ideas and forward them to the status of a working product prototype and to manage their knowledge inquiry and skill development for their future work as professional designers [12]. Through the EGPR course the students work in multicultural, multinational and multidisciplinary teams. Knowledge is built and exchanged by communication and collaboration of

the various participants (students, company experts, instructors, lecturers, researchers, industrial partners, end users) via various forms of interaction and inquiry [12]. EGPR course comprises several steps, such as market analysis, financial issues, product specifications, vision formation, concept generation, concept solution, materialization, prototyping and testing [13]. Teams are formed in such a manner that each team consists of several students from each of the participating universities. Therefore the profiles of students in a team are very different. On the one hand, this has the advantage of providing complementary knowledge and expertise that are needed for the development of a global product and on the other hand it poses the problem of handling the discrepancies not only in skills and expertise but also in view points about the same [13].

From the industry point of view, EGPR provides novel approaches to NPD as students that are at the beginning of their design careers have different approaches to solving the design problem specified. The student teams are also multidisciplinary, multinational and multicultural, which means that the spectrum of knowledge and creativity is much more global than if students all came from similar background. Such teams can work in a more dynamic environment, as they can recognize more changes and trends in customer needs. They can further handle the complexity of the environment easier, because their (multinational, multicultural and multidisciplinary) structure enables more cooperation between different institutional spheres.

4

Creativity and EGPR

Kreativnost i realizacija europskog globalnog proizvoda

As seen in previous sections the creativity is stimulated when individuals and teams have relatively high autonomy in their day-to-day conduct and a sense of ownership and control over their own work and ideas. It is best achieved in open climates where individual steps are taken to realize: (1) interaction with small barriers, (2) a large number of stimuli, (3) freedom to experiment and (4) the possibility of building on earlier ideas [14]. All these conditions are satisfied within the EGPR course.

As it is concluded from literature studies, creativity is enhanced by dynamic, complex environments where competition is high. The design problems of the EGPR course target such environments and are carefully chosen by the instructors and lecturers through several meetings and discussions with different companies. The one chosen design problem usually targets a niche market or is a radical innovation for itself, where markets still need to be created. Students are encouraged to research the customer needs from all environmental dimensions (economic, social, legal and technological). Their in-depth market research before the start of NPD gives an insight into environmental factors affecting the innovation process and can guide their creativity in the process of idea generation.

The other advantage of this course is that the students can engage in more risky activities than the present industries, because of their supporting learning and developmental objectives. Students can so adopt the prospector strategy. They can create change with fresh, creative knowledge and ideas as they are not limited by several organizational factors that hinder such idea generation within a company. Their only limitations are the

time frame of the course, the resources given by the participating universities and industry and the relations within the team. The authority and decision making in the team is up to the students, they are solely guided by their instructors. They are regarded as equals, although they come from different educational fields.

EGPR has managed to integrate all the levels of the strategic management that affect creativity and idea generation within NPD with building multidisciplinary, multinational and multicultural teams of students that work on a NPD project with a company, whereby the strategic management levels are closely studied and integrated into the work of the university as well. We can summarize, that the EGPR course takes all of the (strategic management) factors that influence creativity in the innovation process into account (Fig. 2).

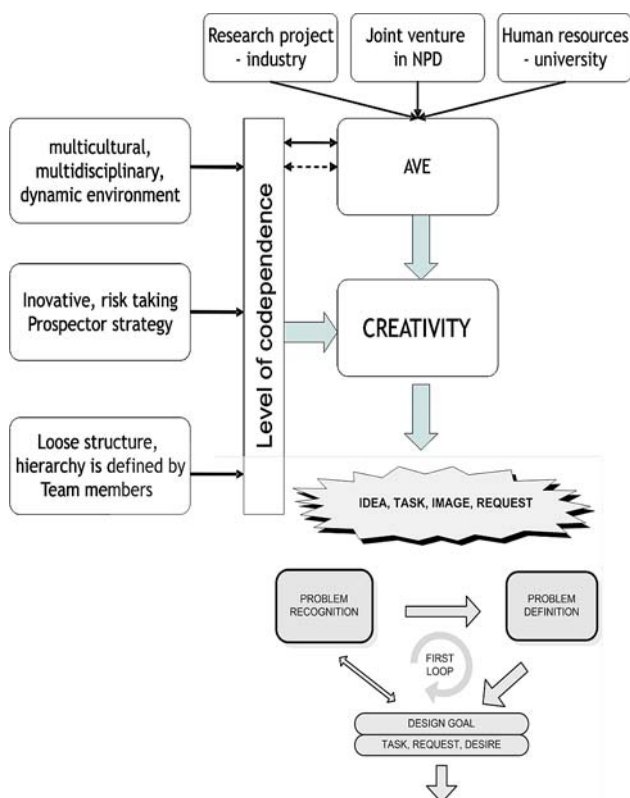


Figure 2 Creativity in EGPR

Slika 2. Kreativnost u realizaciji europskog globalnog proizvoda

The environmental perspective was the most visible level of conduct, especially in the first stages of the course, as the students gathered information and knowledge from the markets and communities of their home countries. Combined knowledge gave as a result a global product that the company can actually introduce to the market. Addressing social issues by creating shared value led to self-sustaining solutions which do not depend on private or governmental subsidies, but are user (and society) friendly, creative and so have the desired competitive advantage.

5 Conclusions

Zaključak

The main issue addressed in this paper is the problem of assuring creativity in the first loop of the NPD process. Analyzing the literature in the field has shown that the

problem is multidimensional. First, we addressed the strategic management point of view, whereby we considered three levels of conduct. We found that the codependence of the three levels significantly affects the creative process and idea generation in a company and have shown how it can actively be put to action in our presented case study. However, although we have defined a certain degree of interconnection of all three levels of strategic management factors further research and empirical confirmation is still needed.

Next, we addressed the need for integration of institutions within the knowledge-based economy for assuring a successful NPD. We showed the benefits of such integration on an example of an Academic Virtual Enterprise and the EGPR course. The research, included in the EGPR course, implemented through several European universities has proven to be beneficial to the graduate students, the institution itself and it also contributes to creativity in industrial innovation.

Combining knowledge, technology, personal characteristics and the social good in processes of innovation can lead to successful, creative and consequently profitable NPD, as it was demonstrated by the case of EGPR. When an industry applies its resources, expertise and management to problems that it understands and in which it has a stake, and gets the cooperation of universities that provide suitable knowledge and expertise (whereby creativity is addressed from the student point of view) it can have a greater impact on NPD and company success.

6 References

Literatura

- [1] McAdam, R.; McClelland, J. Individual and team-based idea generation within innovation management: organizational and research agendas, *European Journal of Innovation Management*, 5, 2(2002), pp 86-97.
- [2] Duhovnik, J.; Balić, S. Detail Functionality Analysis Using Design Golden Loop, in 4th International Seminar and Workshop, EDIProD' 2004.
- [3] Olson, E. M.; Slater, S. F.; Hult, T. M. The Performance Implication of Fit among Business Strategy, Marketing Organization Structure, and Strategic Behaviour, *Journal of Marketing*, 69, July (2005), 49-65.
- [4] Fuentes-Fuentes, M. M.; Albacete-Saez, C. A.; Llorens-Montes, F. J. The Impact of Environmental Characteristics on TQM Principles and Organizational Performance, *Omega - The International Journal of Management Science*, 32, 6(2004), 425-442.
- [5] Miller, D. Relating Porter's Business Strategies to Environment and Structure: Analysis and Performance Implications, *Academy of Management Journal*, 31, 2(1988), 280-308.
- [6] Child, J. Strategic Choice in the Analysis of Action, Structure, Organizations and Environment: Retrospect and Prospect, *Organization Studies*, 18, 1(1997), 43-76.
- [7] Vorhies, D.W.; Morgan, N. A. A. Configuration Theory Assessment of Marketing Organization Fit with Business Strategy and Its Relationship with Marketing Performance, *Journal of Marketing*, 67, January (2003), 100-115.
- [8] Miles, R. E.; Snow, C. C. *Organizational Strategy, Structure and Process*, New York, McGraw-Hill, 1978.
- [9] Aragon-Sanchez, A.; Sanchez-Marin, G. Strategic Orientation, Management Characteristics, and Performance: A Study of Spanish SMEs, *Journal of Small Business Management*, 43, 3(2005), 287-308.

- [10] Etzkowitz, H. The European entrepreneurial university, Industry and higher Education, 17, 5(2003), 325-335.
- [11] Crespo, M.; Dridi, H. Intensification of university-industry relationships and its impact on academic research, Higher Education, 54, 1(2007), 61-84.
- [12] Horvath, I. Design competence Development in an Academic Virtual Enterprise, in Proceedings of IDETC/CIE 2006, Philadelphia, Pennsylvania, USA.
- [13] Bufardi, A.; Xirouchakis, P.; Duhovnik, J.; Horvath, I. Collaborative Design Aspects in the European Global Product Realization, International Journal of Engineering Education, 21, 5(2005), 950-963.
- [14] Andriopoulos, C. Determinants of organizational creativity: a literature review, Management Decision, 39, 10(2001), 834-840.

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