INTERNATIONAL JOURNAL FOR SCIENCE
AND INNOVATIONS FOR THE INDUSTRY

INNOVATIONS IN DISCRETE PRODUCTIONS

YEAR III, ISSUE 1/2015, SOFIA
ISSN 1314-8907

Publishers:

SCIENTIFIC TECHNICAL UNION OF MECHANICAL ENGINEERING

NATIONAL SCIENTIFIC TECHNICAL SOCIETY
AUTOMATION IN DISCRETE PRODUCTIONS

INTERNATIONAL JOURNAL FOR SCIENCE AND INNOVATIONS FOR THE INDUSTRY

INNOVATIONS IN DISCRETE PRODUCTIONS

YEAR III, ISSUE 2 / 2015
ISSN 1314-8907

EDITORIAL BOARD

Publishers:

SCIENTIFIC TECHNICAL UNION OF MECHANICAL ENGINEERING

NATIONAL SCIENTIFIC TECHNICAL SOCIETY AUTOMATION IN DISCRETE PRODUCTIONS

108, Rakovski Str., 1000 Sofia, Bulgaria, **tel.** (+359 2) 987 72 90, **tel./fax** (+359 2) 986 22 40**,** journal@mech-ing.com,

CONTENTS

THE APPLIANCE OF OPEN INNOVATION CONCEPT IN SMEs IN REPUBLIC OF MACEDONIA

Asst. Prof. Janevski Z. PhD.[1], Asst. Prof. Davitkovska E. PhD.[1], Res. Asst. Petkovski V. PhD.[1],
Institute of Economics - Skopje, "Ss. Cyril and Methodius" University in Skopje, Republic of Macedonia [1]
E-mail: zoran.janevski@ek-inst.ukim.edu.mk, elena@ek-inst.ukim.edu.mk, vladimir@ek-inst.ukim.edu.mk

Abstract: *The open innovation is a concept of growing acceptance in the field of innovation management. It is based on the idea that companies can leverage the knowledge generated externally to improve their innovation performance. Open innovation as a process can promote shorter innovation cycles, increase in industrial research, and better optimization of the resources. However the process of open integration is much harder for implementations in SMEs than larger enterprises. The reasons behind the low integration of the open innovation as a process can be seen in the low capacity of the SMEs to deal with the open innovation process, low awareness of the benefits of the open innovation process, lack of knowledge for the intellectual law and rights, etc. This paper is based on the empirical research on 63 SMEs, in order to determine the factors (reasons) for low implementation of the open innovation process in the SMEs in Republic of Macedonia.*

Keywords: OPEN INNOVATION, SME, SMALL AND MEDIUM-SIZED ENTERPRISES, INNOVATION ABSORPTION, INNOVATION PROCESS

1. Introduction

The open innovation is a concept of growing acceptance in the field of innovation management. It is based on the idea that companies can leverage the knowledge generated externally to improve their innovation performance. Open innovation is based on the traditional innovation process which represents a crucial aspect of promoting the growth and development of SMEs. But the process of innovation is usually foreseen as a great financial burden for the SMEs, and inquiring finance for the relatively long and enduring process of research and innovation can present a devastating process for the SMEs [1]. Therefore, new ways of innovation must be looked for, in which open innovation represents a viable alternative for companies. Open innovation as a process can promote shorter innovation cycles, increase in industrial research, increased innovation and better optimization of the resources [2]. Open innovation is defined as "the purposive use of inflows and outflows of knowledge to, respectively, accelerate internal innovation, and expand the markets for external use of innovation process" [3]. Open innovation can be a part of any of the four different types of innovation including the innovation in process of production, innovations in business model, innovations in product and innovation in organization. All of these types of innovations can be made easer through the concept of open innovation, by creating a mutual trust between the SMEs and their innovation partners.

The SMEs sector is very important for Macedonian economy. According to the data of the State Statistical Office [4], the number of active business entities in the Republic of Macedonia in 2014 was 70,659 and SMEs represent 99.7 percent of them. They engaged about 76.7 percent of total number of employees and created 65.6 percent of the value added [5].

According to the Innovation Union Scoreboard 2014 [6] Republic of Macedonia is a modest innovator ranking 31st out of 35 countries with Summary Innovation Index of 0.2458 much below 0.5539 which is the EU average. Situation with SME's innovation are even worst. Macedonia is ranked 31st based on SMEs innovating in-house indicator (0.0155), and 19th regarding Innovative SMEs collaborating with others indicator (0.3590) which gives some perception on open innovation adoption by the SMEs in Republic of Macedonia. Regarding innovation outputs, SMEs introducing products or process innovations indicator is 0.5938 (ranked 15th) and SMEs introducing marketing/organizational innovations indicator is 0.3615 (ranked 24th). So, the open innovation is still a relatively new process in Republic of Macedonia with only small portion of enterprises actually practicing it [7]. The reasons behind the low commitment to the innovation in general can be seen in the lack of innovation network, lack of funding and venture capitalist and very small percentage of GDP devoted to research and development [7]. The low capacity of absorption and the technical problems which SMEs face considering the implementation of new research and developments techniques puts the SMEs into an utmost difficult position on the bargaining side of the process that is open innovation. Despite the larger enterprises witch can reserve a lot more assets into the research and development program SMEs rely on having their idea and innovation process increase their chances of market success. But, the lack of information and data concerning the process of open innovation is one of the possible reasons for low level of awareness for the process of open innovation amongst the Macedonian SMEs. [7]. Also, the lack of networking structure at national and regional level on tackling Open Innovation issues can be foreseen as one of the crucial problems for implementation of open innovation process especially among SMEs.

This paper concerns awareness and constraints for adoption open innovation strategies in SMEs in Republic of Macedonia. The constrains have been categorized and reviewed concerning four open innovation aspects: human constrains, general constrains, policy constrains, and constrains that have evolved due to the rise of global competition [8].

2. Theoretical Review

Open innovation is a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with each organization's business model [9]. This means knowledge inflows to the focal organization (leveraging external knowledge sources through internal processes), knowledge outflows from a focal organization (leveraging internal knowledge through external commercialization processes) or both (coupling external knowledge sources and commercialization activities) [9]. The traditional (closed) innovation system has some serious shortcomings and there is an urgent need of establishing a contemporary innovation system – an open innovation system. The contrasting principles of closed and open innovation are presented on Table 1.

Table 1: *Comparison between Closed and Open Innovation Principles.*

Closed Innovation principles	Open Innovation principles
The smart people in the field work for us.	Not all the smart people in the field work for us. We need to work with smart people inside and outside the company.
To profit from R&D and Innovation, we must discover it, develop it, and ship it ourselves.	External R&D and Innovation can create significant value: internal R&D and Innovation is needed to claim some portion of that value.
If we discover it ourselves, we will get it to the market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	Building a better business model is better than getting to the market first.
If we create the most and the best ideas in the industry,	If we make the best use of internal and external ideas, we will win.

We should control our IP, so that our competitors don't profit from our ideas	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our business model.

There are two important kinds of open innovation: outside-in and inside-out. The outside-in part of open innovation involves opening up a company's innovation processes to many kinds of external inputs and contributions. Inside-out open innovation requires organizations to allow unused and underutilized ideas to go outside the organization for others to use in their businesses and business models [10]. In contrast to the outside-in branch, this portion of the model is less explored and hence less well understood, both in academic research and also in industry practice. In order to further improve the scientific capabilities and commercialize the research output from projects such as the LHC, new businesses and business models must be identified, explored, and undertaken [10].

In addition to being beneficial for large "firms as well as for small and medium-sized enterprises (SMEs) [3], SMEs can open their own innovation processes to implement internal ideas otherwise unexplored, to ensure access to external ideas, to enable better utilization of their partially hidden innovation potential, to share the wealth and efficiency in resource allocation (e.g. per unit cost accounting basis), to extend their potential for growth via alliances and or attraction of funding, to be offered ample opportunities by larger companies to access resources/knowledge otherwise far too expensive for them [11].

3. Empirical Research

The research aims to acquire knowledge about open innovation adoption by SMEs in Republic of Macedonia. The focus is to identify SMEs characteristics especially related to their innovation activities in general, and in open innovation process in particular. The main goal is to identify Macedonian open innovation trends and practices and identify constraints for open innovation adoption. Several specific objectives of this research are:

- To assess the level of open innovation awareness amongst Macedonian SMEs
- To assess the open innovation adoption by SMEs
- To identify the key actors involved in open innovation process in Macedonia
- To recommend measures to improve open innovation adoption rate by SMEs

The survey was conducted using a questionnaire as a research tool for data collection. The questionnaire was developed and placed online using the Google Drive, and emails with a request to fill in the questionnaire were sent to 63 SMEs. Responses were received from 36 respondents, representing 57 percent response rate which is much higher than the average response rate of 35.7 percent for studies that utilized data collected from organizations [12]. Still, the margin of error for this sample size is 16.7 percent, so the survey results are not representative, but only indicative and will use as a pilot for tuning the final design of full research that will be carried out in the next phase.

Respondent sample is consisted of 21 micro, 14 small and 1 medium enterprises. Almost one fifth of all enterprises (19.4 percent) do not have innovation budget at all, and 44.4 percent spent only 0-1 percent from their income on innovation activities (Table 2).

Table 2: *Percentage of income spent on innovation activities.*

Percentage of income spend on innovation [%]	Percentage of enterprises [%]
0	19.4
0-1	44.4
1-2	8.3
2-4	25.0
4-6	0.0
6-10	0.0
10-15	0.0
15+	2.8
Grand Total	100.0

SMEs in Macedonia do not pay much attention on innovation activities. The results also show that 72.3 percent of all enterprises do not have employees dedicated to any innovation activities (16.7%) or only 0-3 percent of the employees are part of some innovation activities in the company (55.6%) (Table 3).

Table 3: *Employees dedicated to innovation activities.*

Percentage of employees dedicated to innovation from all employees [%]	Percentage of enterprises [%]
0	16.7
0-3	55.6
3-6	11.1
6-10	2.8
10-15	0.0
15-20	8.3
20-30	0.0
30+	5.6
Grand Total	100.0

83.3 percent of all SMEs have not heard about the concept of Open Innovation, and 94.4 percent have no knowledge about Open Innovation concept at all. Despite the low awareness amongst Macedonian SMEs, 54.5 percent of all SMEs have cooperated with other companies or organizations in any of their innovation activities, so the SME are not aware of, but still they use the Open Innovation concept.

Table 4: *Main Innovation Partners of Macedonian SMEs.*

Type of Innovation Partner	Mean	n
Suppliers of equipment, materials, components or software	7.5	21
Clients or customers from the private sector		9
Government, public or private research institutes		8
Universities or other higher education institutes		7
Clients or customers from the public sector		5
Competitors or other enterprises in the sector		5
Consultants or commercial labs institutes		0

Table 4 illustrates the type of innovation partners of the SMEs. According to the results the most common partners into their innovation activities are their suppliers (38.2 percent) and clients from the private sector (16.4 percent). The most unlikely partners of the SMEs in innovation activities are the clients from the public sector, competitors and consultants or commercial labs.

Table 5: *Open Innovation Concept Applicable per Type of Innovation.*

Open Innovation Concept Used or Intended to be Used per Type of Innovation		n	Response rate [%]
Product Innovation	Yes	28	84.8
	No	5	15.2
Process Innovation	Yes	15	83.3
	No	3	16.7
Business Model Innovation	Yes	21	80.8
	No	5	19.2
Organization Innovation	Yes	20	18.7
	No	3	13.0

Table 5 shows the percentage of SMEs that intent to use or are already using the concept of Open Innovation for different type of innovation activities. According to the results, all four types of

innovation activities are appropriate to be implemented with the Open Innovation concept.

80.6 percent of the SMEs have dedicated no part of their innovation budget for Open Innovation activities, have no dedicated employees for open innovation and also have no product developed in the last three years which is based on the open innovation principles. 19.4 percent of all respondents spent 0-5 percent of their innovation budget on open innovation activities, resulting in 0-10 percent of their new products developed implementing open innovation concept.

According to the answers provided by the SMEs presented on Table 6, the key constraints regarding Human Resources are the scarcity of skilled employees in their companies (93.3 percent) and the high level of the wages which is burden for their financial condition (36.7 percent).

Table 6: *Key Constraints in Implementing Open Innovation in SMEs.*

Key Constraints	n	Response rate [%]
Recruiting Constraints (Human Resources)		
Scarcity of skilled employees	28	93.3
Wages of the skilled employees are too high, it is a great burden for us	11	36.7
General Constraints		
Lack of knowledge in implementing new technology	18	54.5
Lack of quality managers in the country	18	54.5
The labor market lacks skilled workers	17	51.5
Competition Constraints		
Increase quality of product/service	24	72.7
Increase marketing activity	22	66.7
Policy Constraints		
Government policies, laws and regulations	19	73.1
Unfavorable business climate	17	65.4

The main general constraints are the lack of knowledge to implement new technology (54.5 percent) and the lack of skilled workers on the Macedonian labor market (51.5 percent). In an era of globalization and enormous influence that Internet technologies have on people's private and professional life, the competitiveness constraints to adoption of the open innovation competition constraints, or activities that should be undertaken to compensate the barriers related to competition. The first one is to increase the quality of the products/services (72.7 percent) and to increase the marketing activities (66.7 percent). The last aspects of the constraints for implementing Open innovation in SMEs are the so called policy constraints.

Table 7: *Factors Affecting Success of Implementing Open Innovation Concept in SMEs.*

Open Innovation Success Factors for SMEs	n	Response rate [%]
Support by the top management	19	57.6
Collaborators' training for Open Innovation	18	54.5
Allocate enough resources (employees, time and budget)	14	42.4
Managing an idea generation process (selection and prioritization of the ideas)	11	33.3
Managing the intellectual property (protection and valorization)	11	33.3
Ability to measure Open Innovation success in Enterprises	9	27.2
To have a corporate culture that promotes idea-sharing	7	21.2
Support by the middle management	3	9.1
Existence of systematic and organized approach for acceptance of external ideas	3	9.1
Proper selection and encouraging of partnerships	3	9.1

The last aspects of the constraints for implementing Open innovation in SMEs are the so called policy constraints. Macedonian SMEs have identified the following two key constraints: 1) problems with the government policies, laws and regulations that are not in favor of the open innovation concept, and 2) the unfavorable business climate presence in the country.

Results presented on Table 7 shows that according to the SMEs themselves three main factors important for successful implementation and practice of Open Innovation concept in SMEs are: Support by the top management, Collaborators' training on Open Innovation and Allocation of enough resources (including employees, time and budget) dedicated to Open Innovation.

4. Conclusion

SMEs on their innovation path can follow two possible approaches. The first one is to perform the innovation activities fully in-house (so called close innovation), but for small firms this is a big challenge because they typically struggle with lack of financial resources, scant opportunities to recruit specialized workers, poor understanding of advanced technology, and so on. The second approach is to adopt an innovation model to use ideas and knowledge from outside the firm's boundaries, so called open innovation concept.

The awareness of Macedonian SMEs on Open Innovation is not satisfactory. It is evident from the research results that in general they do not pay proper attention on innovation activities (both closed and open), but the fact that they do not have even idea and information on good SMEs open innovation practices and strategies should raise a 'red flag' among all innovation stakeholders in the country.

The research finds that the two main constraints for the low level of open innovation adoption rate by the SMEs are the problem related to the scarcity of skilled employees and the problem with the government policies, laws and regulations that are not supportive to the open innovation paradigm.

Despite overcoming both key constraints depend more on innovation policy makers, the SMEs themselves could make some actions to improve as well. The research suggests that the most obvious measures are to build a strong commitment and support for open innovation concept by the SME's top management (in most cases the owners of the firms), and to take joint activities with firm's collaborators and partners with focus on promotion and training on Open Innovation concept.

5. Literature

[1] Zimmermann Volker (2014), KfW SME Panel 2013: How German SMEs finance their innovations, KFW Economic Research, pg. 1-3.

[2] Gassmann Oliver & Enkel Ellen (2004), Towards a Theory of Open Innovation: Three Core Process Archetypes, Institute of Technology Management, University of St. Gallen, Switzerland, pg. 1-2.

[3] Chesbrough Henry (2006), "Open Innovation: The New Imperative for creating and Profiting from Technology", Harvard Business School Press, United States, pg. 2.

[4] State Statistical Office of Republic of Macedonia. 2015a. Number of active business entities, 2014. News Release No: 6.1.15.14. Available at: http://www.stat.gov.mk/pdf/2015/6.1.15.14.pdf [Accessed 18 May 2015].

[5] State Statistical Office of the Republic of Macedonia. 2015b. MAKStat Database. Available at http://makstat.stat.gov.mk/pxweb2007bazi/Dialog/Saveshow.asp [Accessed 18 May 2015].

[6] European Commission (2014), Innovation Union Scoreboard 2014. European Commission, Brussels.

[7] Josimovski Sasho (2011), “Thematic Report 2011 under Specific Contract for the Integration of INNO Policy Trend Chart with ERAWATCH”, Pro Inno Europe, pg. 9-15.

[8] Rahman Hakikur & Ramos Isabel (2013), “Challenges in Adopting Open Innovation Strategies in SMEs: An Exploratory Study in Portugal”, Issues in Informing Science and Information Technology, Volume 10, pg. 435.

[9] Chesbrough Henry & Bogers Marcel (2014), “Clarifying an Emerging Paradigm for Understanding Innovation, Explicating Open Innovation”, Explicating Open Innovation, ISPIM, Dublin.

[10] Chesbrough Henry (2015), “From Open Science to Open Innovation”, Institute for Innovation and Knowledge Management, ESADE, Science Business Publishing.

[11] ANNAIN, VDC & INNONET (2011), “Open Innovation: Benefits for SMEs”, EURIS, Brussels.

[12] Baruch, Yehuda & Holtom C. Brooks (2008), “Survey response rate levels and trends in organizational research”, Human Relations vol. 61 no. 8, pg. 1139-1160.

TECHNOLOGY HIGH-SPEED SHARPENING CARBIDE TOOLS

ТЕХНОЛОГИЯ ВЫСОКОСКОРОСТНОГО ЗАТАЧИВАНИЯ ТВЕРДОСПЛАВНЫХ ИНСТРУМЕНТОВ

A.P. Rechenko D., Titov Y., Balova D.
Department of cutting machines and tools, OmSTU, Omsk, Russian Federation

Abstract: *Modern machines allow to position cutting tools relative to the workpiece with an accuracy of 1 micron, but increasing of producing detail accuracy can be achieved only by an increase of sharpness of the cutting tool, which will guarantee allow to cut required metal pads of the size of 2 ... 5 microns, and will reduce the time spent on finishing operations. Existing manufacturing techniques and sharpening of cutting tools let to receive the sharpness of the blade up to 10 microns. A further increase of sharpness is only possible with the use of high-speed sharpening.*

Modern machines allow to position cutting tool relating to workpiece within the accuracy of 1 μm, but fabrication operation accuracy increase can be achieved only with increasing of sharpness of cutting tool that will guaranteed allow to cut necessary metal pad of size 2…5 μm, and also will allow to decrease time spending on finishing operations. Existing fabrication and sharpening technologies of cutting tool allow getting blade sharpness up to 10 μm. Further increasing of sharpness using existing technologies and equipment is impossible [3, 4, 5].

Existing equipment of aerospace enterprises with metal cutting tool doesn't supply stable quality and production of processing key details of aircraft engine and rockets. That's why production of engines comes to individual (selective) selection while assembling engine components. That is existing technologies, wherein cutting tool, process conditions and metal-working machinery, do not make it possible to get stable sizes and quality of work pieces surface in full. The best accuracy that enterprises can really reach in cutting edge machining is approximately 10 μm.

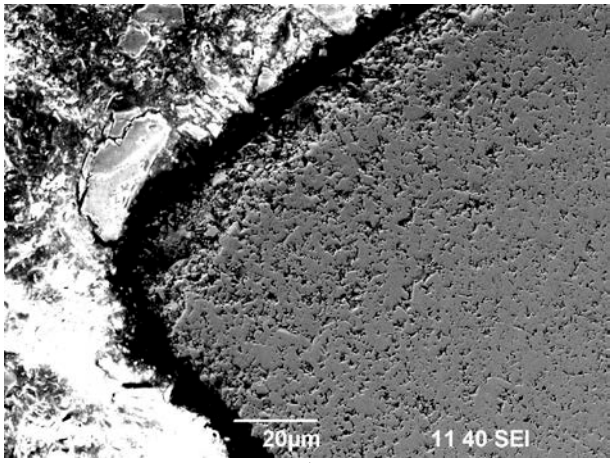
While making turbine blade disk many spark-out operations are utilized at manufacture. It is related to the fact that existing machines and software allow to position cutting tool in relation to work part with accuracy of 1 μm, however, metal cutting tool that is used for treating heat resistant alloy, has sharpness (cutting blade corner radius) of 10…15 μm. For reaching required manufacturing accuracy machine operator has to size details many times, at that, while moving cutting tool for 10 μm, it is pressed into the detail, however, there is no cutting action because of its fragility. The machine operator has to increase depth of cut and repeat the action, at that during another approach cutting edge cuts into the detail and cuts metal pad to excess that can lead to defect of the detail. Using existing metal cutting tool it's almost impossible to get required accuracy.

Of all the details of aircraft engines, building from heat-resistant alloys, 20% satisfy requirements of manufacturing accuracy, defect list is compiled for 50% of the details (at that their value decrease for 1/3) and 30% are completely discarded. Taking into account this fact, engine builds by selective method with the fittest sizes. In the most cases during engine repairing it's impossible to change worn part for a new one, because while producing the standardization is not providing. For standardization it's necessary to increase accuracy of manufacturing that will lead to increasing of details number that fit to size requirements.

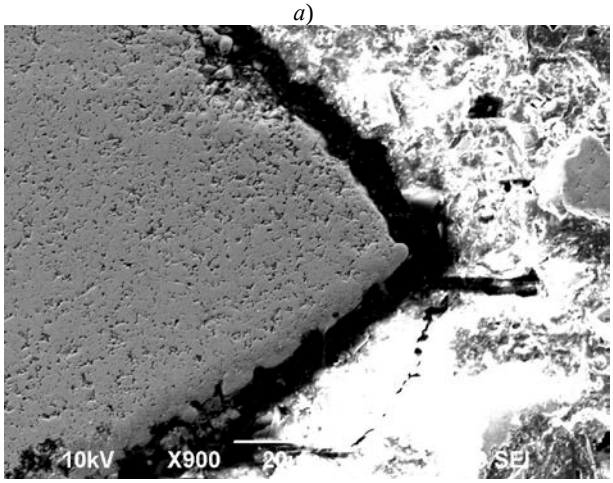
For cost savings and increasing in performance of aircraft details manufacture from heat resistant alloys, it's necessary to solve scientific and technical problem of cutting tool development with the blade corner radius less than 1 μm (super blade). This tool will let to decrease number of details with damages, decrease defective goods on account of accuracy increase and production efficiency.

Classical methods and mode of sharpening with using of finishing operations allow to get the blade with sharpness not less than 5…6 μm (illustration 1,a). Machining was at the sharpening mode of V=30…40 m/s, S=1…1,5 m/min and t=0,01 mm/ double stroke.

High speed machining was at the sharpening mode of V=260…280 m/s, S=1…1,5 m/min and t=0,01 mm/double stroke it allows to get the blade with sharpness of 1…2 μm (illustration 1,*b*).



a)



b)

Fig.1. *Blade carbide cutting tool, from:*
a) the classical sharpening with finishing operation;
b) high speed sharpness

Researches were conducted on a scanning electron microscope Jeol JCM-5700. X-ray analysis is shown in Table 1. Error measurement is from 0.32 to 0.47%.

Table 1

Element	Classical sharpness	High speed sharpness
	Mass %	Mass %
C	18.77	14.84
O	2.25	-
Co	5.49	6.06
W	73.49	79.09
Total	100.00	100.0