

SIGNIFICANCE OF TECHNOLOGICAL ENTREPRENEURSHIP AND CREATIVITY IN METALLURGICAL ENTERPRISES

Received – Priljeno: 2016-02-02

Accepted – Prihvaćeno: 2016-05-25

Review Paper – Pregledni rad

This article presents the categories of technological entrepreneurship and creativity that constitute a new perspective on developmental mechanisms of contemporary enterprises. These mechanisms are of particular significance in relation to industrial enterprises, including metallurgical ones. For the purposes of this publication the significance of technological creativity and entrepreneurship is described with the examples of metallurgical enterprises.

Key words: metallurgical enterprise, industry, technological entrepreneurship, technological creativity

INTRODUCTION

Dynamically changing surroundings contribute to the increase of entrepreneurship and creativity importance in the context of metallurgical enterprise development. Numerous authors, such as Schumpeter J.A., Whiting B.G., indicate the significant relation between the concepts of creativity and entrepreneurship. Their common feature is the use of such concepts as innovativeness, creation and implementation of new solutions. Technological entrepreneurship and creativity in the conditions of contemporary economy based on knowledge are important factors that stimulate the development of enterprises. Metallurgical enterprises, desiring to maintain a competitive position on the international market, need to demonstrate their technological entrepreneurship and creativity, create and commercialise innovations, new technologies, run R&D activities. Such companies as POSCO, JAPAN FUTURE ENTERPRISE, ARCELORMITTAL, THYSSENKRUPP can serve as examples. These enterprises from the metallurgical sector were included in the international ranking of 2 500 companies by R&D (Table 1).

Table 1 **Examples of metallurgical enterprises - World 2 500 companies ranked by R&D [1]**

Companies	R&D /€ million	R&D intensity /€ million	Sales /€ million
POSCO	386,6	0,9	42 504,0
JAPAN FUTURE ENTERPRISE	214,7	0,9	25 250,5
ARCELORMITTAL	195,8	0,3	57 602,8
THYSSENKRUPP	288,0	0,7	39 827,0

The European Commission encourages the metallurgical industry to creation, development, research and in-

novations as forces driving competitiveness, inter alia, by cooperation in the scope of technological platforms, networks and clusters [2]. According to the indicator of sector innovativeness [3], as far as overall effectiveness in innovation is concerned in comparison to other industry and service sectors, this industry has obtained an average result as per the Statistical Classification of Economic Activities in the European Community (NACE).

Technological entrepreneurship and creativity should be the key qualities of any modern metallurgical enterprise. Hence, the great importance of issues connected with technological entrepreneurship and creativity as well as search for knowledge of mechanisms that form the creative and entrepreneurial activities and search for increasingly effective methods regarding dynamics of these phenomena. This is of even higher significance as the scientific accomplishments in relation to these two constructs are minor and fragmentary.

The objective of this publication is to present the essence and significance of technological entrepreneurship and creativity in relation to metallurgical industry enterprises. The Metallurgical industry is not only one of the most important branches of the processing industry but it is also closely related to the condition of major branches of production which are: automotive sector, mechanical engineering, shipbuilding and aircraft industry [4, 5]. For this reason, technological creativity and entrepreneurship play a particular role in this industry. The article includes examples of metallurgical enterprises the essential developmental element of which is technological creativity and entrepreneurship.

CATEGORY OF TECHNOLOGICAL ENTREPRENEURSHIP

The demand for new qualifications, including skills in entrepreneurship and management, is one of the key challenges defined by the steel technology platform.

J. Machnik-Słomka, P. Kordel, The Silesian University of Technology, Faculty of Organization and Management, Poland

These qualifications are crucial for enterprises to become more innovative, develop new products and increase the effectiveness of manufacturing processes and cost reduction.

The literature in the scope of technological entrepreneurship is fragmentary. The research field of category of technological entrepreneurship is formed on the basis of theory of entrepreneurship and theory of innovation that are characterised with well-established scientific grounds. The synthesis of assumptions of the theory of innovativeness and entrepreneurship in the field of technology forms the category of technological entrepreneurship [6]. What the phenomenon of entrepreneurship with technological specificity as a component of a wider phenomenon of entrepreneurship provides is its core in the form of technical innovations or technology development. In the roots of the analysis of the phenomenon of technological entrepreneurship (similarly in the case of general entrepreneurship) the central idea includes processes of creation, exploration, and subsequent use of new developmental opportunities. The criterion of differentiation between the trend of technological entrepreneurship and the general scientific field of entrepreneurship is, nevertheless, its focus on the influence of technological innovation on opportunities for development. In other words, the central component of the phenomenon of technological entrepreneurship is a technological opportunity [6]. Therefore, the scientific field involves the phenomenon of recognition and making use of developmental opportunities, but in the context of technological innovation. Currently, technological innovation is defined as a phenomenon that occurs when the scientific or engineering research is a key component of opportunity which, in turn, becomes a new venture, enterprise, cluster or even the whole industry [7].

Technological entrepreneurship by connecting the social dynamics with the dynamics created with the development of new technologies provides a new perspective on the economical development, including metallurgical enterprises. In the scope of manufacturing processes, current technologies used by metallurgical enterprises are quite advanced [2]. For this reason, the industry is actively looking for groundbreaking technological solutions [2]. In this field the research and development will have a fundamental role at the level of products and in manufacturing processes. Thus, for the purpose of performance of these tasks, the skills connected with entrepreneurship, creativity and ability to implement innovation prove to be indispensable.

CATEGORY OF TECHNOLOGICAL CREATIVITY

In modern economical conditions the creativity of an enterprise is an increasingly essential factor that can be decisive in defending the company's position on the market and its further development. The category of

technological creativity forms an essential developmental mechanism of enterprises and creates a new perspective in terms of development of contemporary economy. It is an important, interdisciplinary subject of research, raising increasing interest, both from the scientific point of view and economic practice. This notion is where more effective methods of conducting business activity, generation of new ideas connected with improvement of implemented process is sought. In the organisational theory of T. Amabile, creativity is treated as a causative factor of innovativeness, and its presence is a function of existence of professional knowledge, task motivation and creative abilities [8].

In relation to technological creation, the current literature is very sparse and fragmentary. Definition of technological creation has been determined in literature by several researchers [9] and is referred to technological thinking and technological activity [9]. Technological creation, defined as assets allowing people for improved and faster methods of application of science and, as a result, improvement of life quality, especially in times when knowledge plays an increasingly important role [10].

Thus, technological creation proves to be a critical competence in functioning of contemporary organisations and entrepreneurial development. This subject appears in papers by Sextor and Browman-Upton who indicated the essential function of creativity in formation of entrepreneurial development of an organisation [11]. The meaning of creation in implementation of new undertakings is particularly emphasised as provided grounds for generation of new ideas that initiate the process of entrepreneurial activity [12]. What differentiates technological creation from the overall creation area is concentration mainly on technological thinking, technological activity and technological development. Technological creation is of essential meaning for implementation of technological innovations, diversification of the final product. There is a wide variety of metals and other materials, such as composites, that compete with each other in order to come first in the technological and economical aspect [2].

TECHNOLOGICAL ENTREPRENEURSHIP AND CREATIVITY IN METALLURGICAL ENTERPRISES

More and more often, entrepreneurship and creativity are a method for adjustment to the dynamically changing market conditions as well as improvement of the competitiveness of metallurgical enterprises. The increase of economy competitiveness requires continuous creation and implementation of innovative solutions and new technologies by these enterprises. Managers should try and promote principled cultures and behaviors, which would yield in positive and beneficial outcomes [13]. Metallurgical industry is one of the main forces driving the global economy. Metallurgy and steel

are an innovative and progressive industry. The steel industry employs directly more than two million people worldwide, plus two million contractors and four million people in supporting industries. Including industries such as construction, transport and energy, the steel industry is a source of employment for more than 50 million people [14]. Globally, the steel industry spends more than €12 billion per year on process improvements, new product development and future breakthrough technology [14].

In the metallurgical industry there are multiple companies that achieved development, and market success through creation of new technologies, innovations, demonstrating their technological entrepreneurship and creativity. An example can be provided by company POSCO, operating in the steel industry and deemed the world leader in technological innovation. POSCO was the first steel company globally to settle a digital information management system, and also commercialized the economical and environment friendly steel production technology, FINEX [15]. The Company has been introducing creative management techniques and culture through cooperation with global companies such as Google and GE, thus receiving positive reviews for leading innovation activities in the global steel industry [15]. POSCO won the Innovation of the Year Award at the 46th annual World Steel Association steel industry conference held in New Delhi, India. During this year's conference, POSCO presented its unique PBC-EV (POSCO Body Concept-Electric Vehicle) technology which allows light yet firm low-cost production. Technological entrepreneurship is a special case of entrepreneurial conduct of the leader and employees whose creatively constituted product and process innovativeness becomes the main driving force for building and development of contemporary enterprises. Metal-Master, established in 2000 in Poland, is an example of such an enterprise. The company is successful in construction, production and development of technological lines for production of elements of all European make cars. Up to 95 % of products are exported, mostly to Europe, Central America and Africa. The company manufactures, among other things, aircraft products, deals with prototypes, construction and optimisation of new versions [16]. Development of the unique ultra light single-engine jet Flaris Lar 1, based on own Polish technical thought, was a great success. A jet plane FLARIS LAR 1 is the first air construction designed by Metal-Master which introduces a new brand onto the international market. Whereas, production will be dealt with by FLARIS Sp. z o.o., a company established in November 2012 [16].

The provided examples indicate that technological creativity and entrepreneurship that aim to introduce and develop new technologies are essential mechanisms that support the development of metallurgical enterprises.

CONCLUSIONS

Entrepreneurship and creativity are an increasingly popular method of responding to dynamically changing conditions on the market and improvement of competitiveness of metallurgical enterprises, playing a key role in their development.

Referring these two mechanisms to development of technology or technological innovations allowed to formulate the assumptions of the notions of technological entrepreneurship and technological creativity. In the context of developmental processes that take place in metallurgical enterprises, theories of innovativeness and entrepreneurship can be used as grounds for the analysis of the categories of entrepreneurship and creativity. Technological entrepreneurship regards, first and foremost, noticing and using technological opportunities as a crucial mechanism of entrepreneurial development of an organisation. Creativity, on the other hand, is connected with generation of original ideas and solutions, being of key importance as a mechanism of creation of technological innovations.

Technological entrepreneurship and creativity, therefore, are the key resources in metallurgical enterprises that create the value of these organisations and build their competitiveness, being also important factors for further development of the metallurgical industry.

Grateful acknowledgement for the research support from the Polish National Science Center in Cracow (grant no. UMO-2012/07/B/HS4/03128).

REFERENCES

- [1] Scoreboard 2014 Ranking world top 2500 companies. <http://iri.jrc.ec.europa.eu/scoreboard14.html> (26.11.2015).
- [2] Komunikat Komisji do Rady i Parlamentu Europejskiego w sprawie konkurencyjności przemysłu metalurgicznego - Wkład w strategię UE na rzecz wzrostu gospodarczego i zatrudnienia. <http://eurlex.europa.eu/legalcontent/PL/TXT/?uri=celex:52008DC0108> (21.09.2015).
- [3] PRO INNO Europe. http://www.proinnoeurope.eu/extra-net/admin/uploaded_documents/EIS_2005_Europen_Sector_Innovation_Scoreboards.pdf (21.09.2015).
- [4] I. Kłosok-Bazan, B. Gajdzik, J. Machnik-Słomka, W. Ociczek, Environmental aspects of innovation and new technology implementation in metallurgy industry, *Metalurgia* 54 (2015) 2, 433-436.
- [5] I. Kłosok-Bazan, Innovations in industrial water preparation in a metallurgical plant, *Metalurgia* 55 (2016) 1, 59-62.
- [6] P. Kordel, J. Machnik-Słomka, Przedsiębiorczość oraz twórczość technologiczna jako mechanizmy rozwojowe organizacji wysokich technologii, *Zeszyty Naukowe Politechniki Śląskiej, Organizacja i Zarządzanie* 80 (2015), 163-178.
- [7] Ch. Beckman, K. Eisenhardt, S. Kotha, A. Meyer, N. Rajagopalan, *Technology Entrepreneurship, Strategic Entrepreneurship Journal* 2 (2012), 89-93.
- [8] T.M. Amabile, A Model of Creativity and Innovation in Organizations, [in:] B.M. Staw, L.L. Cummings (eds.) *Research and Organizational Behavior* 10 (1988), 123-167.

- [9] Hyunjin Kwon, Changyol Ryu, Model of Technological Creativity Based on the Perceptions of Technology-Related Experts, Daejeon Technical High School, Chungnam National University, Korea. http://www.aichiedu.ac.jp/intro/files/seika05_2 (22.02.2015).
- [10] Yu-Chu Yeh, Jing-Jui Wu, The cognitive processes of pupils technological creativity, *Creativity Research Journal – CREATIVITY RES J* 18 (2006) 2, 213-227.
- [11] D.L. Sexton, N.B. Browman-Upton, *Entrepreneurship: Creativity and growth*, New York, MacMillan, 1991, 267-284.
- [12] C. Wu, J.S. McMullen, M.J. Neubert, X. Yi, The influence of leader regulatory focus on employee creativity, *Journal of Business Venturing* (2008), 587-602.
- [13] A. Stachowicz-Stanusch, A. Simha, An empirical investigation of the effects of ethical climates on organizational corruption, *Journal of Business Economics and Management* (2013) No 14 sup. 1, 433-446.
- [14] World Steel in figures 2014, World Steel Association, 2014. <https://www.worldsteel.org> (12.04.2015).
- [15] <http://www.noodles.com/view/7B9562FEB452EC8BD33FF601AEEB55F92C855EF2#sthash.Eq0WqL3A.dpuf> (22.02.2015).
- [16] Flaris. <http://www.flaris.pl/producent/?lang=pl> (22.08.2015).

Note: The responsible translator for English language is Anna Wocka, Mysłowice, Poland