

Innovation Activities of Modern Enterprises of the High-Tech Sector of the Economy



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Abstract: According to some national and foreign researchers, businesses can be conditionally referred to the high-tech sector of the economy today, for example in terms of such an indicator as amounts of costs (in excess of the established level) for research and development (R&D) in relation to the product output volume, added value or to the amount of basic production factors. In the current environment, businesses of the high-tech economic sector (which is an indicator of the development of countries in the field of high technology) face one of the challenges — to increase the level of innovation activity.

The article describes some factors that influence the innovation activity of the high-tech businesses (in particular, instrument-making businesses) in Russia. The higher engineering and technical education problems the existence of which affects the availability of highly qualified personnel of modern enterprises have been studied, and the student survey results are provided.

Keywords: high-tech enterprise, innovation activity, high-tech sector of the economy, instrument-making industry, technological development, student survey.

I. INTRODUCTION

The transition to an innovative economy is a key and, in essence, an economic task for Russia. Only a change in the type of economic growth will allow Russia to join the ranks of the world leaders in production and significantly increase its economic status. Such an important and necessary transition to the innovative path of development will only be possible in the event of efficient and dynamic development of the industries that determine scientific and technological progress.

The experience of the economically developed countries shows that in the modern conditions that determine the competitiveness of the economy the priority industries are the ones that belong to the high-tech sector, which industries with their advanced technologies create conditions for the progressive development of other industries.

A special place among them is held by the instrument-making industry which historically aspires to be one of the basic industries of the national economy since the development of any and all directions of scientific and technical progress is impossible without accelerated development of such industry. The instrument-making industry is considered to be a high-tech machinery-producing industry; products of this industry also serve as a component of many other branches of industry.

However, it must be admitted today that many ties between the enterprises that make up the technological chain of production have been destroyed; the instrument-making enterprises have morally and physically obsolete production fixed assets; the labor productivity and efficiency of use of material production factors have decreased; this is especially critical in the event of rapid growth of the cost of resources, and first and foremost, of the highly qualified labor and materials. As a consequence of all the above negative trends, the competitiveness of the products manufactured by the domestic instrument-making enterprises has fallen not only in the global but also in the domestic market.

As a result, the contemporary Russian instrument-making industry which once played one of the main roles in the national economy and held leading positions in many types of products has turned into the one that is lagging behind and highly dependent on the imported box instruments and component parts; this creates a real threat of loss of the existing scientific, technical and industrial potential. The situation existing at the instrument-making enterprises hinders the development and introduction of new technologies, manufacturing of products of a higher scientific and technical level with qualitatively new consumer properties, which is a necessary condition for the formation of the innovation economy. Intensification of technological development of the instrument-making enterprises is one of the key factors that can ensure the revival of the instrument-making industry and eliminate its significant lagging behind the world leaders. The progress in knowledge and the ability of enterprises to effectively use technological knowledge is recognized by the modern theory as important sources of economic growth. And the enterprises' costs for the development of technological knowledge as a commercially oriented investment in the creation of innovations lead to an increasing returns to scale of such an important production factor as fixed capital. Therefore, today the ability of enterprises to effectively use technological resources to solve specific economic problems is becoming a key source for economic growth and competitiveness.

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II. THE TECHNOLOGICAL DEVELOPMENT

The technological development of the enterprise should obviously be built within a certain functional strategy, i.e. technological development strategy. The technological (or, more precisely, technical and technological development strategy) strategy of the enterprise means a set of strategic decisions that determine, firstly, the technological type of the enterprise and, secondly, the type of technological dynamics of the enterprise [1]. And the strategy of each specific enterprise shall be individual and shall be developed subject to many factors. But in general, any strategy is based on the existing approaches to technological development.

In the economic science, there are two opposing approaches to technological development. The first one is based on the exogenic origin of technologies, i.e. creation and introduction thereof into production are of external origin and are practically unrelated to the needs of industrial development. According to this approach, the technologies are brought in as if from the outside and, therefore, their introduction is associated solely with the commercial goals of the enterprise, and first of all with the expected future return on investments in new technologies.

According to the second approach, the technologies are of endogenic, i.e. internal origin; their emergence is due to the needs of development of the production system (enterprise, in this case).

Considering the approaches to technological development, one can talk about external and internal development strategies, as well as about a mixed variant that combines the elements of both strategies. Each of the strategies has its advantages and disadvantages, and the choice of the strategy is determined by the capabilities of the enterprise to implement such strategy.

Although in a particular case the enterprise is guided mainly by its own considerations when choosing the technological development strategy, nevertheless, one may highlight some key characteristics of external and internal strategies the knowledge and understanding of which ensures their correct choice.

Let us make a comparative analysis of the highlighted types of strategies for technological development of enterprises and evaluate them in terms of expediency and feasibility of implementation by the Russian instrument-making enterprises.

First of all, let us discuss the mechanism of implementation of each of the strategies. The strategy of internal technological development is based on the organization of the proprietary internal system of technological development. In this case, the enterprise should be innovatively active and should be distinguished by its ability to innovate, ability to find new effective technological solutions. This may be possible provided that at least two following conditions are met: presence of research and development units and sufficiently high qualifications of the enterprise's personnel. As to the first condition, the instrument-making enterprises have a different set of functions for the product life cycle. The most typical variant for the instrument-making enterprises (for large enterprises in particular) is the availability of the poly-product structure of

developments and production based on the principle of "subsistence production" [2]. This means that basically the Russian instrument-making enterprises are an integrated product manufacturer that maintains all stages of product development, production and sales. That is, technically, they are able to implement the strategy of internal technological development. However, not the least of the factors is the output product complexity, i.e. the higher the complexity of the output product is, the more the R&D function belongs to the outside organizations. It is also important to consider the degree of diversity of products manufactured by the enterprise, i.e. the more diversity is present, the more difficult it is to organize own research and development. Practice shows that in this case, the enterprises cannot have their own development strategy and they limit themselves to just modernization, technology modification and organization of labor using new equipment while their technological development is performed by an external development system [3]. Prospective development of the Russian instrument-making enterprises assumes (among the main tasks) their transition to up-to-date business models that consider market relations and provide for deeper specialization. In this case, obviously, the functions will be divided into the design and production functions, this means that the main issues of technological development of the enterprise will be outside its own development system.

The World Investment Report [4] provides an overview of the main reasons that determine the decision of enterprises in favor of original research and development. For example, it would be reasonable to conduct proprietary developments if the development is related to the core competence and core competitive advantage of the enterprise. Or, if the knowledge underpinning the technology is predominantly of informal nature, i.e. obtaining non-formalized knowledge from external sources involves high coordination costs. It is likely that decisions on these issues will be made based on the market interests of the enterprise, subject to its portfolio of innovations.

As to the second condition—the level of personnel qualifications—just a high percentage of qualified employees in the total number of employees at the enterprise fails to demonstrate any significant impact on innovation activity, first of all, on the possibility of technological innovations. It can be assumed that the formal attributes of qualifications and education are severely distorted at the present time due to the fact that the enterprises have a large percentage of seemingly highly educated, but insufficiently qualified personnel (in terms of modern HR requirements). As a result, the enterprises, while formally having the necessary potential of qualified employees, can actually implement only some lines of technological development using their own efforts. The personnel problem has been especially significant and relevant for the instrument-making enterprises. Reduction of production and decrease of its efficiency have led to a significant outflow of personnel from the enterprises that once had a powerful human resources potential.

Moreover, being economically unattractive, today's instrument-making enterprises turn out to be out of sight of young specialists, this reduces personnel reproduction potential of the enterprises. All the above-mentioned circumstances lead to the fact that in terms of personnel capabilities the focus on outside developers is more effective.

The strategy of external technological development assumes the use of the mechanism of borrowing of technological solutions. There are different points of view on this issue. There is a view that borrowing is a sign of the technological colony's behavior, which creates a dangerous dependence on a technological partner and reduces the chances of commercialization of proprietary original developments by manufacturers. Another point of view is that borrowing is a way of innovative development no less worthy than original developments, however, one should be able to use them, particularly in regard to what is borrowed, from whom and under what conditions. In addition, such borrowings and original developments do not contradict, but complement each other.

When choosing an external strategy, the enterprises can use several channels of technological development, such as:

- Organization of scientific and technical cooperation and use of contracted R&Ds, this implies selection of a contractor, scientific and technological cooperation organization, and coordination of efforts to implement the developments;
- Purchase of licenses, know-how, technological equipment and engineering services. With this channel, the enterprise focuses on the acquisition of high-tech innovations; this requires a preliminary study of the market of technologies, and selection of the most promising of them in accordance with the interests and capabilities of the enterprise.

According to experts, the acquisition of licenses can contribute to more effective achievement of the organizational goals, however, only in the short term period. In this case, the main question is how this method of technological development will affect the prospects for the enterprise development. One should reckon with the fact that in the technological systems of proprietary development it is easier to ensure design and technological continuity and thus ensure the effectiveness of subsequent introduction of innovations into the current production process. The licensed technologies bind the enterprise with the developers thereof for a long time; therefore, a partner should be selected for a long-term cooperation. Perhaps, the best conditions for such cooperation can be created by mutual acquisition of licenses, subject to the motives for cooperation and maximization of overall success [3].

No less important argument for the borrowing model, i.e. for the strategy of external technological development, for the instrument-making enterprises is the factor of risk which is lower among the followers than among the inventors. The history of science and technology abounds in cases where neither the inventors nor the enterprises that first made the invention were able to obtain technological rents and ceded the market to copycats.

Based on the foregoing, it can be assumed that the strategy of external technological development in modern conditions seems to be more preferable for the instrument-making enterprises, as the own capabilities of the enterprises (even of the large ones) with this regard are relatively limited. This trend is quite regular and means the necessity of development of cooperation ties between the enterprises and scientific organizations, their participation in clusters and interaction with more innovatively active enterprises.

The selection of the strategy of external technological development and its effective implementation for the majority of innovatively inactive enterprises (and such enterprises prevail so far) can become a catalyst to more actively make their own original developments. Although this path is not as linear as it may seem at first glance, it implies compliance with a number of conditions, first of all, the improvement of the qualification level of the core staff and the innovation activity. Technological inactivity of the enterprise, i.e. the situation when the enterprise itself is not engaged in research and development, neither contributes to the increase of the market share of the enterprise nor shortens the distance to the technology leader.

The results of empirical studies show that the imitation model of innovation in Russia has gained an advantage over the original developments. If we assume that receipt of technologies through the purchase of machinery and equipment and the acquisition of licenses is the sign of borrowing, then based on the results of the research conducted by the State University Higher School of Economics and the World Bank, 60% of enterprises can be considered as copycats [5].

However, as practice shows, the effectiveness of this strategy is low: neither the investments in machinery and equipment, nor the purchase of foreign patents and know-how slash the backlog of enterprises in terms of advanced technological level. Most likely, the reason for such phenomenon is that the amount of investments is incommensurable with the scale of depreciation and weakness of fixed capital of the enterprises; and the modernization is not a sufficient measure to improve their efficiency. Thus, in terms of the theory of the issue under consideration, each enterprise should form its own technological development system, however, as practice shows, most enterprises prefer to use a simulation development model. This is due to low innovation activity of the enterprises [6].

It is obvious that the choice of a mixed strategy that combines elements of external and internal technological development will be optimal for the Russian instrument-making enterprises in the current conditions, subject to their smooth coordination.

III. TECHNICAL EDUCATION IN RUSSIA

As it was mentioned above, one of the tasks of the modern high-tech enterprises is to increase the level of innovation activity.

And the continued presence of ongoing competition is one of the factors that motivate the innovation activity of such enterprises.

The competitiveness of an enterprise is determined by a combination of various factors, including the presence of highly qualified personnel in its staff, the implementation of research activities, the use and implementation of innovations, etc.

In this regard, there is an interest in training specialists in technical areas of education. Today, different problems of modern technical education are highlighted that require urgent solution, especially since the quality engineering education is recognized as a necessary factor of existence and development of any state [7].

Let us mention some problems of modern technical education in Russia. The most important problems are unwillingness and unpreparedness to work in the chosen profession. A decreased interest in technical professions is also caused by the difficulties when learning technical disciplines, lack of practical training in educational institutions. One of the problems is low salaries as compared to the representatives of some other professions.

It can also be mentioned that the age of the scientific and engineering and technical personnel and teaching staff at the departments of science, engineering and instrument-making at the higher education institutions mainly exceeds 50 years, and many of them are in their late seventies. At the same time, the inflow of young personnel is insignificant, and the quality of such personnel is low. A similar picture can be seen among the qualified workers [7, 8].

IV. RESULT AND DISCUSSION

A survey was conducted at the MIREA – Russian Technological University in order to study the motivation for choosing a technical profession and the students' opinions on their plans for future professional activities.

The survey was conducted among the 1, 3 and 4 year students by random sampling. 77 bachelor degree program students participated in the survey (specialization: 12.03.01 Instrument-Making Industry, 12.03.02 Optical Engineering, 27.03.01 Standardization and Metrology, 27.03.05 Innovatics) and specialist programs (specialization: 23.05.01 Ground Transportation and Technological Facilities).

Some results of the surveys are displayed below [9].

One of the questions in the questionnaire was about the reasons why they chose to pursue higher technical education. More than half of the respondents (62.5%) mentioned the demand of modern society for technical specialists. The survey results show that the popularization of higher technical education in various mass media is also influenced the students' choice of specialization.

32.1% of respondents believe that they chose to go to study by vocation. It can be considered encouraging that only 12.5% of the respondents chose the answer 'failed to enter anywhere else' (Fig. 1). The answer 'good for the mind' is of interest too.

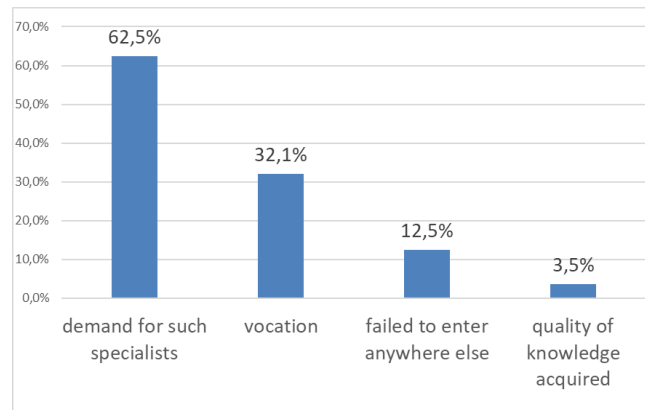


Fig. 1. Diagram of answers to the question: “Specify the reason why you chose to pursue higher technical education?” (In % of total number of respondents)

Considering the problems of modern technical education mentioned in the article, the results concerning the motivation for further work in the chosen profession are not surprising. 92.9% of respondents chose the answer 'good salary'. The second position (39.2%) is held by the answer 'interesting job' and the third position (33.9%) is held by the answer 'opportunity to contribute to the development of society' (Fig. 2).

Also, when respondents were asked to explain what they understand under an interesting job, they mentioned as follows: I understand and can do it; original tasks; willingness to go to work; interest and development in the profession; interesting knowledge, skills development opportunities; participation in new developments. And they described the following as good conditions for work: getting pleasure from work, a good team, management that understand you, high salaries, flexible working hours, and no unqualified boss.

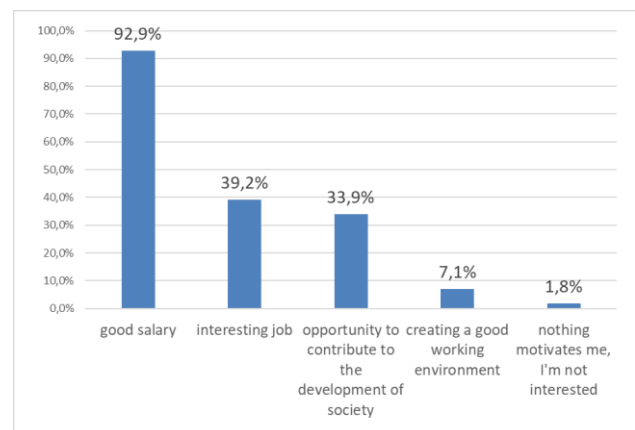


Fig. 2. Distribution of answers to the question concerning motivation to labor activity (In % of total number of respondents)

Two more questions in the questionnaire were about the life plans of the students with regard to their future professional activities and further education.

Slightly less than half of the respondents (46.4%) gave the following answer to the question “Do you plan to work in the chosen field of specialization in the future?”: ‘depending on circumstances’, 41% answered: ‘I do not know yet’ and 37.5% answered ‘yes’. And only 7.1% of the respondents categorically answered ‘no’ (Fig. 3).

Among the reasons why they plan to work / do not plan to work, the following answers were received:

1) They plan to work because: it is interesting; they have abilities required for this work; deficit of technical specialists, interesting job, and a good salary (interestingly the received data are inconsistent: ‘good salary’ and ‘if there is a decent salary’. This can be explained either due to different perceptions of the size of the salary, or because the students do not have accurate data on salaries, or because they already know that that there is a job with a known salary at a particular enterprise) etc;

They do not plan to work because of the wrong choice; because they decided to move into another business area, etc.

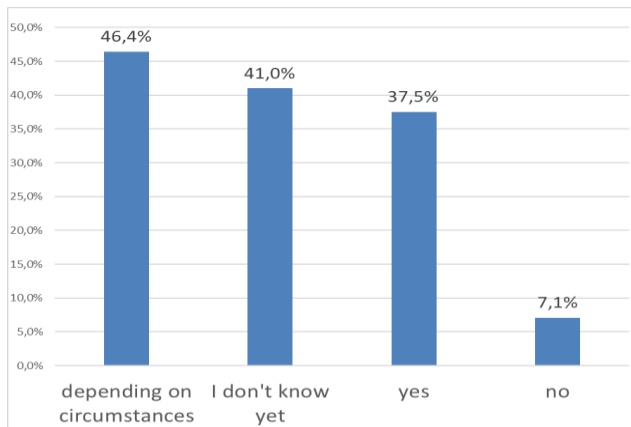


Fig. 3. Results of the answers to the question: “Do you plan to work in the chosen field of specialization in the future?” (In % of total number of respondents)

The following results were received as the answer to the question about the further master’s and postgraduate education in the chosen field of specialization: 82.1% of respondents plan to continue their education (Fig. 4).

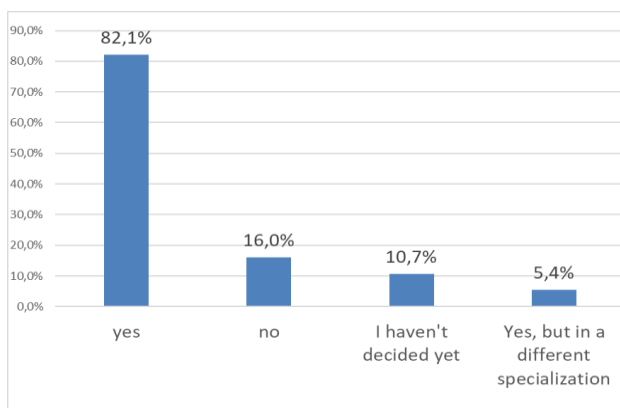


Fig. 4. Results of the answers to the question about further education (In % of total number of respondents)

In general, the survey results have shown that many students mention prestige of their future profession as the

main motive for choosing it since technical specialist are in demand in this country today.

V. CONCLUSION

The current situation and the survey data also indicate that modern technical education needs to be modernized (including improving the quality of education).

In conclusion, it is worth to underline that training of personnel (future highly qualified employees) capable of innovative activity, ready to constantly update their knowledge, develop and implement new technologies, effectively use the existing conditions and transform them, is one of the ways to increase the level of innovation activities of modern enterprises of the high-tech sector of the economy.

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