Innovation capabilities of Russian firms: a crucial role of information component

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The paper aims at investigation the most significant components of firm's innovation capabilities. Having identified four major components of innovation capabilities (financial, HR, information, and technological) and developed measurement scales for each of them, the authors apply fuzzy set qualitative comparative analysis to the study of 75 Russian industrial firms. Information component is found to be a necessary condition for successful innovative performance while technological and HR components are separately sufficient conditions which form two generic configurations of innovation capabilities. Financial component is found to be the least relevant for innovative performance.

Keywords: configuration, fsQCA, innovation capabilities, innovation.

Introduction

Recent changes in global business environment forced firms to develop organizational capabilities in order to obtain sustainable competitive advantages [8, 23]. In conditions of fierce competition innovations have become an important precondition of high performance [7]. With increasing intensity and expansion of firms' innovation activities internal factors related to organization of operational processes stimulating innovations attract more and more attention from management scholars. Recent studies in this area contribute to better understanding of mechanisms that integrate firm's innovative resources into its operational activities. These particular mechanisms are the core of innovation capabilities concept. Despite its theoretical attractiveness and practical relevance, the concept of innovation capabilities still has some areas that need more thorough investigation. The fundamental problem of this concept is that it doesn't explicitly state what are the major sources of innovation capabilities and how a firm could develop these capabilities to be competitive on the market.

The purpose of this study is to examine the structure (i. e. most relevant elements) of firm's innovation capabilities and to develop effective approaches to innovation capabilities management aiming at firm's innovative performance improvement. The empirical data for the study were collected via survey conducted in 2013. The sample includes 75 Russian industrial companies representing various sectors and performing different types of innovation activities. The paper is structured as follows: firstly, we introduce the concept of innovation capabilities, secondly, we provide a more detailed description of empirical data and the method, finally, we present our results, discussion and further agenda.

Theoretical Background

The concept of innovation capabilities attracts significant attention from innovation management scholars nowadays. Traditionally, there are three major approaches to this phenomenon which treat innovation capabilities as either resources [3, 16], or processes [12, 23], or results [9, 24]. Following the logic of resourced-based view (RBV) [1, 25] and dynamic capabilities theory (DC theory) [22, 23] we focus on firm's internal innovation activities and base our arguments on firm's innovation capabilities as processes, distinguishing them from firm's innovation resources.

The emergence of «firm's innovation capabilities» concept and development of research aimed at its understanding is directly related to establishment and dissemination of resource-based view (RBV) concept in modern management theory. RBV undoubtedly has had a significant impact on innovation management theory. There are two key assumptions within RBV: the first one is that resources possessed by the firm define firm's performance, and the second one is that firm's resources must be rare, valuable, difficult to imitate by competitors and non-substitutable [1]. Further development and

conceptualization of RBV caused its partial transformation into a new concept of dynamic capabilities (DC). DC theory fully reflects typical for modern innovative economy shift from traditional managerial mechanisms of costs minimization to entrepreneurial mechanisms of value creation to build and develop firm's specific competitive advantage [22, 23].

Resource-based view and dynamic capabilities theory allowed justification the importance of resources in a broader sense, in particular, as valuable sources of firm's unique capabilities, its competitive advantages, moreover, innovations were considered as key organizational dynamic capabilities [23]. Such a differentiated approach to firm's resources structuring and exploration of their influence on core competences formation has defined allocation of innovation resources and innovation capabilities into independent and very specific categories which congruously interact with each other in innovation management process.

In addition, innovation management development was also affected by core competence concept introduced by Prahalad and Hamel [18]. The scholars stated that the firms perform differently due to different possibilities to exploit tangible and intangible resources. Core competences were considered as systems of capabilities and technologies that enable an enterprise to provide value for consumers emphasizing the importance of routines as sustainable models and practices of innovation activity [18].

The transfer from innovation theory as it is to competence-oriented approach was driven by the shift from consideration of purely innovation activity results to the study of firm's abilities to perform innovation activities and intrafirm processes. This stage of theorizing is characterized by analysis of intra-firm process characteristics of innovation activities where the key subject of research is a transformation process from innovation resources to innovation capabilities within a firm. Development of a new concept of dynamic capabilities and recognition of innovation as a basis for competitive advantage strengthening stimulated introduction of the notion of «innovation capabilities». That is firm's innovation capabilities that demonstrate the ability of the company to innovate in a mode of continuous improvements within different aspects including operations.

Application of the operational approach to innovation management allowed transforming well-stated notion of «production capacity» as firm's ability to manufacture products in a given range into «innovation capacity» as a firm's ability to adopt or implement successfully new ideas, processes or products [2]. Capacity describes the maximum possible output for a certain period and assumes availability and effective exploitation of adequate resources. To manage innovation capacity in conditions of dynamic demand fluctuations it is crucial to identify two components within a combination of innovation resources: constant and variable component. A constant component includes equipment, production space, intellectual property, etc.; it remains the same for long periods and is taken into account in strategic planning. A variable component includes personnel, information, materials; it could dynamically change in a short period and is focused on short-term solutions. Implementation of the operational approach for measuring firm's innovation capabilities extends a range of management functions in innovation management suggesting both strategic, tactic and operational decisions-making.

Table 1 presents a three-stage evolution model of innovation management concepts each of which is characterized by a research subject, key concept(s)/theory, key assumption(s).

The theoretical concepts overview reveals prerequisites for development of research on firm's innovation capabilities. Up-to-date approach to innovation management concentrates on managing a firm to make

Table 1

Evolution of innovation management concepts

Stage	Research subject	Key concept(s)/ theory(ies)	Key assumption(s)	Authors
I. Competition-oriented stage. Innovation as a major activity	Invention, new development as key elements of scientific and technological development; Innovation a an introduced new development aimed at scientific and technological level growth	Entrepreneurship (1910s-1980s)	Innovation as an element of entrepreneurship. Innovation management is not considered	N. Kondratiev, J. Schumpeter
		Neo-classical theory Evolutionary theory (1980s-1990s)	Separation of innovation management from general management. Strategic management is not among priorities. Analysis of innovation impact on the market	C. Nelson, R. Freeman
II. Cooperation-oriented stage. Innovation as a type of interaction	Open innovations paradigm which assumes that firms might and must exploit both internal and external ideas, and implement both «internal» and «external» types of market penetration to offer their advance technologies	Open innovations (2000s)	Sources of innovations are under investigation. The relevance of both internal and external sources	L. Lessig, H. Chesborough
III. Competence-oriented stage. Innovation as an evolving function of management	Innovation resources as a set of unique combination of organizational resources enabling innovation activity. Innovation capabilities as a set of organizational routines enabling firm's innovation activity in dynamic conditions	Innovation capabilities (2000s–present)	Influence of interdisciplinary management sciences. Analysis of firm's abilities to innovate in dynamic conditions	A. Chaveerug, C. Christensen, G. Hamel, C. Prahalad, D. Teece, M. Tuominen

Source: developed by the authors

profit, increase its value and create long-term firm-specific competences through development, implementation and commercialization of innovations.

Despite active scientific discussion around the concept of «innovation capabilities» there is still no common understanding on how to define firm's innovation capabilities and how to measure them. Based on generally accepted definition of firm's dynamic capabilities introduced Teece [23] authors define firm's innovation capabilities as a range of organizational characteristics and dynamic abilities to plan, create and implement innovation resources in operational processes in order to create firm's core competences. This definition treats innovation capabilities as a mediator of relationships between innovation resources and core competences in organizational innovation system. Transformation of accumulated resources into core competencies is carried out within a framework of innovation process where management practices are transformed into routines and are maintained regardless of the personnel directly involved in the processes.

Components of innovation capabilities

Management of innovation development in the framework of innovation system deals with planning of desired profile of both innovation resources and innovation capabilities. The process of development of this profile includes decomposition of aggregated innovation resources and capabilities into structural elements and selection of proper metrics to measure them. On the basis of profound analysis of existing methodological approaches to innovation resources measurement, we identified four components that were formed on functional differentiation basis. Then, we put the same differentiation principle into theoretical justification of innovation capabilities components and ended up with the following list of innovation capabilities components:

- financial component — an ability to accumulate financial resources from different funds, efficiently allocate them and exploit to fulfil strategic goals of innovation development;
- human component — an ability to form and manage employment patterns according to innovation strategy;
- technological component — an ability to find, develop and implement new and advanced technological decisions for innovation;
- information component — an ability to implement advanced IT solutions and generate new knowledge in order to form and use flows of ideas and inventions and defend intellectual property rights;

An effective combination of different components of innovation capabilities ensures firm's ability to balance managerial decisions in planning innovation resources, organize efficient innovation process and develop innovation capabilities.

Data, variables and method

The data for empirical analysis were collected through a survey conducted in 2014. The respondents were reached directly during special events like innovation forums, industrial exhibitions, etc. and were asked to fill in a specifically developed questionnaire. The final sample accounted for 75 Russian industrial companies, in particular, from metallurgy, optics, equipment manufacturing and food industries. These industries were chosen as they are traditionally more inclined to innovative activities. As for the size and age of the companies, about 80% are medium-sized with a number of employees working on permanent basis of more than 100 people, and the other 20% are large companies with more than 250 employees.

To measure innovation capabilities we developed a new scale with a total number of 37 indicators. To get more reliable and convenient approach to data processing we used five-point Likert scale for all variables with the following options: 1 — strongly disagree, 2 — disagree, 3 — don't know, 4 — agree, 5 — strongly agree. Due to the fact that we didn't have an opportunity for data triangulation and all the data were collected via survey, we implemented statistical procedures to test for common method variance (CMV). CMV is «a variance that is attributable to the measurement method rather than to the constructs the measures represent» [17]. To control CMV statistically, Harman's single factor test, widely used for CMV diagnosis, was implemented; it confirmed the appropriateness of the data for further analysis.

Each component of innovation capabilities was addressed from various angles which formed a set of questions (items) for each latent variable; they accounted for intensity of exploitation of a particular type of resources in innovative operating activities, uniformity of distribution of resources in various fields of activity, completeness and adequacy of resources, as well as the process of planning. The items composition was formed on the basis of recommendations from a number of consulting agencies, Eurostat, Rosstat, as well as some previous empirical studies. While developing a questionnaire specific forms of statistical reporting were analyzed and integrated in the survey, i. e. Rosstat № 2-Science «Data on R&D implementation»; № 3-Inform «Data on information and communication technologies exploitation and production of related goods (works, services)»; № 4-Innovation «Data on innovative activities of organizations»; № 1-Technology «Data on creation and exploitation of advanced manufacturing technologies».

The financial component of firm's innovative capabilities include the following initial list of indicators evaluating firm's capabilities to create and exploit financial resources in its innovation activities to create core competencies:

- an ability to attract adequate financial investment in innovation activities;
- an ability to matching its growth rate to its innovative development;
- an ability to actively exploit all possible forms of investment attraction including budget funding on various levels and government support;
- an ability to distribute investment rationally among innovation actors;
- an ability to allocate funds for the implementation of innovative projects completely and uniformly.

The initial composition of the human component includes a number of items that characterize HRM practices and tools for stimulation of personnel's innovative activity. As part of the HR component of innovation capabilities a firm's management should fulfil the tasks of innovation activity development through both individual employee's development and stimulation of joint project work. Indicators of human component must evaluate firm's abilities to introduce and implement specific managerial tactics such as:

- an ability to successfully implement employees' development and training programs;
- an ability to integrate organizational culture which positively affects employees' innovative potential development;
- an ability to balance adequacy and diversity of staff qualifications;
- an ability to organize balanced distribution of qualified personnel;
- an ability to plan staff development together with their heads;
- an ability for distribute staff responsibilities in a balanced way between formal duties and innovation activities.

Technological component characterizes firm's abilities to select and implement advanced technological solutions aimed at accelerated process of innovation implementation and higher degree of development of firm's existing technological base. To assess technological component the following aspects were addressed:

- an ability to apply technologies and equipment to speed up innovation development;
- an ability to maintain similar technological level in various divisions of a firm;
- an ability to meets firm's technological needs, including availability staff with necessary qualifications to work with existing technologies;
- an ability to exploit firm's technological capacities evenly.

Indicators of information component are focused on information and communication technologies, competencies, knowledge and intellectual property. They primarily measure:

- an ability to introduce new advanced information and communication technologies and constantly increase their level;
- an ability to effectively interact via integrated information and communication technologies;
- an ability to develop and apply new methods for knowledge creation, dissemination and exploitation;
- an ability to compile competences development within different departments;
- an ability to successfully implement available competencies in operating activities to reach common goal.

This study presents one of the first attempts to measure innovation capabilities as a whole and via individual components. The results of scale reliability testing is not included into this paper due to its different focus, however, the scale appeared to be well-articulated and reliable. To address research question stated above we apply a method of fuzzy-set qualitative comparative analysis to our empirical data which allow obtaining valuable insights on the nature of innovation capabilities in Russian firms. Due to comparable novelty of the method for management field we will, firstly, elaborate a bit on its key assumptions and implications, and then, present our results.

Fuzzy set qualitative comparative analysis (fsQCA) was chosen as a major method on a number of reasons. First of all, it is based on the sets theory which allows conducting a detailed analysis of the role played by a complex of particular factors in achievement of declared results. The basic statement of fsQCA method is that a particular situation is best understood as a specific configuration of features [10]. FsQCA is especially relevant for the study as it is successfully applied to small samples which is always a limitation for traditional statistical methods. Moreover, unlike conventional linear methods, considering the influence of individual independent variables on the dependent variable, fsQCA focuses on the ways of combining independent variables to achieve the desired result, i. e. it offers various combinations of independent variables to obtain expected outcome.

FsQCA provides causal analysis by determining outcome determinants, as well as allocating sufficient and necessary conditions to achieve it [20]. Necessary conditions are those which are absolutely necessary in order to achieve the desired result. However, the presence of necessary conditions doesn't guarantee desired result achievement. Sufficient conditions are those that always lead to the desired result. The core idea of this method is that the desired result could be obtained through one of the configurations of necessary and sufficient conditions, and usually the configuration is not unique. FsQCA allows exploring equifinality, consequently, to move away from the use of averaged models which give general explanation and focus on the selection of determinants typical for various clusters of objects. Thus, fsQCA combines benefits of both qualitative and quantitative research methods, i. e. takes into account diversity and specificity of each particular case and, at the same time, reveals factors and patterns common for the whole data array which allows more extensive formal generalizations [26].

The first important step of fsQCA is calibration of original data which assumes assignment of values corresponding to a degree of certain object belonging to a particular set [19]. During calibration procedure it's crucial to choose the right external criterion to convert original values. An external criterion may be chosen on the basis of common knowledge, shared scientific knowledge or own experience of a researcher obtained while exploring

Table 2

Thresholds for variables calibration

Variable	Threshold for full membership	Cross-over point	Threshold for full non-membership
Financial component	4	3	2
HR component	4	3	2
Technological component	4	3	2
Information component	4	3	2
Innovation capabilities	4	3	2

Source: developed by the authors

the problem. The external criteria must be defined explicitly, applied systematically and transparently which also serves as a distinctive feature that differentiate this method from traditional qualitative research methods and confirms its combinatory nature [20].

To prepare original data for further analysis and calibrate it, at least three thresholds should be appointed: the first one deals with a border value for full membership in a set of high values, full non-membership in set of high values and a cross-over point. Table 2 presents thresholds for the variables. Due to the fact that all the variables were measured by Likert scale thresholds values for all the values were similar.

Results

Primary analysis of calibrated values includes truth table construction and reduction of combinations under investigation. Truth table is a data matrix that contains all possible combinations of independent. Each row of a truth table describes a unique combination of variables values, and the entire table is a list of all possible combinations. As a result of the analysis and transformation of a truth table some combinations are excluded from the analysis. The remaining lines are analyzed according to two criteria: a minimum number of observations required for exploration of a particular combination and a minimum value of consistency. In order a combination of variables can be regarded as sufficient, the consistency value must be greater than 0,75-0,8 [10, 19]. Following the recommendations we set up minimum number of cases at the level of 2 and consistency level at 0,75.

The implementation of Quine-McCluskey algorithm resulted in three type of solutions: complex, intermediate, and parsimonious, the last two are specifically relevant for the analysis. Parsimonious solution provides with necessary condition for high value of output variable. In our case, to develop high level of innovation capabilities, in other words, high innovative performance, a firm must have high value of information component (Table 3).

Intermediate solution provides sufficient conditions for high values of output variable. As a result of the analysis we obtained two configurations of innovation capabilities' components that lead to high level of innovative performance through well-developed innovation capabilities (Table 4).

The first configuration assumes high values of information and HR components to develop advanced innovation capabilities. At the same time, within this configuration financial and technical components are of less importance which means that firms might be equally successful in terms of innovative performance possessing extensive financial resources or not. Technical component is not a determining factor in this configuration as well. It seems that this configuration is mostly exploited by firms introducing and developing organizational or marketing innovations, i. e. those that don't require specific equipment and large investment. The second configuration is even less dependent on financial component of innovation capabilities, however, it has technical component as an important condition of high innovative performance. This configuration might be more appropriate for mature companies that have already created a platform for innovation development and mostly focus on product and process innovations. In both configurations we see the crucial importance of information component that means the need of codification and transformation information into more constant component.

Table 3

Parsimonious solution

Variable	Raw coverage	Unique coverage	Consistency
Information component	0,893870	0,893870	0,837820

Source: developed by the authors

Conclusions

The present study provides a comprehensive analysis of firm's innovation capabilities. In order to identify factors that are essential for innovation capabilities formation and development, a configuration approach is applied to the phenomenon. To measure firm's innovation capabilities the study uses an approach based on aggregated assessment of firm's resources, processes and results of innovation activities.

In this study firm's innovation capabilities are treated as a set of firm's properties characterizing its ability to dynamically plan, create and integrate innovation resources, and, then, exploit them in operational processes. Thus, firm's innovation resources are different from innovation capabilities, moreover, they form a fundament of innovation capabilities development, more precisely, innovation capabilities characterize firm's abilities to apply, and not only accumulate innovation resources.

Using statistical forms of Rosstat as a basis for indicators development to measure firm's innovation capabilities, we ended up with four components: financial, human resources, technological, and information. Having collected the data on 75 Russian industrial firms and applied fuzzy set qualitative comparative analysis, significant theoretical and practical results were obtained. Information component of innovation capabilities was confirmed to be the core condition of successful innovative performance. This finding is in line with

Table 4

Intermediate solution

Components of innovation capabilities	Configurations	
	1	2
Financial component		⊗
HR component	●	
Information component	⬤	⬤
Technical component		●
Consistency Raw coverage Unique coverage	0,909304 0,814711 0,681961	0,851361 0,145009 0,032259
Solution coverage: 0,826970 Solution consistency: 0,870254		
Note: «⬤» — presence of core condition; «●» — presence of peripheral condition; «⊗» — lack of peripheral condition		

Source: developed by the authors

some other streams of research in the field of strategic management. Recently, a large portion of attention is given to the concept of firm's absorptive capacity which deals with firm's capabilities to attract, assimilate, transform and exploit new knowledge that is both external and internal to a firm [6, 27]. Our study contributes by specification relationships by firm's ability to obtain and process information and its innovative performance. Furthermore, two generic configurations of core and peripheral conditions identified the relevance of HR and technological components. Firm's human resources are an important storage and processor of valuable information, that's why firm's abilities to motivate and manage personnel in terms of information development and exploitation stimulate firm's innovative activities. Firm's abilities to use effectively technological capacities provide background for development of competitive advantages, first of all, driven by new technological solutions that are difficult to replicate by competitors.

Our study is not without limitations. Firstly, the sample includes only Russian firms from industrial sector which inevitably narrows the scope of application of the recommendations. Secondly, there are a number of organizational factors (firm's characteristics like age, size, life-cycle stage) could influence the relevance of this or that component. Additionally, external factors, such as a level of competition in an industry, or its technological level, could also significantly affect components combination. These issues form an agenda for further research.

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Инновационные способности российских компаний: определяющая роль информационной компоненты

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Цель статьи состоит в исследовании наиболее значимых элементов инновационных способностей фирмы. Выделив четыре ключевых элемента (финансовый, кадровый, информационный и технологический) и разработав специальные шкалы для их измерения, авторы применяют качественный сравнительный анализ с использованием нечетких множеств к исследованию данных по 75 российским фирмам промышленного профиля. Доказано, что информационный элемент выступает необходимым условием для достижения высоких результатов инновационной деятельности, в то время как кадровый и технологический элементы являются достаточными условиями и формируют по отдельности две конфигурации инновационных способностей. Выявлено, что финансовый элемент является наименее значимым для результатов инновационной деятельности.

Ключевые слова: инновационные способности, инновация, конфигурация, КСА.