Dynamic capabilities and their impact on research organizations' R&D and innovation performance

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Abstract

Purpose – The purpose of this paper is to reveal and justify influential factors of dynamic capabilities on research organizations' R&D and innovation performance.

Design/methodology/approach – Adoption of seminal D. Teece's (1997) concept of dynamic capabilities and operationalized matrix of key performance indicators in the area of R&D and innovation allowed the construction of the strategic management model for research organizations, consequently tested by methods of statistical analysis.

Findings – The empirical findings reveal that there exists positive influence of the dynamic capabilities on research organizations' R&D and innovation performance. Explicitly, sensing, seizing and re-configuring dimensions of dynamic capabilities have positive impact on R&D and innovation results; consequently, the peculiarities of their inter-dependencies are identified.

Research limitations/implications – Delivered research is based on the investigation of Lithuanian research organizations' dynamic capabilities and their impact on their R&D and innovation performance. Therefore, further research could be extended to foreign countries.

Practical implications – The model on management of research organization's dynamic capabilities with the aim for better R&D and innovation performance is conceptualized and specified hereinafter. In the course of the research, constructed toolkit to eventually measure research organization's R&D and innovation performance or use it as the set of key performance indicators in the benchmarking exercise is suggested.

Originality/value – The paper is one of the first to suggest novel application of dynamic capabilities' view within the domain of research organizations.

Keywords Dynamic capabilities, Strategic management, R&D and innovation performance, Research organization

Paper type Research paper

Introduction

At present, the pace of research on dynamic capabilities suggests rich intellectual structure of the research domain, providing the foundations of a concept on dynamic capabilities, an individual organization and further extrapolating to growth, markets and alliances (Stefano *et al.*, 2010). However, ambiguous scholarly interpretation on the notion of dynamic capabilities, starting from Teece *et al.* (1997), Eisenhardt and Martin (2000), Winter (2003), Teece (2007, 2010), Helfat and Peteraf (2009) and Helfat and Winter (2011), only suggests theoretical considerations that argue in favour of dynamic capabilities influencing organization's performance in response to market and technological changes. Despite variety of forms and functions, dynamic capabilities provide opportunities for knowledge exploration and exploitation, continual update of routine processes, interaction with environment and base for strategic decision-making (Easterby-Smith *et al.*, 2009). Accordingly, dynamic capabilities are assumed to be at the core of strategic management in

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the field of organization theories, even though operationalization of the notion itself by various academicians differs.

The emphasis in this article is that despite diverse theoretical considerations and empirical works on dynamic capabilities of small and medium size enterprises (SMEs) or global firms, universities or research institutes (research organizations) rarely consider dynamic capabilities of prime importance for strategic management, value creation or competitive advantage in research and development (R&D) and innovation area. But the contradictory reality is that the heterogeneity of R&D evaluation systems across countries provide with the assumption that governments seeking for research "excellence" and striving for outstanding academia-business cooperation results, position institutional R&D and innovation performance as competitive fundamentals of national economies.

Research problem of this article therefore concentrates on whether dynamic capabilities of research organizations influence their R&D and innovation performance. The proposed subject of interaction between dynamic capabilities and R&D and innovation performance is important for research organizations as complimentary part of their strategic management that should be taken into account responding the changing R&D and innovation context and validating their competitive strategy.

The article reviews theoretical and empirical research findings on research organizations' dynamic capabilities and R&D and innovation performance indicators. It includes analysis of yearly reports of Lithuanian research organizations on their achievements. Pilot questionnaire for the target groups (administration related to institution's R&D and innovation activities, academic community (leading and young researchers) is conducted within the network of Lithuanian research organizations. Subsequently, conceptual interaction model of research organizations' dynamic capabilities and their R&D and innovation performance is provided. Validated suggestions for the formation/development/change of strategic management for research organizations in the light of changing R&D and innovation context are drawn.

Theoretical framework

While introducing the notion of dynamic capabilities, Teece *et al.* (1997) suggested their primary importance for the ultimate effectiveness of organizational performance. According to Teece, dynamic capabilities indicate the firm's abilities to uniquely align and realign idiosyncratic resources/competences to respond the changing market requirements, and thus such firm's attributes as sensing, seizing and transforming the business strategy are essential to enable the firm dynamically react to business environment (2010). The firm's capacities might be categorized into three attributes of the firm: sensing, seizing and transforming or reconfiguring the opportunities. Sensing the opportunities as well as threats across markets and technologies involves continuous customer and partner relationship management and observation of good practices on the market. *Seizing* the opportunities involves existing and emerging capabilities together with potential investments into market-friendly or potential to the market technologies. Transforming or reconfiguring the opportunities means recombination of firm's resources and operating capabilities to respond to dynamic market (Teece, 2007). This notion of dynamic capabilities, however, does not indicate clear distinction between the paradigms of sensing, seizing and reconfiguring, which creates infinite notion of the source of competitive advantage (Collis, 1994) as well as vacuum for further discussion.

In contrast to Teece's concept, Eisenhardt and Martin (2000) claim that dynamic capabilities comprise a set of specific and identifiable processes like product development, strategic decision-making and forming of alliances; thus, they are not unique or vague but at

the same time idiosyncratic and organization path dependent. This suggests the feature of distinct commonality or "best practice" cases across organizations. Certainly, dynamic capabilities are context dependant and differ when compared more stable environment with its variation notion for the organization or highly changing environment and its selection emphasis for the organization, but the centric role in any case belongs to the learning mechanism, which is most important for the evolution of dynamic capabilities. Finally, the emphasis of this scholarly interpretation lies in the resource reconfiguration for competitive advantage, not dynamic capabilities, if to take the long-term perspective (Eisenhardt and Martin, 2000).

Researchers try to unify these two conflicting or altering clarifications on dynamic capabilities. Peteraf *et al.* (2012) argue that these two different conceptual frameworks can be logically integrated into one predictable model based on the assumptions that despite the nature of dynamic capabilities or market dynamism, dynamic capabilities may enable organizations attain competitive advantage in certain conditional cases. These could be framed by assessing the dynamism of environment, taking into account idiosyncratic aspects of best practice, weighing the level of managerial decisions or looking for the so-called higher-order dynamic capabilities (Peteraf *et al.*, 2012).

Furthermore, some researchers claim that essential dynamic capabilities include such attributes as reconfiguration, leveraging, learning and knowledge creation, integration and sensing as well as seizing (Ambrossini *et al.*, 2009; Barreto, 2010). Learning is central, the so-called higher-order capability, that supplies an organization with new but adequate knowledge that facilitates creation and modification of its capabilities and resources (Teece, 2007; Zahra and George, 2002; Zollo and Winter, 2002, Easterby-Smith and Prieto, 2008). Sensing and seizing opportunities together with the capability to generate new knowledge are the base for creation of new products in response to market demand (Helfat and Peteraf, 2003). But here it should be emphasized that new knowledge inside an organization is impossible; therefore, it is vital to absorb knowledge from outside sources (Chesbrough, 2003; Lichtenthaler and Lichtenthaler, 2009). These notions on dynamic capabilities are based on the provision that they arise from the firm's ability to continuously create new capabilities, but not necessarily are caused by tangible or intangible resources or organizational routines, processes or ordinary firm's capabilities (Cepeda and Veras, 2007).

One may expect that greater use of dynamic capabilities enable an organization to reach better performance; especially, this is argued in the early discussions on dynamic capabilities and its direct impact on organizational performance (Teece *et al.*, 1997; Zollo and Winter, 2002). Certainly, scholars like Eisenhardt and Martin (2000) were less confident on this direct influence, stating that dynamic capabilities *per se* are not the only source of competitive advantage; resource configuration that managers build using dynamic capabilities matters a lot. Whereas Zahra *et al.* (2006) already claimed this relationship being indirect, influencing the quality of substantive capabilities changed by dynamic capabilities.

The impact of dynamic capabilities to direct and indirect organizational outcomes were recently also tested by Nedzinskas (2013) presuming the causal relations between organization's dynamic capabilities and its financial (direct) and non-financial (indirect) performance. This research proved immense role of organizational inertia in volatile environment in this way justifying exploitation of dynamic capabilities in highly dynamic environment for the construction of organization's competitive advantage.

Continuing this, there still are doubts whether the organization can use all the potential of dynamic capabilities; thus, scholars like Helfat and Peteraf (2003), Barreto (2010) and Wilden *et al.* (2013) claim that dynamic capabilities are context dependant, explicating the influence

of environmental needs. This means that two factors are essential: organizational structure and competitive intensity in the market.

Organizational performance with the implication to innovativeness according to Akwei *et al.* (2007) depends on the activities invoked while creating dynamic capabilities: in-house innovations, human resource management, collaborations, acquisitions and learning activities.

Competitive intensity in its own turn determines the effectiveness of organizational performance, as dynamic capabilities become the foundation of adoption to competitive pressure and strive for survival (Wilden *et al.*, 2013). However, changing environment may have negative effect to operational/ordinary capabilities, and on the contrary, positive – to dynamic capabilities. This means that the effects of the environment is noticeable at the firm-level, but not the process one, implicating that organizations may reach better performance increasing ordinary capabilities in stable environment and dynamic capabilities in highly dynamic environments (Drnevich and Kriauciunas, 2011).

Some theories explicate the nature and effect of dynamic capabilities and organizational performance that concentrate on the path dependence of organizations, i.e. certain organizational features persisting over time, despite their relevant efficiency. According to Vergne and Durand (2011), contingency and self-reinforcement are essential conditions for path dependence, as they generate lock-in situation for the organization.

Knowledge management is claimed to be the central paradigm joining dynamic capabilities and organization's R&D and innovation performance (Easterby-Smith and Prieto, 2008; Zheng *et al.*, 2010; Yang, 2010; Zheng *et al.*, 2010). Organization's ability to absorb knowledge and create commercial outputs is also centric, when the scholars try to measure organization's absorptive capacity in accordance with innovations and performance (Kostopulous *et al.*, 2001). However, knowledge-utilization capabilities directly reflect organization's innovative performance rather than R&D intensity's effect on organization's outputs. Therefore, knowledge acquisition and dissemination capabilities enable and support immensely organization's innovation functions, but this for better results should be embedded by managing organization's dynamic capabilities (Jantunen, 2005).

When coming to research organizations in scientific literature, they are unanimously called knowledge-based entities (Guldenberg and Leitner, 2008). Most scholars tend to stress importance of knowledge management as the source for profitability or competitive advantage (Artz *et al.*, 2010). But knowledge management processes and strategic planning should be intertwined, which means that strategic management of knowledge creation should be flexible, highly participatory and give opportunities to organizational learning (Guldenberg and Leitner, 2008).

The reality is contradictory, as due to the shift from basic to more applied R&D as well as innovation activities, research management has become highly complex, sometimes even highly bureaucratic and legalistic (Chronister and Kulakowski, 2006, pp. 4-31), requiring multitude attitudes to common goal and leadership for R&D activities simultaneously.

Entrepreneurial research organizations are claimed to be more competitive, hence possessing greater abilities to be context-sensitive and in this way capable to implement sustained long-time strategy (Gibbons, 2000). The concept of Triple Helix theory even more inclines the research organizations towards the market-orientation. Scholars referring to this perspective argue that research-industry-government collaboration generate greater sources of funding for research organizations, consequently fulfilling market imperfections and responding social welfare problems (Etzkowitz and Leydesdorff, 2000). Inter-institutional collaboration between the funding bodies, academia and entrepreneurs thereof is

fundamental for R&D and innovation agenda (Benner and Sanstrom, 2000). Consequently, management of research organizations shift from original purely academic bottom-up approach towards more market-oriented top-down approach to address this "third mission", but these attempt face difficulties due to barriers of reframing attitudes of academic community (Philott *et al.*, 2011).

When elaborating on R&D and innovation performance measurement, its needs to be stated that publication and co-publication metrics are most conventional measures for evaluating scientific productivity. Denominating feature of such evaluation is individual. At present, publication and co-publication evaluation is expanded with certain coefficient on academic journal rankings. The latter, on the one hand, provide qualitative features for the performance measurement, but on the other hand, they may influence research agenda due to specific issues considered in the journals themselves. That is the reason why, such scientific metrics include citation assessment, even though publication and citation patterns may vary across disciplines. The number of variations on indices on scientific productivity (like Redner's index, g index, etc.) indicates a gap for universal scientific metrics for assessing individual researcher's input (Kaur *et al.*, 2013).

But the approach of new public management with its methods taken from private sector and adapted to the public one caused an increased attention to the measurement of, first, public entities' and currently on research organizations' performance. Accountability and efficiency based on quantitative performance instruments and external audits became the main elements of performance assessment.

As for research organizations, measurement from more individual level concentrating more on a researcher's job assessment has shifted to institutional level and takes judgemental perspective, i.e. evaluates past performance results by quantitative indicators (Ter Bogt and Scapens, 2012; Bazeley, 2010). Due to these factors, there was a subsequent increase in the number of new accounting practices and adoption of new measurement systems. Together with the number of publications of R&D results, citation indices such attributes as rankings of research organizations (on either regional or international level), balanced scorecards (with non-financial and financial data as well as elements of qualitative data) or financial measures indicating economic added value are included (Ter Bogt and Scapens, 2012; Zangoueinezhad and Moshabaki, 2011).

The judgemental paradigm of such quantitative approach on performance measurement affects proximity within the research agenda. This could also have implications for creativity and innovativeness of research issues. Allocation of core funds and scale of external funding influence implementation of the organization's strategy and, consequently, performance or change their research agendas (Auranien and Nieminen, 2010).

In general, scholars agree though that performance measurement of research organizations should include unambiguous measurement indicators or criteria, explicating the output (R&D and innovation products and services), input (investments of diverse nature and for diverse purposes, human resource management) and processes (networking, internal procedures). Alongside objective judgement of each sort of indicator/criteria set should follow keeping the balance for negotiating academic and managerial values.

After analysis of literature review on dynamic capabilities as well as scholarly works devoted to performance of research organizations, the need to determine literature review on their combination is obvious. However, dynamic capabilities and performance measurement of research organization up to today received little attention in scholarly literature.

Indirect link of research organizations' performance to dynamic capabilities is suggested by the definition of organizational performance as Lee *et al.* (2012) provide – "the capability

to develop new products/services, the capability to predict business or risks, the improvement of capability to cope with new information of markets".

Other researchers analyse competitiveness issues, emphasizing the influencing of the context to efficiency of research organizations. For example, according to Bazeley (2010), research performance comprise such dimensions as engagement, task orientation, research practices and intellectual processes. Hicks (2012) provide with considerations on performance-based research funding systems as national systems for evaluation of research output and its direct link to the funding means.

Herewith, despite diverse theoretical considerations and empirical works on dynamic capabilities of enterprises, research organizations rarely consider dynamic capabilities of prime importance for strategic management, value creation or competitive advantage in R&D and innovation area.

Research design, hypotheses and theoretical model

Little attention has been paid to interaction and joint effect between dynamic capabilities of research organizations and their influence on R&D and innovation performance. In scientific literature, dynamic capabilities were addressed more from the perspective of efficient knowledge management in firms (Cegarra-Navarro and Cepeda-Carrión, 2010; Zheng *et al.*, 2010; Wallin and Krogh, 2010), but no thorough analysis were performed on research organizations as the ones producing knowledge and in this way influencing the whole knowledge transfer path. *Research problem* of this article therefore concentrates on whether dynamic capabilities of research organizations influence their R&D and innovation performance. *The goal of the article* is to reveal and justify influential dimensions of dynamic capabilities on research organizations' R&D and innovation performance. The proposed subject of interaction between dynamic capabilities and R&D and innovation performance is important for research organizations as complimentary part of their strategic management that should be taken into account responding the changing R&D and innovation context and validating their competitive strategy.

Research design starts with the definition of research constructs. Afterwards, raising of hypotheses and elaboration of theoretical model follows. Subsequently, research instrument is developed and processing data collected and analysed.

The architecture of dynamic capabilities during this research invokes the essential dimensions of research organization's knowledge management constructed with Teece *et al.* (1997). Teece (2007) suggested elements of ecosystem framework for sensing, seizing and reconfiguring capabilities. This principle allowed adaptation of the concept of dynamic capabilities mainly used for the private sector organizations to be applied for research organizations (Table I).

In such a way, the *sensing* element of research organization includes dimensions of external (environment) and internal (institution performance) assessment to analytically filter, shape, sense and calibrate the opportunities. Collaboration readiness as an inner feature of research organization to provide with intellectual and technical capabilities, simultaneously invoking external partners (academic, business, social, etc.) on either individual or institutional level suggests ways for identification of novel solutions based on R&D results. Learning and training dimension forms the platform for the sensing capability, as it allows development of analytical skills and institutional system for continuous search of new opportunities.

Seizing attribute is based on the strategic organizational management components; therefore, it includes strategic planning, organizational design, infrastructure base and organizational processes. Addressing the opportunity requires relative activity model, even

Dynamic capability	Dimension of dynamic capability
Sense	Collaboration readiness
	Learning and training (analytical skills and individual capacities)
	Performance assessment
	Environment assessment
Seize	Strategic planning
	Organizational design
	Infrastructure base
	Organizational processes
	Organizational compatibility (culture, motivation and loyalty, decision making, collaborative working style, diverse professional orientation, conflict resolution)
Reconfigure	Leadership
	Governance (de-centralization, co-specialization)
	Resource configuration (technological assets, intellectual capital)
	Commercialization of R&D and innovation results (knowledge and technology transfer; intellectual property protection)

Sources: Adopted from Teece (2007), composed by authors

Table I. Framework of research organization's dynamic capabilities and their dimensions

though research organizations, especially the public ones, sometimes find it difficult to perform in flexible way. Architecture of organizational structure and processes, as well as maintenance and improvement of technological assets, allows possibilities to match demand in this capturing the opportunities. Here, organizational compatibility plays immense role for effective strategic management of research organization. This dimension indicates status of organizational culture, collaborative working style, motivation and loyalty of personnel, decision-making, conflict resolution provisions as well as professional co-specialization, which forms the background for the team work.

Reconfiguring capabilities here denominates the way to success of research organization's activities. Contrary to the private sector organizations that usually measure their success by profitability and economic growth, the key to research organization's successful performance depends on its ability to demonstrate relevant leadership and execute adequate governance for transformation. Resource recombination following the dynamics of the environment build the foundation for research organization's ability to become flexible and choose other solutions distracting from sort of "path of dependency". Commercialization of R&D and innovation results here gains immense importance, as this dimension enables research organization to break limitations of academic results and create the balance between academic "supply" and social or business "demand".

The second construct in the research – research organization's R&D and innovation performance is defined invoking analysis of research organizations' yearly activity reports and includes the number of R&D and innovation indicators. This framework is composed after analysis of selected Lithuanian research organizations' yearly reports for 2011, 2012 and 2013 (four state university; three state research institutes; two private universities). The choice of these research organizations justified flexibility of the framework, as state and private universities and research institutes are included at the same time representing diverse profile of them: technical vs social/humanities; classical vs technical and the like. The period of three years for the content analysis of the yearly reports was chosen due to the repetitiveness of data in the reports. In this way, validity of the formed construct for this research is ensured.

The matrix on R&D and innovation performance below is constructed including two paradigms for measuring research organization's performance: indicators of individual activities of researchers and indicators of institutional activities. However, it should be noted that the proposed framework does not depict official toolkit for R&D and innovation performance; rather; it demonstrates most frequently mentioned key performance indicators that are provided by research organizations themselves in their publicly available yearly activity reports (Table II).

This toolkit has certain limitations as it includes only quantifiable indicators, without qualitative notions. It also is based on the principle of frequency of occurrence in the yearly reports; thus, it cannot be considered the final list. Despite this, the suggested toolkit can propose a possibility to note dynamics of R&D and innovation performance over a certain period, differentiate between universities and institutes that have diverse organizational architecture and strive for diverse goals. In this way, the toolkit for measurement of R&D and innovation performance can also serve as benchmarking instrument – for either internal (between structural units of research organization) or external benchmarking (between separate research organizations).

It should also be stressed that research design is composed taking into consideration that research organizations' dynamic capabilities in this research denote independent variable, whereas R&D and innovation performance hereinafter refers to the dependant variable. In summary, both research constructs – dynamic capabilities and R&D and innovation performance – are multi-dimensional. Their detailed and structured operationalization explicated above allows the formation of the background for the whole process of research design, especially formation and testing the hypotheses.

Following the goal and objectives of the thesis, three groups of hypotheses were developed. Presumably, dynamic capabilities and their dimensions in more detail (sensing, seizing and reconfiguring) positively influence research organizations' R&D and innovation performance and then the hypothesis would be stated as follows:

H1. Dynamic capabilities have positive impact on research organizations' R&D and innovation performance.

H1a. Sensing has positive impact on research organizations' R&D and innovation performance.

H1b. Seizing has positive impact on research organizations' R&D and innovation performance.

H1c. Reconfiguring has positive impact on research organizations' R&D and innovation performance.

By considering the contrary presumption, dynamic capabilities may have negative influence of research organization's R&D and innovation performance. In such case, the following hypotheses can be formulated:

H2. Dynamic capabilities have negative impact on research organizations' R&D and innovation performance.

H2a. Sensing has negative impact on research organizations' R&D and innovation performance.

H2b. Seizing has negative impact on research organizations' R&D and innovation performance.

Table II. Toolkit for measurement of R&D and innovation performance used by Lithuanian research organizations

Individual indicators	*Individual R&D activity results*	*Financial flows*	Institutional indicators *Project management*	*Doctoral studies*	*Initiatives*	*Innovation output*
Research organization						
Publications in Thomson Reuters Web of Knowledge data base ISI (with citation index; without citation index); Conference presentations; Science populiarization articles, Awards	Income from national R&D programmes; Income from international R&D programmes; Direct state subsidies for R&D activities acc. to R&D; Income for R&D servces from economy subjects (incl. private sector) assessment results	International projects (FP7, H2020, Eureka, COST, etc.); Projects from national programmes (LMT, MITA)	New PhD students; Defended PhD theses	Organized scientific conferences; Publication of institution's academic journals and conference articles; New partnerships; Entrepreneural training; Student scientific activities	Submitted patent applications to LR national patent bureau; Submitted patent applications to EPO; Submitted patent applications to WIPO; Received patents; Established spin-off companies	
Universities						
Institutes						

Source: Developed by authors

H2c. Reconfiguring has negative impact on research organizations' R&D and innovation performance.

Finally, dynamic capabilities may have no impact on research organizations' R&D and innovation performance. This probability can happen involving all dimensions of dynamic capabilities or each of them separately and thus can be stated in the following way:

H3. Dynamic capabilities have no impact on research organizations' R&D and innovation performance.

H3a. Sensing has no impact on research organizations' R&D and innovation performance.

H3b. Seizing has no impact on research organizations' R&D and innovation performance.

H3c. Reconfiguring has no impact on research organizations' R&D and innovation performance.

Theoretical model provided below depicts the raised hypothesis to be tested and the research plan (Figure 1).

Theoretical model consists of four parts. In the first place, it directs to R&D and innovation performance as a constant of key performance indicators (without numerating them separately) that are usually used by research organizations to measure their R&D and innovation performance.

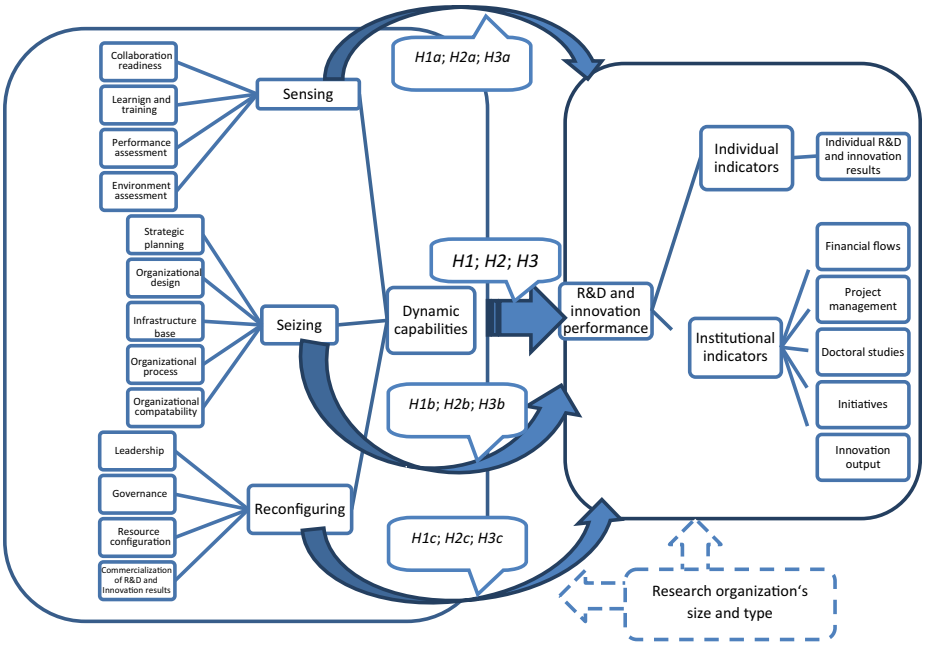


Figure 1.
Theoretical model of research organization's dynamic capabilities and their influence on R&D and innovation performance

Source: Composed by authors

Second, this model evaluates research organization's dynamic capabilities *per se* and analyses their influence on research organization's R&D and innovation performance. Third, it provides with detailed analysis of such impact of each dimension of dynamic capabilities – sensing, seizing and reconfiguring. The hypotheses for these two elements raised are depicted presuming the causal relations between dynamic capabilities and R&D and innovation performance exist and have positive impact (exist), but have negative impact, and they do not exist.

Finally, the rating opportunity of dimensions of dynamic capabilities allows assessment their importance and inter-dependencies for successful research organization's R&D and innovation performance. At the same time, attempts to reduce and indicate statistically important components within the framework of dynamic capabilities provided with additional considerations for the heterogeneity of the concept of dynamic capabilities and substantial implications for their application for research organization. This step of the research plan finalizes the foundation for the suggestions on the strategic management of research organizations.

Lithuanian context chosen for the analysis of this research can be justified by several factors. From a general perspective, dynamic capabilities are context-dependant, and this refers to the necessity of change to stay competitive within changing environment. Lithuanian R&D and innovation ecosystem is of small scale, but currently experiences due to market-oriented changes. External environment needs (e.g. local, regional and even global; rising from business or societal stand-points) force Lithuanian research organizations that are structurally small, but numerous within local R&D landscape to apply different adaptation measures. Inner competition within the national system influences the degree of openness and patterns of flexibility of strategic decisions of Lithuanian research organizations, even though it should be admitted that the velocity of change sometimes rises more from inertia than deliberate endeavours.

Nevertheless, such context for this research allows generalizability of research results to a more global perspective. It can be grounded on the general pattern that only several decades ago research organizations have started developing entrepreneurial competences. Context-sensitivity of Lithuanian research organizations has also become relevant due to external drivers. From political perspective, the country's accession in the European Union a decade ago and its simultaneous participation in the European R&D and innovation area caused changes for the research organizations as well. In parallel, greater expectations from society together with requirements for accountability for the tax-payers money investment into research activities also cause efficiency and higher degree of openness of research organizations. In this way, framing of competitive advantage in dynamic and highly changing market environment becomes crucial, despite the rigidity of academic community.

According to the official register of Lithuanian Science and higher education institution available on the website of the Ministry of Education and Science of Lithuania (www.smm/aikos.lt), there are 42 research organizations in Lithuania. These are 16 public universities, 6 private universities, 13 public research institutes and 7 private research institutes. However, among public universities there are 2 priest seminaries that execute only studies, but do not perform any role in R&D and innovation activities being not the target of this research. In this way, the sample of this research does not include priest seminaries, finalizing the total of 40 research organizations included. The notion of institutional sample is important here, as the empirical findings will be based on the institutional features.

A pilot questionnaire was designed for the research organizations in Lithuania. Pilot questionnaire for two target groups (administration related to institution's R&D and innovation activities and academic community (leading and young researchers) comprise 55

questions that are formed to evaluate research organization's dynamic capabilities and their impact on R&D and innovation performance. Pilot questionnaire was helpful in gaining the evaluations of research organizations' strategic (formal and informal) management, the path of value chain within the institutions and its harmonization with R&D and innovation environmental context.

The link to the pilot questionnaire to the target groups was sent via e-mail in January 2015. Received quantitative research data were analysed by applying methods of statistical analysis, looking for correlations between operationalized paradigms determining dynamic capabilities: sensing, seizing and reconfiguring – and R&D and innovation results. Other instruments of descriptive statistics, for example, used for reliability, frequency and ranking testing, were also used in the data analysis.

Research results

During this research, 48 completed questionnaires were received, representing 31 research organizations in Lithuania. The questionnaire was completed by 16 universities (13 state and 3 private) and 15 research institutes (11 state and 4 private). As the basis of the research is institutional, statistical reliability of the intended sample of 40 research organizations that act in Lithuania is 28, when confidence interval is 10 and confidence level 95 percent. In this case, the sample of the research with 31 research organizations conducted is statistically reliable.

Quality of scale was tested by Cronbach's alpha coefficient, which indicated the reliability of the chosen scale, when its index is close to 0.8 and comes closer to 1.0 (Vaitkevičius and Saudargienė, 2006, p. 156). Cronbach's alpha test resulted in 0.893 for six sections of the questionnaire, which indicate substantial reliability.

Demographical features of respondents were measured in five ways: according to their age, degree of education, employment institution, position in this institution and tenure in the position. A typical respondent is aged over 41, has a PhD, occupies either science administration position or deals with R&D and innovation activities working for 10 and more years at current research organization. In this way, responses to the questions in the questionnaire were based on the respondents' sufficient professional experience and provides with rich and reliable information.

While testing the hypotheses, Pearson's correlation coefficient (hereinafter - r) was chosen to measure relations of these two research constructs. Table III depicts that correlation between the constructs is very significant ($r = 0.827$). Therefore, *H1* is supported, whereas *H2* and *H3* are not approved. In other words, research organizations' dynamic capabilities have positive impact on R&D and innovation performance, in this way rejecting the hypotheses that dynamic capabilities may have negative or no impact on R&D and innovation performance.

Further on, *H1a*, *H2a* and *H3a* were tested. For this step, the replies in the questionnaires were categorized for sensing capability and R&D and innovation performance. Pearson's correlation coefficient for this step (Table III) indicated that the correlation is also significant, i.e. $r = 0.784$. In other words, it resulted in the relation of sensing capability to R&D and innovation performance.

Pearson's correlation coefficient for the replies categorizing the seizing capability was also calculated and resulted as significant ($r = 0.688$); thus, there exists the relation between seizing capability and R&D and innovation performance of research organization. In this way, the result supports *H2a* and denies *H2b* and *H2c*.

Finally, reconfiguring capability and its relation to R&D and innovation performance resulted as $r = 0.670$. Certainly, the relation is weaker in comparison with the above

	Dynamic capabilities	Correlations R&D and innovation performance	Sensing	Seizing	Reconfiguring
Dynamic capabilities					
Pearson Correlation	1	0.827**	0.742**	633**	707**
Sig. (2-tailed)		0.000	000	000	000
N	48	48	48	48	48
R&D and innovation performance					
Pearson Correlation	827**	1	784**	688**	670**
Sig. (2-tailed)	000		000	000	000
N	48	48	48	48	48
Sensing					
Pearson Correlation	742**	784**	1	733**	695**
Sig. (2-tailed)	000		000	000	000
N	48	48	48	48	48
Seizing					
Pearson Correlation	633**	688**	733**	1	733**
Sig. (2-tailed)	000	000	000		000
N	48	48	48	48	48
Reconfiguring					
Pearson Correlation	707**	670**	695**	733**	1
Sig. (2-tailed)	000	000	000	000	
N	48	48	48	48	48

Note: **Correlation is significant at the 0.01 level (2-tailed)
Source: Developed by authors

Table III.
Correlations between dynamic capabilities (incl. sensing, seizing and reconfiguring) and R&D and innovation performance

analysed correlations, but anyway, the test shows that relation between reconfiguring capability and R&D and innovation performance exists. In this way, *H3a*, *H3b* and *H3c* were tested, where *H3a* was supported, and *H3b* and *H3c* were not approved.

Summarizing the hypotheses tested, four hypotheses (*H1*, *H1a*, *H1b* and *H1c*) with positive dynamic capabilities' influence on research organizations' R&D and innovation performance were approved. Eight hypotheses (*H2*, *H2a*, *H2b* and *H2c*; *H3*, *H3a*, *H3b* and *H3c*) with negative or no dynamic capabilities' influence on research organizations' R&D and innovation performance were disapproved. Thus, it can be stated that dynamic capabilities have positive impact on research organizations' R&D and innovation performance (presuming that type and size of research organization are not influential, but may be considered as control variables). The strongest impact according to the research conducted has the sensing capability. Afterwards, seizing capabilities influence the research organization performance. Significant, but weaker impact has been noticed by reconfiguring capabilities. Hypotheses rendering dynamic capabilities' negative or no impact on research organizations' R&D and innovation performance were rejected during the research.

Furthermore, to estimate the relationships among dimensions of dynamic capabilities (sensing, seizing and reconfiguring) and R&D and innovation performance deeper multiple regression analysis was performed (Table IV).

Multiple correlation coefficient $R = 0.809$ indicated a good level of prediction. $R^2 = 0.655$, which showed that independent variables explain substantially the variability of the

Table IV.
Regression analysis summary results

Model		Coefficients[a] Unstandardized coefficients B	Standard error	Standardized co efficients Beta	*t*	Significance	95% Confidence interval for B Lower bound	Upper bound
1	(Constant)	−244	408		−600	552	−1,066	577
	Sensing	646	164	545	3,931	000	315	978
	Seizing	159	143	162	1,109	273	−130	448
	Reconfiguring	181	145	173	1,248	219	−111	474

Note: [a]Dependent variable: R&D and innovation performance
Source: Developed by authors

dependant variable, i.e. R&D and innovation performance. F-ratio resulted in overall fitness of regression model for the data [(F 3, 44) = 27,797, $p < 0.0005$].

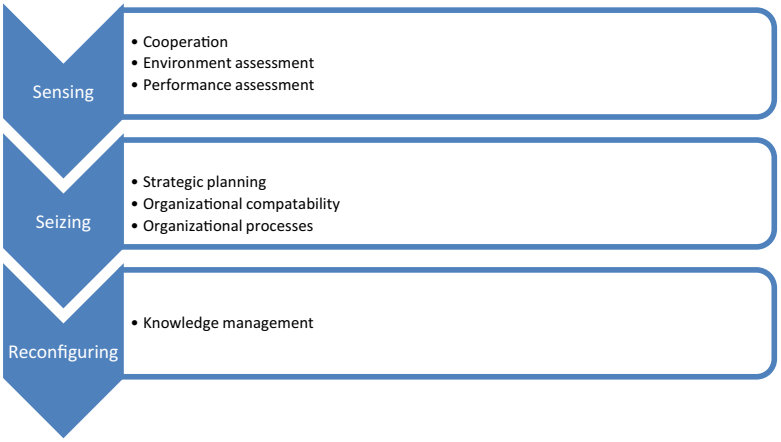
The results of the regression analysis revealed that sensing capabilities were statistically mostly influential for R&D and innovation ($\beta = 0.545$; $p = 0.000$). Seizing capabilities showed less regression effect for R&D and innovation performance ($\beta = 0.162$; $p = 0.273$), which was similar to the regression effect of reconfiguring capabilities and R&D and innovation performance ($\beta = 0.173$; $p = 0.219$).

Therefore, implications for the significance of sensing capabilities for R&D and innovation performance results should be maintained high when strategically forming research organization's competitive strategy. This, in detail, suggests positioning of collaboration, learning and training activities as well as performance assessment and assessment of environment highly on the research organization's strategic management agenda. At the same time, statistically similar weights of seizing and reconfiguring capabilities presuppose the importance of balance between the decisions to seize the opportunities and reconfigure the capabilities and resource to achieve the best performance results.

In the second part of the questionnaire, the respondents were also asked to rank all dimensions of dynamic capabilities according to their importance. The replies hereinafter were analysed in two ways. First, the ranking exercise allowed clarification of important attributes within dimensions of dynamic capabilities. Second, it also provided with the opportunity to test for possible inter-dependencies and new dimensions within the elements composing dynamic capabilities.

Using the frequency scale, the results indicated that most important dimension of dynamic capabilities is cooperation. Afterwards, strategic planning plays important role. Organizational compatibility is weighted by almost the same importance. Organizational processes are also vital. Finally, knowledge management concludes the top five most important dynamic capabilities.

Summary of the prioritization of dimensions of dynamic capabilities by the respondents and their dependency to dynamic capabilities (sensing, seizing and reconfiguring) can be pictured (Figure 2).



Source: Developed by authors

Figure 2.
Most important dimensions of dynamic capabilities

Furthermore, this exercise indicated that to capture beneficial opportunities, collaboration readiness plays immense role, despite the sort of collaboration (external, internal) or its object (academic, business). Analytical evaluation of historical perspective of institutional performance as well as objective analysis of environment here also helps to capture or sense the opportunity.

Moreover, the seizing element requires strong skills in strategic planning, which is natural for any company, despite its performance either on private or public domain. Surprisingly enough, the respondents indicated the importance of organizational processes, with significantly less attention to organizational design or infrastructure base. This denies the stereotypical notions that R&D and innovation results basically depend on modernity, suitability and complexity of possessed infrastructure. Smooth and relevant processes within organization determines adequate address of opportunities. Organizational compatibility in the seizing attribute ranked high, and this suggests the importance of positive organizational culture in research organization.

Finally, reconfiguring capability was basically described by knowledge management during the conducted research. This suggests that to satisfy the market dynamism flexibility within knowledge management processes is vital. Therefore, recombination of technological assets, prominence of leadership or manner of governance goes into the secondary plan. Thus, strategic assumptions within research organizations should be addressing efficient and effective knowledge management.

One of non-parametric ranking coefficients – Kendall's tau-b coefficient (hereinafter – τ) was used for testing the relations of dimensions of dynamic capabilities, as all variables in this case were measured by the same values (i.e. Likert's scale type measurement). The results showed the following inter-dependencies between the dimensions of dynamic capabilities (Table V).

Although unequal in power as indicated by Kendall's tau-be coefficient scores, these inter-dependences of dimensions of dynamic capabilities analysed indicate that the management of dynamic capabilities is heterogeneous.

To further clarify the variability of the observed correlated components, at the same time searching for unobserved but meaningful components, exploratory factor analysis was performed. Total of 13 dimensions composing the framework of dynamic capabilities as stated in Table I were entered for the analysis. The type of extraction used was principal axis factoring.

Kaizer–Meyer–Olkin measure of sampling adequacy was 0.666, which is acceptable, and the diagonal elements of anti-correlation matrix a $>$ 0.5. The analysis of average extracted communalities (Table VI) and application of the Kaiser criterion (it is reliable when the average extracted communalities are greater than 0.4) allows stating that three components should be rejected in further analysis.

In this way "Organizational processes" (0.331), "Resource management (intellectual capital, infrastructure)" (0.313) and "Organizational compatibility" (organizational culture, motivation and loyalty, decision-making and conflict resolution) (0.419) were deleted. Results of exploratory factor analysis further revealed that there were four significant factors with the eigenvalue $>$ 1 and together composing 63.5 per cent of squared loadings of all components (Table VII).

The fitness of the model is demonstrated by 11 per cent of the non-residuals with absolute values that are greater than 0.05. Oblique rotation was chosen, as there is a presupposition that factors correlate. Rotated factor matrix indicated the factor loadings, the last two factors showing one loading per each factor. To make interpretation of the factor

Influential dimension	Influenced dimension
Cooperation (sense)	Organizational design (seize)
	Knowledge management (reconfigure)
Training and education (sense)	Analysis of environment (sense)
	Organizational compatibility (seize)
Institution activities' self-analysis (sense)	Management (decentralization, professional specialization) (reconfigure)
	Leadership (reconfigure)
	Organizational design (seize)
Analysis of environment (sense)	Institution activities' self-analysis (sense)
	Management (decentralization, professional specialization) (reconfigure)
	Organizational processes(seize)
Strategic planning (seize)	Knowledge management (reconfigure)
	Management (decentralization, professional specialization) (reconfigure)
	Leadership (reconfigure)
Organizational design (seize)	Institution activities' self-analysis (sense)
	Management (decentralization, professional specialization) (reconfigure)
Infrastructure base (seize)	Organizational design (seize)
Organizational processes (seize)	Management (decentralization, professional specialization) (reconfigure)
	Institution activities' self-analysis (sense)
Organizational compatibility (seize)	Organizational processes (seize)
Leadership (reconfigure)	Institution activities' self-analysis (sense)
	Management (decentralization, professional specialization) (reconfigure)
	Organizational design (seize)
Resource management (reconfigure)	Knowledge management (reconfigure)
Knowledge management (reconfigure)	Strategic planning (seize)
	Institution activities' self-analysis (seize)

Source: Developed by authors

Table V.
Summary of inter-dependencies of dimensions of dynamic capabilities as indicated by τ

	Communalities	
Dimensions of dynamic capabilities	Initial	Extraction
Cooperation	361	609
Training and education	453	510
Institution's activity self-analysis	720	806
Analysis of environment	536	530
Strategic planning	566	580
Organizational design	525	567
Infrastructure base	503	605
Management (decentralization, professional specialization)	596	597
Knowledge management (knowledge and technology transfer, IPR protection, etc.)	637	757
Leadership	455	450
Organizational compatibility (organizational culture, motivation and loyalty, decision-making, conflict resolution)	378	419
Organizational processes	369	331
Resource management (intellectual capital, infrastructure)	412	313

Note: Extraction method: principal axis factoring
Source: Developed by authors

Table VI.
Output for communalities of the first exploratory factor analysis

Table VII.
Output for the total variance explained for extracted factors

	Total variance explained								
	Factor	Initial Eigen values		Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3,635	36,351	36,351	3,265	32,649	32,649	2,592	25,918	25,918
2	1,753	17,526	53,877	1,426	14,258	46,907	1,567	15,670	41,588
3	1,292	12,920	66,797	944	9,435	56,342	1,111	11,107	52,695
4	1,032	10,324	77,121	718	7,180	63,522	1,083	10,827	63,522
5	590	5,898	83,019						
6	505	5,045	88,064						
7	432	4,316	92,380						
8	304	3,040	95,420						
9	254	2,542	97,962						
10	204	2,038	100,000						

Note: Extraction method: principal axis factoring
Source: Developed by authors

analysis simpler, the rotation was performed again with only two factors maintained (results of the rotations – in Tables VIII and IX).

In summary, the largest factor retrieved seemed to cover all dynamic capabilities (sensing, seizing and reconfiguring). However, the second factor extracted indicated the relation to only two dimensions – knowledge management and strategic planning, which leads to reconfiguring and seizing capabilities accordingly. In essence, it allows the presumption that the first factor is related to research organization's operational capabilities dealing with organization's routine procedures, but requiring leadership, analytical skills and good management competences. The second factor implies the strategic drivers (i.e. strategic planning and knowledge management (knowledge and technology transfer, IPR protection, etc.) that are heading for higher performance potential.

Pattern matrix[a]

Dimensions of dynamic capabilities	Factor 1	2	3	4
Institution's activity self-analysis	824			
Organizational design	695			
Management (decentralization, professional specialization)	687			
Leadership	660			
Infrastructure base	581			
Knowledge management (knowledge and technology transfer, IPR protection, etc.)		−790		
Strategic planning		−771		
Training and education			895	
Analysis of environment				
Cooperation				827

Notes: Extraction method: principal axis factoring. Rotation method: Oblimin with Kaiser normalization.
[a]Rotation converged in 12 iterations
Source: Developed by authors

Table VIII. Output for rotated factor matrices

Pattern matrix[a]

Dimensions of dynamic capabilities	Factor 1	2
Institution's activity self-analysis	896	
Management (decentralization, professional specialization)	668	
Infrastructure base	633	
Organizational design	630	
Leadership	629	
Analysis of environment	542	
Training and education		
Cooperation		
Knowledge management (knowledge and technology transfer, IPR protection, etc.)		768
Strategic planning		757

Notes: Extraction method: principal axis factoring. Rotation method: Oblimin with Kaiser normalization.
[a]Rotation converged in seven iterations
Source: Developed by authors

Table IX. Output for rotated factor matrices

In this way, the implications of the exploratory factor analysis contribute to the research results by suggesting maintaining additional dimensions important for the concept of dynamic capabilities. Heterogeneity of dynamic capabilities, subsequently, signalizes precautious decisions in strategic management of research organizations.

The mosaic of dynamic capabilities within management processes of research organization may be diverse, but the attention in this case should be also maintained on the linkages among dimensions of each dynamic capability.

Consequently, the ranking exercise as well as adequate analysis of these results provided with the matrix of dynamic capabilities, which is complex, inter-connected, influential, but simultaneously can be practically adopted for projection of organization's R&D and innovation performance.

Considered all above, the summary of empirical findings can be depicted in the Figure 3 on influence of research organization's dynamic capabilities on R&D and innovation performance.

The model distinguishes the dimensions of dynamic capabilities that are important for better R&D and innovation performance results (presuming that type and size of research organization are not evaluated, but may be treated as control variables). Emphasis on the direct relation between the strategic planning capability and relevant competences to manage knowledge circulation is evident in the reconfiguring attribute of concept of dynamic capabilities. This suggests its central role on the strategic management of research organization under changing circumstances.

At the same time, the model includes the notions of operational capabilities that are vital to have efficient results when projecting the strategic drivers the research organization. This

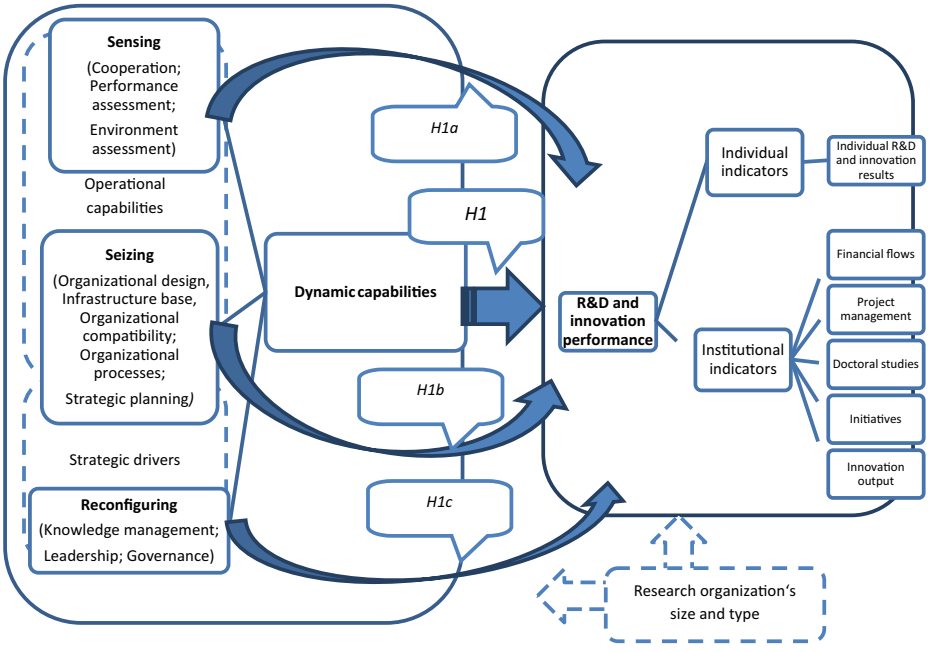


Figure 3.
Theoretical model of research organization's dynamic capabilities and their influence on R&D and innovation tested

Source: Developed by authors

presupposes that when sensing the opportunity, great attention should be devoted to analytical skills to scan environment and analyse research organization's performance results, proper choice of partners to cooperate. Seizing the opportunities requires optimal contribution of organizational design, infrastructure base, inner processes and flexibility within organizational compatibility to finally picture the organizational setting towards better performance results. Transformation processes are certainly dependant on leadership and governance modes, which indicates the reconfiguring capabilities in place. In this way, the spectrum of operational capabilities support and are vital for strategic drivers of research organization's competitive vision and pursue of an action pan.

On the other side, the model details two-side perspective towards measuring the R&D and innovation performance. The split between individual and institutional achievements to be monitored suggests heading for the best possible balance when framing the research organization's competitive strategy.

Discussion

Theoretical overview of the research constructed around two research constructs – dynamic capabilities and R&D and innovation performance – in the domain of strategic management of research organization allowed presupposing their causal relations. In this way, the empirical findings on the main research issue, whether dynamic capabilities of research organization influence its R&D and innovation performance, is provided.

Synthesis of theoretical findings indicated that for the past couple of decades, numerous considerations on dynamic capabilities as one of the central strategic management issues in the field of organizational theories have taken place. An academic discussion started by Teece *et al.* (1997), Teece (2007, 2010) and followed by the contrary perspective of Eisenhardt and Martin (2000) tried to conceptualize dynamic capabilities (perceived as composed of sensing, seizing and reconfiguring dimensions), their origins (unique vs identifiable) and management importance for the firm's competitive advantage in highly changing environment. Integration of these rather altering views was followed by more explicit indications of paradigms of dynamic capabilities, introducing the new attributes of dynamic capabilities such as leveraging, learning and knowledge creation, integration (Zahra and George, 2002; Zollo and Winter, 2002; Easterby-Smith and Prieto, 2008; Ambrossini *et al.*, 2009; Barreto, 2010).

However, all above-mentioned research studies, although analysing dynamic capabilities as part of strategic management field, just presented from various perspectives, had concentrated on private sector in various industries. Perhaps due to the usual fact that research organization act under public domain or stereotypical assumptions that research organizations are inflexible to environmental dynamism, the subject of research organization's dynamic capabilities had not received attention in scientific debates or studies.

Consequently, during this research, the construct of dynamic capabilities referred to the seminal consideration of Teece (2007), explicating the dimensions of sensing, seizing and reconfiguring as heterogeneous when approached by research organization. Therefore, such multi-layered composition of the paradigms of dynamic capabilities allowed reflection of research organization's strategic management dominants. Certainly, this attempt neither offers completely new determinants of each dynamic capability nor does it suggest new definition for the concept itself. It presumably allowed adopting the dynamic capability approach for research organization as usually considered inflexible or rigid. Lithuanian context, competitive due to small in size, but numerous research organizations acting in relatively limited local R&D and innovation system, chosen for the analysis only revealed

the importance of openness and noticeably higher degree of flexibility of academic community towards larger market – European or global – needs. Thus, taken contemporary research organization into consideration, the dynamic capabilities approach, on the contrary, becomes relevant due to inevitable dynamic environment and continuous requirement to sustain its competitive advantage on either regional or international R&D and innovation area.

Scientific attempts to determine dynamic capabilities suggested rich spectrum for discussion. Separation of dynamic capabilities from operational/ordinary/routine capabilities (Helfat and Peteraf, 2003; Winter, 2003; Drnevich and Kriauciunas, 2011) or the diverse notions on categories of dynamic capabilities (Wang and Ahmed, 2007; Ambrossini *et al.*, 2009; Prange and Verdier, 2011) supplemented to framework of strategic management of private companies. Quite complex assumptions on influencing factors/conditions for the firm's dynamic capabilities (Helfat *et al.*, 2007; Zahra *et al.*, 2006; Akwei *et al.*, 2007; Nedzinskas, 2013; Leih *et al.*, 2014; Makkonen *et al.*, 2014) suggested multi-layered implications on organizational performance. Organizational design, competitive intensity, innovativeness, organizational process alignment, organizational learning culture and the path dependence of organizations together with the notion of changing environment were empirically tested and scientifically proven influential. Thus, generalization can be formulated that majority of researches performed indicate that organization's dynamic capabilities are influential on the organizational performance in its broadest sense.

Research organization's performance, on the other hand, cannot be merely measured by profitability. Certainly, research organizations have their own management and performance peculiarities, but their role in the chain of knowledge transfer process up to commercialization of R&D and innovation-based results (products, services, processes) on the market is of high importance.

The central role joining dynamic capabilities and organization's R&D and innovation performance in scientific literature is attributed to knowledge management by a number of academicians (Jantunen, 2005; Zheng *et al.*, 2010, Yang, 2010, Wallin and Krogh, 2010). Knowledge processing capabilities and their impact on organization's innovativeness were analysed and convincingly stated a norm for building up and sustaining the competitive advantage on evolutionary market.

New public management forms embedded by contemporary governments, condition refusal of linear governance approach at research organizations and introduce more flexible, accountable and transparent management modes, certainly based on justification of R&D and innovation performance. Entrepreneurial mode of strategic management of research organizations determines academic considerations and diverse suggestions for scientific metrics: from citation indices (h index, Redner's and other), rankings of academic journals to balanced scorecards with financial and non-financial data or groups of key performance indicators on financial, internal, learning, etc., performance (Bazeley, 2010; Auranien and Nieminen, 2010; Van Looy *et al.*, 2011; Wu *et al.*, 2011; Ter Bogt and Scapens, 2012; Kaur *et al.*, 2013).

Furthermore, synthesis of scholarly findings on organization's dynamic capabilities, strategic management of research organizations, their performance and their metrics disclosed the fact that only few studies (Lee *et al.*, 2012; Bazeley, 2010; Hicks, 2012), even though indirectly, approached dynamic capabilities view within management of research organization. However, the subject of dynamic capabilities of research organization and their impact on R&D and innovation performance remained as scientific gap in the strategic management field. Therefore, the research conducted can be assumed to have approached this gap for the first time.

The delivered results suggests that contemporary research organizations performing under fast-changing circumstances can base their strategic management on the dynamic capability approach in general due to the proven fact by previously mentioned researchers that the latter have positive influence on R&D and innovation performance.

The complexity of research constructs suggested theoretical model of research organization's dynamic capabilities and their influence on R&D and innovation. It indicated positive causal relations of separate dimensions of dynamic capabilities and R&D and innovation performance. At the same time, most influential dimensions of dynamic capabilities (sensing capability with implications on cooperation and analytical competences to assess organizational performance as well as dynamic environment) imply necessity of monitoring and evaluation of changing environment and actions of performers in R&D and innovation ecosystem. Research organization's seizing capability directing to balanced organizational design, processes, infrastructure base, relevant organizational compatibility and importance of strategic planning, should be leveraged with reconfiguring capability including leadership, governance issues and stressing the importance of knowledge management.

Here, the approved central role of knowledge management for research organization is essential and proves previous scientific findings declaring that efficient knowledge management as basic axis of research organization's strategic management impacts greatly its R&D and innovation performance results (Mets, 2006, Dooley and Kirk, 2007; Easterby-Smith and Prieto, 2008; Zheng *et al.*, 2010; Yang, 2010). Recombination of resources for appropriate knowledge circulation within research organization and on its cooperation network guarantees its successful reconfiguring capability influencing its higher R&D and innovation performance results, especially evaluating contextual dynamism.

Also, inter-dependencies between all dimensions of dynamic capabilities during the conducted research revealed complexity of the dynamic capabilities' conceptual mosaic. The analysis of the underlying primary dimensions of dynamic capabilities suggested additional components of strategic drivers and operational capabilities to be addressed when formulating the competitive strategy of research organization. Simultaneously, these results provide the notions for practical implications to take these additionalities, their inter-dependencies and heterogeneity into consideration while projecting dynamic capability management.

Managerial implications

Practitioners should keep in mind that sensing or capturing the opportunities is usually influenced by adequate analytical tools for monitoring and evaluation of environment and research organization's performance in the long term. Relevant cooperation, either on academic, business or social level is critical to grasp the moment for possible success. Cooperation inside research organization, i.e. between structural units, on personal level or between early researchers and professional employees, also matters a lot.

While seizing the opportunities practitioners should concentrate on strategic planning dimension, carefully projecting and anticipating the balance of organizational design, infrastructure base and inner processes towards the strategic drivers. Similarly organizational compatibility plays immense role for seizing the opportunity for higher R&D and innovation results. Such implications as motivation or loyalty, conflict resolutions and decision-making form the foundation for changes in the organizational mindset.

When reconfiguring or transforming capabilities and/or resources within research organization, the core attention is to be kept on knowledge management. Leadership skills and research organization's governance mode serve equilibrate organization's strategy

under highly changing circumstances. In this way, essential resource of research organization, i.e. knowledge – produced, assimilated or differently used in various stages of R&D activities – can result in expected benefit.

Limitations and directions for future research

Conducted research has several limitations, which in their own turn might be taken into consideration when projecting future research on research organization's dynamic capabilities and their influence on R&D and innovation performance.

The perspective of research context might be considered as prevailing limitation of this research. The specifics of Lithuanian R&D and innovation ecosystem hinder competition on the local area by small in size and numerous research organizations. From purely theoretical considerations, this implies relevance for the research of dynamic capabilities *per se*. Practically, this also imposes certain limitations of market forces, as regional or European market might have higher velocity of dynamics, which subsequently might mean greater degree of influence on the change of competitive strategy of research organizations. But the applicability of the research findings to other economic settings can be supported by the fact that Lithuanian R&D and innovation context is orienting towards market and societal needs and evolving to completely being integrated to the European R&D and innovation area.

Also, even though reliability of sample for the questionnaire is sufficient, the fact that till today, universities and research institutes in Lithuania are treated as separate groups in terms of legal status (universities hold the status of public institution, research institutes – budgetary institution) create contradictory situation with knowledge management. Research institutes acting as budgetary institutions cannot dispose their proprietorship on intellectual activity results (patents, licences, start-ups, etc.), whereas all universities act as public institutions with proprietorship on intellectual activity results. Thus, the responses from research institutes did not include sufficient information on management of intellectual activity results.

Therefore, further investigation of dynamic capabilities at research organizations could be extended to foreign countries, for example, based on regional aspect. In this way implications on different legal status and different treatment of intellectual activities' results proprietorship would be minimized.

The same is noticed when creating the toolkit for R&D and innovation performance results. Research institutes neither provide those R&D and innovation performance results that may generate direct revenue for organizations itself nor the researcher (licences from patents, established start-ups and the like). Private research institutes in Lithuania are very few and in small scale (in terms of number of researchers and research fields explored); thus, further investigation could include foreign private research institutes that measure their R&D and innovation performance in more diverse performance.

Conclusions

The baseline of organizational theories referring to strategic management includes the concept of dynamic capabilities as substantial instrument for projecting organization's performance in constantly changing environment. Scientific contribution of the conducted theoretical and empirical research into strategic management field is dual.

First, it suggests the approach of dynamic capabilities adapted to research organizations. The research based on the analysis of Lithuanian research organizations had proven the approach on dynamic capabilities relevant to research organization despite its stereotypically presumed rigidity to changes. The main findings of the research emphasize positive impact of research organizations' dynamic capabilities (in general and as separate dimensions) for

their R&D and performance results. Therefore, the conclusion can be made that efficient exploitation of dynamic capabilities within research organization can produce beneficial R&D and innovation results under highly changing environmental conditions.

Second, it provides with the model on management of research organization's dynamic capabilities with primary aim to influence R&D and innovation performance. While delivering the research, it was proven that sensing, seizing and reconfiguring capabilities, although determined multi-dimensional, each can create solid foundations for desirable R&D and innovation performance results. This model implies that the central axis for transformational pattern within research organization lies in the strategic planning and efficient management of knowledge circulation within research organization and externally. Moreover, the model is also supported by the map of inter-depending and additional, but significant relations between dimensions of dynamic capabilities. These suggest managerial peculiarities when projecting and deploying research organization's dynamic capabilities.

As monitoring of evolutionary patterns of dynamic capabilities plays equally important role, management practitioners can also find the suggested toolkit for R&D and innovation performance results, measured on individual and institutional levels, serving for either eventual self-reflection or benchmarking exercise.

To conclude, the attempts to apply dynamic capabilities approach on research organization also offer directions for further investigation. These might be expanded to the research landscape of foreign countries with possibly more intense dynamic R&D and innovation ecosystems, regional paradigm, and inclusion of numerous private research organizations. Hereby, multi-dimensionality of dynamic capabilities may gain even more complex, but perhaps significant patterns to facilitate acceptance of such mode of strategic management among the executives of research organizations striving for better R&D and innovation performance.

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