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## Managing innovation processes in industrial sector. Qualitative study

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### ABSTRACT

The aim of this paper was to confirm the conceptual representation of innovation process by raising two interrelated questions: what is the impact of interactions on company innovation performance, and what is the relation between the design of innovation processes and company innovation performance? The aim was achieved through in-depth literature studies using the Salsa method and empirical study relying on the semi-structured interviews carried out with 24 respondents from Central and Eastern European companies. The paper presents a six-stage innovation process and the link between the design of the process, interactions within the process and innovation performance. The research suggested that designing the process to assure pre-preparation, reproducibility, information sharing, control together with managing outcome, resource interactions, external cooperation are essential from the innovation performance viewpoint. In most of the studied companies active innovation managing process was noted. The interviewees pointed out routines, formalised procedures, information sharing, transparency, reproducibility, and traceability as the key elements of improved innovation performance. Also, the role of resources interactions, benefit interactions and outcome interactions appearing at different stages of innovation process was discussed. The paper attempts to fulfil the research gap concerning the role of interactions and design of innovation process in increasing its efficiency.

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## Introduction

The importance of the management of innovation process in organizations has been a subject of many researchers, practitioners and policy-makers. However, within 85% of enterprises that name themselves as innovative only less than 50% established formal innovation process and 60% stated problems in succeeding at innovation (Sucher, 2007). The shortage of resources and the lack of knowledge and methodical

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tools were indicated as the primary obstacles impeding innovation process (Ruggerberg & Burmeister, 2008). Moreover, according to Skarzynski and Gibson (2008), most of companies do not measure innovation performance despite its importance in company development and growth. Zizlavsky (2016) confirmed this observation in Czech companies, where enterprises mainly concentrate on productivity and operational excellence.

Nevertheless, innovation performance measurement is a scientific challenge (Bititci et al., 2012). Innovation performance depends on many structural and organisational factors and varies between different sectors and even between companies in the same sector (Tidd, Bessant, & Pavitt, 2005; Božić & Rajh, 2016; Hilkevics & Hilkevics, 2017). Adams, Bessant, and Phelps (2006) showed that it depends on the range of activities such as idea generation, knowledge management, strategy, organisation and culture or commercialisation. Crossan and Apaydin (2010) indicated leadership, external knowledge, know-how, work well-being or employee activity. Recently, Ellwood, Grimshaw, and Pandza (2016) examined how innovation projects may be accelerated from original idea to launch based on the mechanisms underlying management interventions to promote speed of innovation. Recently, Benešová et al. (2018) based on young companies with high rate of growth studies in the Slovak Republic argue that management ability to optimise innovative processes, human resources and performance is considered to be of great importance. Curado et al. (2018) indicated that organisation learning capacity determines product innovation performance. Saunila (2017) points out that current knowledge of SMEs innovation performance measurement seems to be limited and suggests further qualitative studies to understand the relationship between different measures.

Therefore, the general form of innovation process was determined based on the systematic literature review taking into account its complexity. Despite determining the consecutive stages of the process such research did not offer the in-depth view on the relation between organisation of innovation processes and company innovation performance. Thus the purpose of the present research was to confirm the conceptual representation of innovation process. Moreover, in this context two research questions emerged. The first one was formulated as: what is the impact of interactions on company innovation performance? The second was specified as: what is the relation between the design of innovation processes and company innovation performance? Thus the research had both confirmatory (conceptual representation of innovation process) and exploratory (the role of design and interactions in improving innovation performance) character.

In order to achieve such purpose qualitative research was performed. It covered 24 semi-structured interviews with innovation management specialists, such as: senior management, project leaders and research and development specialists recruit from manufacturing companies representing the high and medium-high categories of technological intensity (OECD, 2011) operating in Central and Eastern Europe.

Based on detailed literature studies, a six-stage innovation process was defined as well as the link between the design of the process, interactions within the process and innovation performance. In most of the surveyed companies active innovation managing process was observed. The interviewees referred mainly to routines, formalised

procedures, information sharing and transparency, reproducibility, and traceability of innovation processes. The key components of the design of innovation process in improving company innovation performance were indicated as pre-preparation, reproducibility, information and control. Also, the interviewees discussed resources interactions, benefit interactions and outcome interactions appearing at different stages of the innovation process. The key interactions in improving company innovation performance were defined as outcomes, resource and external interactions.

Despite answering to both research questions the research was not free from limitations. First, some of the respondents experienced time pressure. Secondly, in the case of the snowballing sampling procedure it caused interviewees to respond in a cautious and conservative manner.

The presented article was prepared according to the following structure: Introduction, Conceptual framework followed by description of applied methodology and completed with Results and discussion as well as Conclusions.

### **Conceptual framework**

Innovation is of crucial importance for companies operating in highly competitive contemporary economics (Shiller, 2006). It provides them with competitive edge and allows entering new markets, increasing the market share and growing (Gunday, Ulusoy, Kilic, & Alpkın, 2011). Also it constitutes an effective tool for increasing the market value (Szutowski 2016). The evolving approach to innovation led to the perception of innovation as a complex process rather than a simple occurrence (Griffin & Moorhead, 2011). The evidence suggests that it is only through a well-established innovation processes that a company may seek for a sustained competitive advantage. Assuming that innovation is a function of all the company's core processes, inter-functional coordination and integration are required for its successful development and implementation (Vitezic & Vitezic, 2015).

The organisation of single innovation processes impacts on the innovation performance of the whole company. The impact may be perceived from different perspectives. Shenhar et al. (2002) argue innovation process to be evaluated based on three elements: customer satisfaction, budget and schedule, and business success and future potential. From the whole company perspective Kester et al. (2011) and Cooper (2001) proposed a framework consisting of three dimensions: balance, strategic fit, and value maximisation. In the present research this framework is used to analyse company innovation performance.

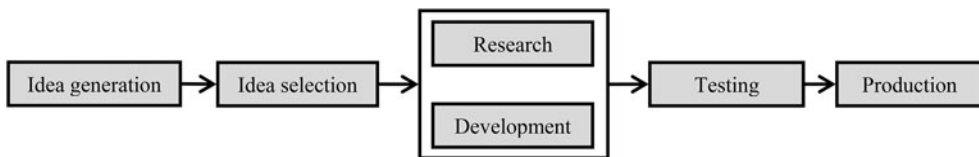
### **Innovation process**

To review extant literature associated with the relation between the organisation of innovation processes and company innovation performance, we collected 548 books, academic papers, and conference proceedings. We selected the relevant publications with the use of the Salsa method, as suggested by Booth, Papaioannou, & Sutton (2012). First we eliminated the non-English ( $n = 40$ ) and non-scientific journals ( $n = 49$ ). Secondly, we performed the title sifting, i.e., we eliminated inadequate

**Table 1.** Papers selected for synthesis and analysis.

No	Author(s)	Model type	Stages included in the model
1	Neese (2015)	Descriptive	Idea generation and mobilisation, advocacy and screening, experimentation, commercialisation, diffusion and implementation
2	Trias and Kotler (2011)	Descriptive	Objectives, research, ideas, evaluation, development, launch
3	Kamps (2013)	Graphical	Main innovation management process: Idea management, filtering, R&D, innovation controlling, patent management Supplementary process: Strategic management, customers marketing, production, market implementation, customers/market
4	Vaikuntam, Raja, and Ramachandran (2016)	Graphical	Model 1 Phase I (goal setting, project identification, project selection), phase II (research, development, production), phase III (diffusion) Model 2 Exploration (idea studies, pre-studies), process development (testing and modelling, pilot studies, plans trials), technology transfer (prestudies, preparation for production), production
5	Cormican and O'Sullivan (2004)	Graphical, descriptive, functional	Analyse environment and identify opportunities, generate innovations and investigate, plan project and select sponsors, prioritise project and assign teams, implement the plan
6	Hansen and Birkinshaw (2007)	Descriptive	Idea generation, idea conversion (including screening and funding), idea diffusion
7	Andrew and Sirkin (2008)	Descriptive	Idea generation (including development, testing, and evaluation), commercialisation and realisation (begins with the market launch and ends when the product or service comes to the end of its lifecycle)
8	Havlicek, Thalassinou, and Berezkinova (2013)	Graphical, descriptive	General process: Research, development, testing, production, commercialisation Process in SMEs: Looking for business opportunities, analysis of resources, innovation plan and decision
9	Vitezic and Vitezic (2015)	Graphical	Analysing the company to understand situation, idea generation and selection, idea realisation, implementation and launch, monitoring
10	CGMA (2013)	Graphical	Idea generation, idea selection, investment phase, launch, post-launch

Source: own development.

**Figure 1.** The innovation process.

Source: own development.

publications based on their titles ( $n = 375$ ). Thirdly, we conducted the full-text sifting. Nine papers were selected due to their high accordance with the research topic. Fourthly, we included additional paper based on the reference check using one-step forward and one-step backward snowballing, as suggested by Jalali & Wohlin (2012). Thus we synthesised and analysed 10 publications in total (Table 1).

Based on the meta-synthesis (Siau & Long, 2005) of the papers selected the general form of the innovation process emerged. It is composed of six stages necessary to develop and deliver an output. The model is a graphic presentation (Figure 1).

The starting point of innovation process – idea generation – consists of developing new concepts (Neese, 2015). It is composed of internal and external sources of ideas

and requires both creativity and astute environment observation (Hansen & Birkinshaw, 2007). The selection of ideas relies on their critical assessment from the point of view of all the departments involved (Trias & Kotler, 2011). Both stages challenge managers as the mistake here causes the whole process to fail (Andrew & Sirkin, 2008). Research and development involves creating new knowledge and implementing it in new or improved products and services (Vaikuntam, Raja, & Ramachandran, 2016). Both stages challenge staff creativity and management supervision (Cormican & O'Sullivan, 2004). It is especially the case of experimental development where establishing fixed order may be impossible (Kamps, 2013). The new solutions require to be tested, and if they succeed large-scale production follows (Havlicek, Thalassinos, & Berezkinova, 2013). Testing is generally divided into internal and external which entails either the assessment within the company or the involvement of the external actors (Vitezic & Vitezic, 2015). Production concludes the main process and dominates it as far as time and resources spent are concerned (CGMA 2013).

### ***The design of the innovation process***

Existing literature evidence explored the link between systematic and formalised decision-making and the performance of innovation process (Cooper et al., 1999; Martinsuo & Lehtonen, 2007). Structuring and formalising the management of the process may enforce the evaluation of different innovation projects and foster the communication of responsibilities, which in turn improves the overall innovation performance (Barczak et al., 2009; Cooper et al., 2001; McDonough & Spital, 2003; Müller et al., 2008; Lerch & Spieth, 2011). Formalising the innovation management process increases its acceptance among managers. Implementation of a certain routine introduces transparency, reproducibility, and traceability. The processes with such characteristics offer higher quality in decision-making and thus result in improved innovation performance (Chi & Holsapple, 2005; Kalpic & Bernus, 2006). Also such processes enforce the information sharing, which is one of the most significant factors contributing to innovation project performance (Martinsuo & Lehtonen, 2007). High information availability entails rational managerial decisions, which in turn improve the innovation performance of the whole company. The systematic and formalised design of the innovation process appears to improve its performance through objective and reproducible decisions. In this light the following research question arose: what is the relation between the design of innovation processes and company innovation performance?

### ***Interactions in the innovation process***

The success of innovation process might depend on how it deals with the interactions between the parties involved. Girotra et al. (2007) argue that project management interactions impact significantly on the success of the project. The issue is especially important in companies pursuing different innovation projects at the same time, companies using synergies between the projects or companies conducting

substitutional and complementary processes (Kavadias & Chao, 2008). The extant literature in innovation process management has not yet controlled for such factors. Evidence on the impact of interactions on certain outcome factors is rare. In this context Eilat et al. (2006) determine the three facets of project interactions. First, in the case of projects sharing same resources, resource interactions exist. Secondly, in complementary or competitive projects, benefit interactions occur. Thirdly, given that the success of a project may depend on whether another project is undertaken, outcome interactions appear. Moreover, the resources and input/output interdependencies may result in a complementation or substitution in marketing aspects. The critical role of interactions emerges in resource allocation decisions (Kavadias & Chao, 2008). Hence it is argued that interactions may shape innovation process, which in turn determines the overall company innovation performance. The following research question emerged: what is the impact of interactions on company innovation performance?

## Research methods

The methods used in the present research corresponded to both confirmatory (conceptual representation of innovation process) and exploratory (the role of design and interactions in improving innovation performance) needs of the study. Qualitative research was conducted as it allows describing, understanding, and interpreting phenomena to achieve the deep understanding of the various factors (Merriam, 2009).

The empirical research took place in the third quarter of 2016 and the first quarter of 2017. It focused on companies operating in Central and Eastern Europe. The methodology adopted in the research was based on building a theory from multiple case studies (Eisenhardt, 1989). To answer the research questions, the research was conducted using seven steps. In Step 1 the model representation of innovation process was created, the actual research questions were formulated and the initial construct was built for the study. In Step 2 theoretical samples were selected as cases. In Steps 3 and 4 the data was collected from multiple sources (interviews and secondary data) and three independent investigators performed the cross-case analysis. Further data was collected and existing analysis was overlapped to reach the theoretical saturation in Step 5. In Step 6 the conclusions were compared with conflicting or similar literature. The research questions were answered in Step 7.

As Step 2, the cases were selected to theoretically correspond to the research questions. The scope of the research encompassed manufacturing companies representing the high and medium-high categories of technological intensity, especially (OECD, 2011): pharmaceuticals (Isic Rev. 3, no 2423), chemicals and chemical products (Isic Rev. 3, no 24 excl. 2423), electrical machinery and apparatus (Isic Rev. 3, no 31) and computing machinery (Isic Rev. 3, no 30). The study reached the saturation point within the 24 respondents (representing 18 companies). First, the purposive sampling was employed to recruit innovation management specialists, such as: senior management, project leaders and research and development specialists. The selection of interviewees was based on publicly available documents and organizational web sites. The knowledge and experience in innovation management was pre-assessed. The

**Table 2.** Interviewees' characteristics.

No	Age	Gender	Job position	Experience	Industry	Area of expertise	Length of interview	Sampling
1	38	M	Project leader	13	Chemicals	Prod	23:12	P
2	45	M	Senior management	21	Electrical machinery	Prod	29:55	P
3	35	F	R&D manager	10	Pharmaceuticals	Prod	14:16	P
4	28	F	R&D manager	2	Chemicals	Prod	19:06	P
5	64	M	Senior management	40	Pharmaceuticals	Prod/proc	21:16	P
6	38	M	R&D specialist	13	Pharmaceuticals	Prod/proc	17:48	S
7	37	M	Project leader	14	Pharmaceuticals	Prod/proc	21:33	P
8	47	M	Senior management	25	Electrical machinery	Prod	12:32	P
9	36	M	Senior management	9	Computing machinery	Prod	13:22	S
10	34	M	Project leader	10	Computing machinery	Mrkt	12:40	P
11	41	M	Senior management	3	Electrical machinery	Prod	13:42	S
12	40	M	R&D manager	18	Electrical machinery	Prod	16:23	P
13	43	M	R&D manager	20	Computing machinery	Prod	22:45	S
14	37	M	Senior management	14	Computing machinery	Mrkt	17:23	P
15	32	F	Senior management	10	Pharmaceuticals	Prod	19:39	P
16	58	M	Project leader	35	Chemicals	Prod	21:37	P
17	40	M	Senior management	16	Pharmaceuticals	Prod	14:11	P
18	32	M	Project leader	7	Electrical machinery	Prod/proc	25:01	S
19	50	F	Senior management	25	Computing machinery	Mrkt	18:57	P
20	33	M	R&D specialist	23	Electrical machinery	Prod	16:41	P
21	38	M	Project leader	16	Pharmaceuticals	Prod/proc	27:38	P
22	37	M	Project leader	13	Pharmaceuticals	Prod/proc	11:26	P
23	38	F	Senior management	13	Chemicals	Prod	15:46	S
24	37	M	Senior management	15	Electrical machinery	Prod	26:45	P

Source: own development.

M – male, F – female, prod – product innovation, proc – process innovation, mrkt – marketing innovation, P – purposeful sampling, S – snowball sampling.

respondents were invited through e-mail and telephone to take part in the single interview. Secondly, snowballing sampling was used to complement the patterns presented by the initial respondents. The interviewees indicated additional participants. The characteristics of respondents are summarised in Table 2. Age and (job) experience are presented in years, industry presents the Isic Rev. 3 classification, area of expertise stands for the respondent's innovation area of expertise, length of interview is presented in minutes.

In Step 3, the data was collected through the semi-structured interviews. The unstructured interviews are useful, when there is little known about the topic. The structured interviews on the other hand rely on the ordered and fixed set of questions and patterns, which entail reduced richness and constrain respondents (Langridge & Hagger-Johnson, 2009, p. 65). The semi-structured interviews offer a consensus between the two.

The research protocol used in the semi-structured interview included 11 substantial questions. In accordance with the literature (Langridge & Hagger-Johnson, 2009), nine questions were open-ended which allowed respondents to elaborate freely. In addition to substantial questions the complementary ones covered respondent's age, experience and area of expertise. The substantial questions referred to: design of innovation process (n = 8) and interactions (n = 3). In order to prepare a protocol a trial-and-error through field-testing was performed.

The secondary data collected for the research covered firms' innovation plans (n = 6), strategies (n = 18), as well as the data on employment and age (n = 18). The



data gathered through interviews was triangulated with other sources to avoid the possible bias resulting from collecting information from only one source (the interviewees).

In Step 4, the collected data was coded and analysed. The data analysis process corresponded to the confirmatory and exploratory needs of the study. In the confirmatory mode, data was used to deliver further support for the theoretical model representing innovation process. In the exploratory mode, data was used to fill in the knowledge gaps concerning the roles of interactions and design of the innovation process in increasing company innovation performance. Thus both the 'theory first' and the 'theory after' approaches were used jointly. In this regard the research relied on the constant comparative method, which combines coding and analysis (Glaser, 2008). In order to schematise the process, the ladder of analytical abstraction by Carney (1990) was adapted. It organises data analysis and confines the coding and analysis to four interrelated steps. In the present research, the ladder was composed of:

1. Coding categories to find a set that fits (the interviews were coded and the analytical notes on linkages to various frameworks of interpretation were written).
2. Identifying themes and trends in the data overall (the relationships, emphasis and gaps in the data were identified).
3. Answering research questions and reducing the bulk of the data for analysis of trends in it (the tentative findings were cross-checked, major themes in data were re-assessed).
4. Delineating the deep structure (the data was integrated to the explanatory framework).

A group of three academics possessing necessary qualifications and experience performed the procedure. The process was highly effective as the questions corresponded to the respondents' competences. Furthermore, by dint of the methods selected the researchers could clarify and summarise the material, check the accuracy of interpretation, and explore the unanticipated responses. The use of ladder of analytical abstraction allowed passing from telling a first 'story' about innovation processes, by formalising the elements of the story – locating key details, to developing new concepts on interactions and design of the innovation process. The analysis was complemented by the data gathered from secondary sources.

It was not possible to determine the sample size a priori. The interviews were carried as long as the saturation point was not achieved and the new interviews added value to the research. In other terms, the saturation point was achieved when responses started to follow already discovered patterns. Here the studied population was homogenous, the content of the study was precisely structured and the research was well focused, which allowed reaching the saturation point by 24 interviews. When theoretical saturation was reached, additional case studies came to a halt in Step 5 of the research process.

The procedure allowed answering the research questions concerning the roles of interactions and design of the innovation process in improving company innovation

performance. However it was not free of limitations. First, some of the respondents experienced time pressure which forced the interviews not to exceed 15 min. Secondly, in the case of the snowballing sampling procedure it caused interviewees to respond in a cautious and conservative manner. The risk of the desirability bias (interviewees say what they think the researcher wants to hear) was substantial.

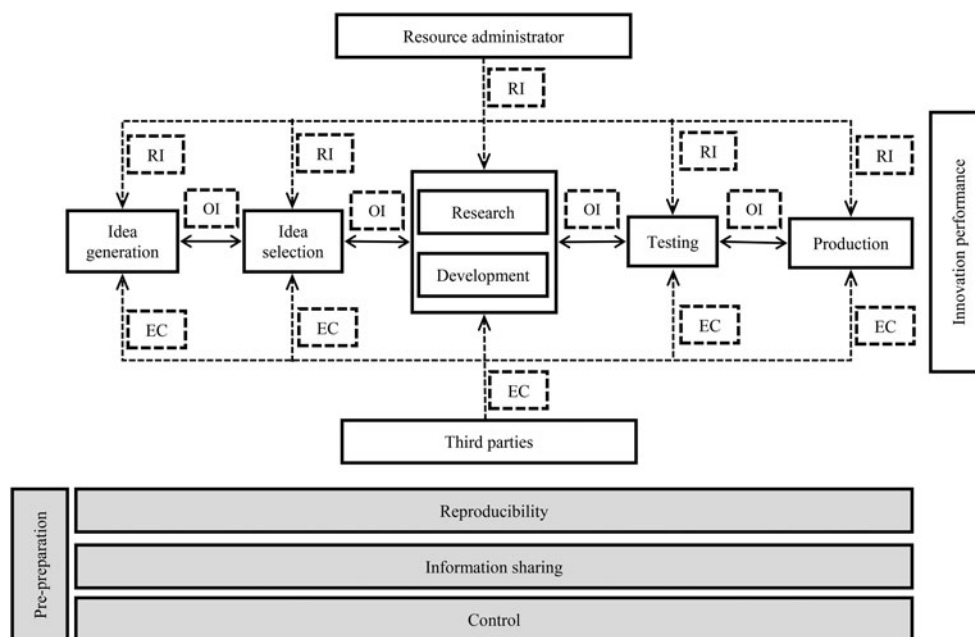
## Results and discussion

The section is organised to respond to both confirmatory and exploratory character of the study. First, the shape of the conceptual representation of innovation process is confirmed. Secondly, the research questions are answered. The concepts of design and interactions in innovation process are broken down into four (pre-preparation, reproducibility, information sharing and control) and three (outcome interactions, resource interactions and external cooperation) components consecutively.

All the respondents confirmed that innovation process covers separate stages with different parties involved at each step. It was clearly stated that efficient management of single innovation processes leads to the improved company innovation performance. All the respondents confirmed the conceptual representation of the process, but a discussion emerged for the idea generation and idea selection stages. On the one hand respondent 15 indicated that 'we do not separate these stages, we evaluate the ideas on a regular basis'. Respondent 8 followed 'once an interesting idea occurs we develop it, it happens continuously'. On the other hand the role of idea selection was stated explicitly: 'the selection of right ideas is crucial, otherwise the whole development process is pointless' (respondent 24). Furthermore, the interviewees pointed out that the innovation projects are perceived from the point of view of their impact on the whole company. The performance was verified *inter alia* by means of consumer satisfaction and product recognition (respondent 5), return on investment and the ability to build competitive advantage (respondent 14) and sales revenues (respondent 19). Despite the above-stated measures interviewees indicated that each project is perceived from the point of view of its value maximisation potential. The stated measures are partially consistent with the innovation performance framework adopted in the present research by Kester et al. (2011) and Cooper et al. (2001) who evaluate the impact of innovation project based on three dimensions: balance, strategic fit, and value maximisation.

Answering the research questions allowed indicating that designing the process to assure pre-preparation, reproducibility, information sharing and control throughout the entire process is essential from the innovation performance viewpoint. Moreover, it suggested the crucial role of interaction management at each stage of the process with special regard to outcome and resource interactions as much as external cooperation. [Figure 2](#) presents the general framework of company innovation performance including interactions within and design of innovation process. The grey boxes represent the key components of the design of innovation process, while the dotted-line boxes stand for key interactions in innovation process. The management of both leads to the ultimate high innovation performance.

In reference to the first research question on the relation between the design of innovation processes and company innovation performance the interviewees referred



**Figure 2.** Key components of the design and interactions within the innovation process.

Source: own development

mainly to routines, formalised procedures, information sharing and transparency, reproducibility, and traceability of innovation processes. The key components of the design of innovation process in improving company innovation performance are summarised in Table 3 followed by a descriptive component. The thematic presentation is based on the recommendations of Boyatzis (1998), which include label, definition, description, exclusion and an exemplary quote concerning each component.

In relation to the design of the innovation process, most respondents claimed that it is preceded by the analysis of the market opportunities 'always' ( $n=12$ ) and 'sometimes' ( $n=12$ ) and by the analysis of the company internal capabilities 'always' ( $n=14$ ) and 'sometimes' ( $n=4$ ). Such routine lays the sound foundation for the innovation process to build on as 'it guarantees the coherence of company actions' (respondent 18). Six respondents stated that internal capabilities are not analysed. 'Analysis of the market is necessary and is performed on a daily basis', respondent 2 stated. 'Our strategy determines our actions. As far as innovation is concerned the strategy determines the target portfolio of products', respondent 11 indicated. Therefore the pre-preparation was essential considering strategic fit dimension of company innovation performance. Setting the larger context encompassing both internal and external conditions was indicated as a starting point in most companies. The result supports previous evidence signalling the importance of the analysis of company environment (Cormican & O'Sullivan, 2004) and the re-examination of company strategy (Vitezic & Vitezic, 2015) before the innovation process.

The respondents largely supported the importance of the reproducibility in improving innovation performance. As stated by the interviewees, formalised

**Table 3.** Key components of the design of innovation process.

Label	Definition	Description	Exclusion
<b>Pre-preparation</b>	Actions taken before the innovation process	Interviewee speaks about the actions taken before the actual innovation process begins and their impact on the process	Interviewee speaks about actions detached from the innovation process
	E.g. 'Company determines all its activities based the on analysis of the market, thus we build also our innovation policy based on it' (respondent 5)		
<b>Reproducibility</b>	Procedures allowing the reproducibility of processes	Interviewee emphasises the importance of formalised procedures in repeating successful processes	Interviewee speaks about other formalised procedures
	E.g. 'We are not interested in developing one innovation, we are interested in creating a system that guarantees a constant influx of innovation' (respondent 2)		
<b>Information sharing</b>	Sharing information between the parties involved	Interviewee stresses the role of sharing full and objective information in improving decision-making process	Interviewee speaks about publicly/company-wide available information
	E.g. 'Both (testing procedures) are often performed simultaneously, which means that information flow needs to be instantaneous' (respondent 18)		
<b>Control</b>	Monitoring and control of the process	Interviewee underlines the benefits of innovation control system which allows modification of the process in response to deviations	Interviewee speaks about control mechanism detached from innovation process
	E.g. 'Once a deviation occurs we need to be able to act straight away' (respondent 7)		

Source: own development.

procedures are especially important in the idea generation stage to assure the constant supply of new ideas ( $n = 18$ ). As stated by the interviewees 'the ideas are indicated by the management based on the marketing research' (respondent 12), 'all innovation is developed in reference to the environment' (respondent 7) and 'we seek for the ideas through conferences and meetings but we develop innovation internationally' (respondent 19). Despite only one innovation plan stating explicitly the importance of constant/reproducible innovation process, ten respondents claimed that internal and external information sharing is used jointly to assure reproducibility. 'Nowadays it is impossible to survive without innovation, we exploit all its sources' interviewee 24 said. Two respondents (20 and 21) indicated that as market leaders it is their role to set trends, not to follow others, and thus they rely mostly on internal sources. The formalised procedures included the exploitation of both internal and external sources of ideas, which guaranteed the strategic fit of innovation projects. The result is consistent with the previous research arguing that formalising and structuring the innovation process helps fostering the communication which consequently impacts innovation performance positively (Cooper et al., 2001; Müller et al., 2008; Lerch & Spieth, 2011).

Respondents indicated the importance of information sharing, which in turns supports the objectivity of decision-making. According to the respondent the issue is especially important during the testing stage. Once an innovation is developed 23 companies introduce testing procedure. One respondent claimed no tests to be performed. It appears that the level of advancement is key here – 'it all depends on innovation. Minor upgrades are not formally tested' respondent 13 said. Testing is usually divided into two parts – formal and marketing ( $n = 16$ ). Information sharing between the managers is especially important for the companies leading several projects. It

allows maintaining balance in the innovation portfolio and supports adequate reaction if one of the projects fails. The results are consistent with previous research signalling information availability as one of the most significant factors that affects innovation performance. Yet it strengthens the quality of decision-making and impacts on the innovation performance positively (Martinsuo & Lehtonen, 2007). ‘The testing procedures are closely connected and failure in one of them impacts directly on the other’ respondent 2 stated. The well-established design of the testing procedure was claimed essential, as ‘there is no going to the market without it’ (respondent 18).

Interviewees stated explicitly the particular importance of the control procedures in improving innovation performance. However the implementation of control mechanism was explicitly stated in only one innovation plan. Respondents emphasised the right design of production stage. Once new solutions are tested they are produced and commercialised on the market. The production stage involves the application of the procedures developed in the previous stages on a large scale. In the result the design of production process should assure information sharing, transparency and traceability so that ‘the deviations may be observed on the daily basis and the corrections of the process implemented’ (respondent 2). The purpose of such control system is to maximise company value through cost control and steering the process according to the strategic and operational plans. Such approach supports previous evidence indicating the role of a monitoring mechanism (Vitezic & Vitezic, 2015). Furthermore, it contributes to control theory, where controlling the system so that the output follows a desired control signal is through the designed controlling schemes (Liu, Wang, Golnaraghi & Kubica, 2010), by adapting it to innovation process. Also, respondent 2 claimed that ‘the solutions successfully tested in the laboratories may not prove useful in the large scale due to the specificity of the process, energy consumption, etc.’. The production process is carefully designed in all the companies, as ‘it is the large-scale production and commercialisation that are the ultimate test for the new products’ (respondent 19). Furthermore, all the respondents stated that their companies monitor the performance of new products and processes. ‘Due to the specificity of our products we control their composition on a daily basis’, respondent 12 claimed. ‘The clients are in the centre. We verify their satisfaction and product recognition’ (respondent 5), ‘we calculate the return on investment and determine the growth prospects and the ability to build competitive advantage’ (respondent 14), ‘we observe the sales revenues and the number of complaints’ (respondent 19) the interviewees enumerated. However the interviewees pointed out that the comprehensive monitoring system allowing making decisions on continuing the sales, supporting the product or withdrawing it would be of high practical importance.

With regard to the second research question on the impact of interactions on company innovation performance the interviewees discussed mainly resources interactions, benefit interactions and outcome interactions appearing at different stages of innovation process. The principal interactions in improving company innovation performance are summarised in Table 4, which is organised in line with the recommendations of Boyatzis (1998). The table is followed by a descriptive component. Three interactions are indicated.

**Table 4.** Key interactions in innovation process.

Label	Definition	Description	Exclusion
<b>Outcome interactions</b>	Interactions between the representatives of interconnected stages E.g. 'We rely strongly on marketing research, otherwise you may develop a breakthrough innovation that no one pays for' (respondent 16)	Interviewee emphasizes the importance of one stage's outcome in determining the success of the consecutive stages	Interviewee speaks about a stage's outcomes that have no relation to the success of the following stages
<b>Resource interactions</b>	Interactions between resource administrator and resource user E.g. 'Although we are highly autonomous, we usually struggle to acquire the financing that we need' (respondent 4)	Interviewee stresses the role of mutual understanding in granting the resources and determining the level of autonomy	Interviewee speaks about non-negotiable resources
<b>External cooperation</b>	Cooperation with the third parties E.g. 'We cooperate closely with universities and research labs as it is cost-effective' (respondent 8)	Interviewee underlines the significance of cooperation with universities, research institutes and other companies	Interviewee speaks about intra-firm cooperation

Source: own development.

Interactions within the innovation process were indicated as crucial determinants of the overall company innovation performance ( $n = 22$ ). Such result supports previous evidence demonstrating that project interactions can significantly affect project success (Girotra et al., 2007). Especially the outcome interactions and resource interactions seem crucial. The importance of outcome interactions was emphasised during the idea selection stage ( $n = 19$ ). This stage is key as it determines the whole process to follow – success of research and development stage depends on whether idea selection stage produced the right outcome (respondent 24). At this stage the interactions are essential as they assure maintaining the balance in innovation portfolio, which ultimately leads to improved company innovation performance. The results confirm previous studies indicating that higher transparency leads to a higher quality in go/kill decision-making, which affects innovation performance positively (Chi & Holsapple, 2005; Kalpic & Bernus, 2006). The interactions may be analysed based on game theory. It appears that the general paths were determined in the intra-organisational game between the resources' administrator (senior management), marketing department and R&D department. Only three respondents claimed any formalised selection procedure exists. 'The procedure is there for the new products. As we develop lots of them we learned to evaluate the ideas. However, there is no procedure for process and organisational innovation, here the management decides' respondent 6 claimed. Twenty-one interviewees indicated no systematic selection procedure. In most cases the lack of interactions was harmful and a single manager had to make the decision ( $n = 14$ ). In the case of new products it was based on his/her estimate of sales revenues ( $n = 6$ ). The game that emerges from the study is sequential as the study of market needs is followed by idea selection which in turn is followed by research and development. Also the game appears asymmetric as despite the lack of specialised knowledge, management concentrates the entire decision-making power. Therefore the issue of interaction within the idea selection stage seem crucial as companies lack procedures and tools to objectively select the ideas to develop further.

The resources interactions were important as the innovation managers often may not guarantee the results and struggle to acquire financing. The issue is especially

pressing within the research and development stages, as 'the interactions here require substantial knowledge' (respondent 17). Improving company innovation performance through the management of resource interactions results from maintaining balance in innovation portfolio and the strategic fit of innovation projects. The result supports previous research emphasising the crucial role of resource attribution in companies pursuing innovation projects in related market segments, in projects that are substitutional or complementary and in projects using synergies (Kavadias & Chao, 2008). Fifteen companies had R&D departments; the next seven had a department whose responsibilities cover those of R&D. Despite 14 company strategies stating explicitly the importance of research and development, only three respondents (7, 8 and 9) were satisfied with the resources attributed to R&D. Twenty-one respondents argued the resources to be below optimal. In 11 cases the R&D department was 'highly autonomous' and 'acted independently from company actions' (respondent 12). In the remaining cases it was subordinate to general management and its duties covered finding 'specific solutions for precisely determined problems' (respondent 20). Such contradictory approach was stated to result from company age and size. 'New companies may be spontaneous, we on the other hand rely on precise planning and the execution of these plans' (respondent 18). However, such opinion appeared to be partially detached from the data. On the one hand the average age of the companies with the highly autonomous R&D department was 67 years, while for the companies with low R&D autonomy it was 32 years. On the other hand the average payroll of companies with the highly autonomous R&D department totalled 217 employees while for the firms with low R&D autonomy it was 759 employees. Strong interactions in the bigger companies were asymmetric as the management held the decision-making power.

Eighteen interviewees stated their companies to cooperate with third parties. Fifteen claimed the cooperation to take place on a daily basis. The result appears high as the intent for the external cooperation was declared in 16 overall company strategies but only one innovation plan actually included it. Fourteen respondents stated that the cooperation is crucial during the research and development stage. Exploiting external cooperation allows companies to manage knowledge. They benefit from the knowledge of other organisations without having to develop it internally, which is important from the value maximisation perspective. Such approach is consistent with previous research signalling the benefits of substitution or complementation of innovation process in marketing (Eilat et al., 2006). The interactions expand on the inter-organisational level. Universities and research laboratories 'are essential but must be carefully controlled as they lack business aptitude' (respondent 18). External cooperation with other companies boils down to acquiring technology. 'We buy patents, exchange technology, and sometimes buy the entire companies', respondent 17 stated. The game played at the inter-organisational level appears to be zero-sum – 'if we don't outsmart them, they will outsmart us' (respondent 23). Thus, it is of strategic importance. Improving the overall company innovation performance is possible only if the company does not dilute the benefits from new solutions (through effective protection) and effectively adapts the solutions developed in the company surroundings. Only two respondents claimed their companies to engage in open-innovation initiatives.

## Conclusions

Innovation is of a key importance for all companies' growth; however, most companies do not measure innovation performance and the measurement itself still remains a scientific challenge. Hence the research undertaken had both confirmatory (conceptual representation of innovation process) and exploratory (the role of design and interactions in improving innovation performance) character.

In terms of theoretical implication, detailed literature studies about relation between the organisation of innovation processes and company innovation performance were preceded using the Salsa method. The study complements earlier research by providing six-stage innovation process and informs the later research questions. The research contributes to project management literature by exploring the link between the design of the process (with special regard to pre-preparation, reproducibility, information sharing and control), interactions within the process (outcome and resources interactions and external cooperation) and innovation performance.

In reference to the first research question on the relation between the design of innovation processes and company innovation performance the interviewees referred mainly to routines, formalised procedures, information sharing and transparency, reproducibility, and traceability of innovation processes. The key components of the design of innovation process in improving company innovation performance were indicated as pre-preparation, reproducibility, information and control.

In terms of the second research question on the impact of interactions on company innovation performance the interviewees discussed mainly resources interactions, benefit interactions and outcome interactions appearing at different stages of innovation process. The key interactions in improving company innovation performance were defined as outcomes, resource and external interactions.

With regard to the practical applications, 24 semi-structured interviews with senior management, project leaders and research and development specialists were conducted where all of the respondents agreed that innovation process covers separate stages with different parties involved at each step. Also, it was clearly stated that efficient management of a single innovation process improves company innovation performance and affects maximization of company value.

The research allowed gathering all the data necessary to answer the original research questions. Further research could validate the results in extensive quantitative study. Despite the careful performance of the interviews, the research was burdened with such limitations as respondents experiencing time pressure and due to the snowballing sampling procedure it caused interviewees to respond in a cautious and conservative manner.

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## Appendix 1. Research protocol

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1. How do you select projects to be implemented in your company?

- a formalised procedure is applied
- there is no formalised procedure

If there is a formalised procedure, how and at each stage of the process is it applied?

2. Does your company have formal research and development (R&D) department?

- yes, we do have dedicated R&D department
- no, but other department has similar functions (if this answer is selected, specify which department and what functions exactly)

- no we do not have any R&D department

3. To what extent R&D department depends on developed routines?

- there are no routines (each project is entirely autonomous)
- there are routines (R&D reproduce the previously developed solutions)

If there are routines, what is the optimal level of the routinisation?

4. Is information sharing inside the company, or with the external environment mostly exploited in innovation processes?

- only inside the company
- mostly inside the company
- both are equally important
- mostly with external environment
- only with external environment

Are there any formalised procedures to structure information sharing?

5. Is the selection of new product/technology/solution directions preceded by the environmental business analysis?

- it is always confirmed by the environmental business analysis
- sometimes/partially confirmed by the environmental business analysis
- it is not based on environmental business analysis

6. Is the selection of new product/technology/solution directions based on business strategy analysis?

- it is always based on the company's strategy
- sometimes/partially based on the company's strategy
- it is not based on company's strategy

7. Does your company have any formalised testing procedures?

- yes we test mainly inside the company
- yes, we test both internally and directly on the market
- yes, we test mainly directly on the market
- no

Why?

8. Are there any features subjected to the control after new product/technology/solution introduction? Which features? Who controls?

- no control is carried out
- there is a control and includes among others:

9. Final success of a project may depend on the decisions made at its initial stages. When is your company's commitment to developing innovation the largest, in the initial or in the later phases of the process?

- the most attention is paid to innovations before and during R&D
- the most attention is paid to ready-made solutions during introduction to the market/implementation

Explain how the later stage representatives interact with the initial stage representatives

10. In the case of complementary and competitive projects what is the generally accepted approach in your company - is it better to introduce more small projects simultaneously or individual large one?

- it is better to introduce more small projects simultaneously
- it is better to occasionally run a project with a breakthrough potential

Explain what are the basis for making such decision

11. In the case of limited resources does your company focus more on launching new products/technology/solutions or on optimizing processes?

- resource administrator usually supports new products/technology/solutions
- resource administrator usually supports the improvement of internal processes

Explain what determines the decision of the resource administrator

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## Personal survey questions

age	sex
position	seniority
company	area of expertise