

Critical success factors for public procurement of innovative solutions in Central Europe: Empirical study

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Abstract: This article aims to evaluate critical success factors in the use of the Public Procurement for Innovations (PPI) concept. The first part of the article deals with a systematic research literature review on the topic of critical success factors for PPI. In the second part, the authors present empirical research conducted as an add-on to the projects PPI2Innovate and RI2integrate within the Europe and Interreg Danube programs. These projects (whose research team included one of the authors of this paper) analyzed the use of the PPI concept in the EU. The authors approached the teams of experts formed in six countries for the purpose of these two projects to make a list of critical success factors, engaging the Delphi method, for the implementation of projects using the PPI method. Sixteen most frequently recurring critical success factors were chosen for further evaluation. These critical factors were then evaluated on a Likert scale in terms of their significance. This is followed by a discussion of the results of the critical factors identified within the systematic literature review with regards to other authors and existing research. In the final part of the article, possible solutions based on experience from pilot projects are proposed to strengthen the usability of the PPI concept. When comparing the key success factors resulting from the literature review with those identified within the expert research, it is apparent that they are mostly the same, although there are slight differences. The expert research identified the sharing of best practices and model projects in the country as additional key success factors.

Keywords: PPI, public procurement for innovations, critical success factors.

JEL Classification: H57, O31.

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Introduction

As early as the 1980s and the early 1990s, empirical studies showed that public procurement can boost innovation, even more so than subsidies for research and development (Geroski, 1990; Rothwell & Zegveld, 1981).

In 2006, Viviane Redding (EU Commissioner for Innovation) stated in a press release by the European Commission: “Europe needs to create such a trade environment that will support faster innovation and the acceptance

of research results. The public sector has an immense purchasing power; however, it needs the right incentives to share the risks and benefits of investing in new technologies and services” (European Commission, 2006). Subsequently, in around 2007 there was a shift towards public procurement innovations in the EU, and a number of policies and tools to support this decision have been created since then. These policies and tools are currently being implemented, to a varying degree

of success, in the national policies of individual EU member states.

As stated in a report by the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), the purpose of applying these policies and tools is “to allow public contracting authorities to achieve efficiency, strengthen their position in the market and thus reduce costs” and “this will allow them to increase their impact on environmental, social and innovative goals” (European Commission, 2011).

Three new tools were introduced, which EU member states had to gradually incorporate into their legislative frameworks and policies. These included:

- Green public procurement (GPP);
- Socially responsible public procurement (SRPP);
- Public procurement of innovation (PPI) or public procurement of innovative solutions.

That refers to a contracting authority procuring innovative goods and services that are not yet commercially available on a large scale. Given that a public authority acts as a customer initiating the procurement process, public procurement of innovations is a demand-driven tool aimed at supporting innovations. Worth noting is the fact that PPI does not necessarily need to include contracts for services in the area of research and development, which corresponds with another approach referred to as “pre-commercial procurement” (PCP). PPI and PCP are very similar tools and the difference between the two will be explained in detail later on in the text. Besides that, in the coming years new guidelines on public procurement will help support PPI by incentivizing contracting authorities to develop favorable bidding procedures for innovations and thus support enterprises in the development of their innovation capacity and at the same time ensure that fundamental economic competition, transparency and fair treatment requirements are met (European Commission, 2011).

The PPI concept was subsequently integrated into the respective national legislative frameworks.

In practice, we also encounter the PCP concept, i.e., Pre-Commercial Procurement, which, unlike PPI, also contains a research or development phase.

From the point of view of European legislation, both PPI and PCP are public sector tools

aimed at supporting innovations. However, these terms need to be differentiated, which is not as easy as it may seem at first sight. The lack of a clear definition of the basic parameters of what can be considered research or development and what is a mere “modification” of an existing solution, i.e., what can or cannot be considered “innovative,” poses a number of questions, according to Januska and Stankova (2019). The first question is where specifically PPI starts and PCP ends if, for example, a commonly used technology is used in a new way and the solution still needs to be developed or only modified for the customer’s specific needs. On the other hand, the boundary between the procurement of an existing solution and PPI is equally unclear. Another question is how it can be determined whether the new solution is “sufficiently” innovative.

Unfortunately, there is no specific type of public contracts for PPI projects. They are implemented in one of the standard public procurement procedures, which is why the number of PPI projects implemented cannot be monitored according to the procurement procedure type.

The research conducted within the PPI2Innovate and RI2Integrate projects discovered that although the PPI concept is in theory and according to political proclamations an ideal tool for supporting innovations by the public sector, the measure of its use in practice is negligible (for example, in 2019, there were fewer than 10 PPI projects identified in the Czech Republic within the PPI2Innovate project). The question is why this concept is not used more in practice?

This article aims to identify the critical success factors for the PPI concept based on a systematic literature review, empirically verify these conclusions, and subsequently suggest measures that would lead to a wider use of this concept.

1. Literature review

The first step involved a systematic research literature review based primarily on scientific articles from the Web of Science, Scopus, and Elsevier (Science Direct) databases and other freely available resources, such as reports from the European Commission. The literature review focused on the identification of critical success factors of the PPI concept and, by extension, the barriers and risks of PPI implementation. Research literature by authors dealing with

the issue of PPI offers various types of classification of the key, or rather critical success factors – according to the entity that the particular factor concerns, the phase the given factor is in, the area the success factor applies to, the size and the number of stakeholders, etc. There is also a high degree of disunity among various authors in the designation of the respective key success factors, with virtually identical factors often being referred to by different terms, or being further split down into more detail.

1.1 Literature review methodology

The methodology applied in the systematic literature review contains three basic phases that consist of: the search for potentially relevant (in terms of the topic) articles, analysis of the selected literature, including the elimination of resources that do not deal with the issue at hand, and finally the creation of an overview of the identified key success factors based on the selected criterion.

In the first phase, articles were searched for using the key words “PPI” and “key performance factors.” The abbreviation PPI turned out not to be suitable in the identification of relevant resources, as it is primarily used with a different meaning – particularly in medicine, which resulted in the vast majority of the search results being thematically irrelevant. Therefore, the phrases “procurement of innovation,” “procurement for innovation,” “key performance factors,” “key success factors,” “critical success factors” and “critical success barriers” were used instead. There was a limit set in terms of the articles’ publication date. The exact procedure employed in the search in the aforementioned research databases is described in the following three points.

The search using the combination of the keywords “PPI” AND “critical success factors” in the Scopus database led to 13 search results; however, following the perusal of their abstracts, none of them was found thematically relevant. The next keyword combination of “PPI” AND “key success factors” led to 9 articles being identified, though none of them was relevant for the purpose of this literature review. The search criteria set to “PPI” AND “key success barriers” brought four irrelevant search results. Using the combination of “public procurement on innovation” AND “key success factors” resulted in the identification of a total of five articles, of which three were found to

be relevant. The search using the keywords “public procurement on innovation” AND “success barriers” found ten documents that were thematically relevant; however, only one resource was added to the literature review as the remaining three articles were identical to the results of the previous search;

The next step consisted of the search for articles in the Web of Science database using the same combination of keywords as in the search in the previous research database. Ten articles were found using the search criterion “PPI” AND “key success factors”; however, none of them was suitable for the purpose of this research, which also applied to the search using the keywords “PPI” AND “key success barriers,” when none of the eleven articles identified was found relevant. The combination of the keywords “public procurement on innovation” AND “success barriers” delivered six search results, of which the only two thematically relevant articles had already been identified within the previous search in the Scopus database. The search using the combination of “public procurement on innovation” AND “success factors” identified 13 results, of which only three articles were thematically relevant, and they had all been among the previous search results;

Article search in the Science Direct database using the keywords “procurement of innovation critical success factors” identified 3 literature resources, none of which was relevant. The phrase “procurement of innovation key success factors” led to four search results; however, once again, none of them was relevant for the purpose of this research. The same was true for the search criteria “procurement of innovation critical success barriers,” which delivered one irrelevant search result. The results (i.e., the number of relevant resources concerning key success factors for PPI) were the same regardless of the preposition used with PPI (“of” or “for”). As a result, no resources from the Elsevier publishing company were added to the literature review.

Based on the conducted search in the Scopus, Web of Science and Elsevier databases, four research articles were identified that dealt with the issues at hand, i.e., key success factors or barriers in the implementation of contracts using PPI. This result confirms that the research gap was identified correctly and this issue needs to be studied in more detail.

The resulting sample of resources was found insufficient by the authors, therefore, the systematic review of research articles included resources dealing with the issue of PPI in general, and additional resources were sought. Using the keywords “public procurement on innovation” OR “public procurement on innovation” delivered 502 search results in the Web of Science database and 679 search results in the Scopus database. Following the elimination of thematically irrelevant and duplicate articles and those to which the authors were not able to gain access, the core sample used for the literature review consisted of a total of 137 resources. It can thus be said that the issue of PPI in general is relatively widely dealt with by the scientific community.

1.2 Key success factors

Within the PPI concept, a number of problematic and high-risk areas can be identified, and without overcoming these the resulting effect of PPI does not reach its potential value, and in the worst case the public contract is not successfully completed. Based on the problematic areas, it is possible to determine the key success factors, i.e., such factors that lead to the desirable result and without whose fulfillment PPI fails. For the sake of comparison, the authors divided the key success factors based on the respective areas they apply to.

PPI faces both external and internal barriers, hence the key factors are divided into internal factors, i.e., those that can be influenced by companies, and external factors that pertain to the regional, national or even supranational sphere (Michaelis et al., 2003).

For the purpose of this research, the key success factors were divided by the authors based on their characteristics into the following categories:

- Needs, requirements, goals;
- Personnel requirements;
- Legislation;
- Procurement procedure.

These factors were then further subdivided, or more precisely assigned critical factors identified within the systematic literature review. The identified key factors, including the authors who distinguish them, are listed in the following Tab. 1. The categories were created by the authors in such a way that it would be possible to compare the key factors analyzed in research literature so far and the key success factors identified in the practical part.

Needs

The literature review indicates that the key success factors identified within the **Needs category** include: correct identification of needs, appropriate specification of requirements and

Tab. 1: Key success factors identified in literature overview – Part 1

Category	Critical factor	Authors
Needs, requirements, goals	Specification of requirements	Askfors & Fornstedt, 2018; Georghiou et al., 2014; House of Lords, UK Government, 2011; Kalvet & Lember, 2010; OGC, 2010; Uyarra, 2016; Uyarra, 2010; Uyarra et al., 2014
	Goals	Cabral et al., 2006; Caloghirou et al., 2016; Cave & Frinking, 2007; House of Lords, UK Government, 2011; Kalvet & Lember, 2010; Nyiri et al., 2007; OGC, 2010; Uyarra & Flanagan, 2010; Uyarra et al., 2013; Uyarra et al., 2014
	Coherence in needs translation	Bovaird, 2007; Edler et al., 2012; Hommen & Rolfstam, 2008; Kallio et al., 2013; Rothwell & Zegveld, 1981; Torvinen & Ulkuniemi 2016; Uyarra, 2016; Uyarra, 2010
	Application of procurement procedures and practices	Erridge & Greer, 2002; Kalvet & Lember, 2010; Uyarra, 2016; Uyarra et al., 2014; Uyarra et al., 2013

Tab. 1: Key success factors identified in literature overview – Part 2

Category	Critical factor	Authors
Personnel requirements	Skills and capacities	Aschhoff & Sofka, 2009; Bonaccorsi et al., 2012; Cabras, 2011; Edler et al., 2015; Edquist & Hommen, 2000; Erridge & Greer, 2002; European Commission, 2008; European Commission, 1990; Flynn & Davis, 2016; Flynn et al., 2015; Georghiou et al., 2014; Georghiou et al., 2010; Lember et al., 2008; Loader, 2013; Loader, 2005; OECD, 2011; Rolfstam, 2016; Rolfstam, 2009; Rolfstam, 2005; Rolfstam et al., 2011; Uyarra, 2016; Uyarra, 2010; Uyarra et al., 2014; Uyarra et al., 2013; Yeow & Edler, 2012
	Capabilities of PPI participants	Chicot & Matt, 2018; Erridge & Greer, 2002; European Commission, 2008; European Commission, 1990; Flynn & Davis, 2016; Flynn et al., 2015; Georghiou et al., 2010; Loader, 2013; Loader, 2005; Rolfstam, 2016; Torvinen & Ulkuniemi, 2016; Uyarra et al., 2014
Legislation and the environment of PPI implementation	Long-term orientation and flexible legislation	Caloghirou et al., 2016; Hommen & Rolfstam, 2008; Lember et al., 2015; Rothwell & Zegveld, 1981; Suhonen et al., 2019; Uyarra, 2010
	Sufficient legislation – definition of terms	Obwegeser & Müller, 2018
	Supporting international legislation	Edquist, 2009; Edquist & Hommen, 2000; Karjalainen & Kempainen, 2008; Torvinen & Ulkuniemi, 2016
	Process time and effective administration	Amann & Essig, 2015; Askfors & Fornstedt, 2018; Erridge & Greer, 2002; Lember et al., 2015; Uyarra, 2013; Valovirta & Edler, 2015
	Motivating and supporting innovation policy	Georghiou et al., 2014; Lember et al., 2015; Rolfstam, 2012
	Budget and transparency	Amann & Essig, 2015; Aschhoff & Sofka, 2009; Bonaccorsi et al., 2012; Edler et al., 2015; Edquist & Hommen, 2000; Georghiou et al., 2014; Karjalainen & Kempainen, 2008; Lember et al., 2008; Nyiri et al., 2007; Rolfstam, 2012; Rolfstam, 2005; Rolfstam et al., 2011; Rothwell & Zegveld, 1981; Sánchez-Carreira et al., 2018; Torvinen & Ulkuniemi, 2016; Uyarra, 2016; Uyarra, 2010; Uyarra et al., 2014
	Essence of time	Amann & Essig, 2015; Kalvet & Lember, 2010; Lember et al., 2015; Sánchez-Carreira et al., 2018
	Institutional setup of the public procurement process that is oriented towards innovation	Amann & Essig, 2015; Bloch & Bugge, 2013; Koch & Hauknes, 2005; Koch et al., 2006; Nyiri et al., 2007; Peck & Cabras, 2011; Pickernell et al., 2011; Preuss, 2011; Rolfstam, 2012; Rolfstam et al., 2011; Rothwell & Zegveld, 1981; Uyarra, 2010; Uyarra et al., 2014; Sánchez-Carreira et al., 2018
	Adequate demand from the private sector	Kalvet & Lember, 2010; Uyarra et al., 2014

Tab. 1: Key success factors identified in literature overview – Part 3

Category	Critical factor	Authors
Legislation and the environment of PPI implementation	Professional procurers and procurement expertise	Georghiou et al., 2010; OECD, 2011; Uyarra, 2010
	Integrated public markets	Kalvet & Lember, 2010
	Interactive learning space	Chicot & Matt, 2018
	Information symmetry	Chicot & Matt, 2018
	Environment conducive to R&D – demand for innovation	Caloghirou et al., 2016; Uyarra, 2016; Uyarra et al., 2014
	Specific regional characteristics need to be taken into account	Kalvet & Lember, 2010; Uyarra, 2016; Uyarra et al., 2017; Uyarra et al., 2016; Uyarra et al., 2014
Procurement procedure	Communication and strong coordination + feedback	Amann & Essig, 2015; Caloghirou et al., 2016; Erridge & Greer, 2002; Georghiou et al., 2014; House of Lords, UK Government, 2011; Kalvet & Lember, 2010; Lember et al., 2015; OGC, 2010; Uyarra, 2016; Uyarra, 2010; Uyarra et al., 2014; Uyarra et al., 2013
	Flexibility	Caloghirou et al., 2016
	Risk management	Bloch & Bugge, 2013; Cabras, 2011; Caloghirou et al., 2016; Cave & Frinking, 2007; DIUS, 2008; Erridge & Greer, 2002; Georghiou et al., 2014; Georghiou et al., 2010; House of Lords, UK Government, 2011; Kalvet & Lember, 2010; OGC, 2010; Koch et al., 2006; Koch & Hauknes, 2005; Lember et al., 2015; Nyiri et al., 2007; Suhonen et al., 2019; Uyarra, 2016; Uyarra et al., 2014

Source: own

goals, and last but not least, the method of applying procurement procedures and practices.

Correct identification of needs requires coherence in the perception of the private and public sectors' needs by contracting authorities as well as the participants themselves. Needs cannot be correctly identified without coherence in the perception of the various stakeholders' needs (Elder et al., 2012; Hommen & Rolfstam, 2008). Here is an example: the residents in a town which provides them with an Internet connection complain about the slow speed of their Internet connection. The town may come to the conclusion that it will be necessary to increase the Internet bandwidth compared to the current service. However, the problem may not be the bandwidth

itself, which may very well be more than sufficient for the town's residents, but the reliability and stability of the connection, with frequent Internet outages resulting in the slow Internet connection. If needs are not correctly identified, the entire PPI (its preparation and implementation) would be distorted and the resulting product would not fulfill the function for which it was primarily procured. If we stay with our example, the town would end up paying for an Internet connection twice as fast, but the resulting effect for its residents would be the same as before, because the underlying problem with the network's reliability would not have been dealt with.

The requirements should be defined in such a way that they are neither too general nor

too specific and leave room for an innovative solution (Cave & Frinking, 2007; Nyiri et al., 2007). Overly general requirements can result in an insufficient solution in the sense of lower technical or technological parameters that are critical for the success of the product. A high degree of detail in the definition of the requirements prevents creativity, hampering the competitors' will to propose an innovative solution, which can result in their proposals not differing in aspects in which following the principle of PPI they should, i.e., in technical parameters and the overall execution of the proposed solution, and also primarily in terms of price (Caloghirou et al., 2016; Uyarra et al., 2014). This brings us to a much-discussed barrier of PPI, which is a fact that significantly prevents the successful implementation of PPI, i.e., the role of price in the entire PPI process. When specifying requirements, emphasis should be placed on innovation and other factors, not the price, as is often the case. Worth mentioning is the fact that it is important to define the result that is to be achieved rather than the process or technology that should be used. For example, when making an inquiry about a high-speed Internet connection for the town, the instructions should include a definition of the parameters in terms of the minimum connection speed required, reliability and the maximum installation and operating costs rather than demand a high-speed Internet connection with clearly specified parameters using a specific technology and then base the selection criteria solely on the installation costs.

Another key factor is the definition of the goals, which should meet the criteria of the particular solution (for the correctly identified needs). This key factor is dealt with in more detail by Nyiri et al. (2007), who addressed the fundamental problem of defining the goals of a public contract consisting of a number of different areas, with some of these areas or the goals themselves sometimes being mutually exclusive. The most frequent simultaneous goals include cost reduction, low environmental impact, and social responsibility. It is therefore imperative to set SMART goals in PPI, i.e., goals that are specific, measurable, acceptable by all, realistic and time-bound. The individual goals should be in harmony and should ideally support one another and achieve the synergy effect. If the defined goals are contradictory, the final solution cannot be as good as it would be if the goals were not

antithetical. If the contracting authority demands an advanced technological solution for the lowest price possible, the possibility of an innovative solution will be greatly limited (Cabral et al., 2006; Cave & Frinking, 2007; Nyiri et al., 2007).

Last but not least, the key success factors in the category of Needs should include the application of procurement procedures and practices, which should follow all the principles of public procurement, such as allowing enough time and space to correctly identify the needs, define the specifics and goals of the contract, and decide on the parameters which result in any limitations for certain participants (contract size, etc.). Emphasis should be placed particularly on the choice of the technology used in the sought solution (Erridge & Greer, 2002; Uyarra, 2016; Uyarra et al., 2013)

Personnel requirements

Personnel requirements represent a group of key success factors related to the capabilities, skills, knowledge and capacities of individual participants in PPI.

The basic prerequisite for a company's participation in PPI is having a sufficient amount of resources to be able to participate in a public contract. Entities that do not have at their disposal sufficient resources of any kind (material, technological, human resources, etc.) obviously cannot participate in a public contract. If the number of tender participants is not sufficient, there is not enough competition, which among other things supports innovativeness, and the resulting product is not necessarily as sophisticated as it would be if there was a larger number of entities competing with one another (Flynn et al., 2015; Yeow & Edler, 2012). Skills and capacities affect the project result, as it can be expected that the greater the skills and capacities the contracting authority or the supplier have at their disposal, the greater the chances of a successful execution of the contract. According to Hartl and Hartlová (2015), skills are defined as "learning and practice-based disposition to correctly, in good quality, quickly and efficiently carry out certain activities in an appropriate method." Public procurement must take into account capacities and resources, whether in the sense of capacities and resources of the public contract market itself or their respective participants (Cabras, 2011; Flynn & Davis, 2016). The individual participants in the procurement procedure should

have sufficient capacities and resources in order to support the procurement process – to avoid doing things in a hurry, but rather thinking things through and defining goals appropriately (Amann & Essig, 2015). In other words, the contracting authority must have sufficient expertise to be able to define the contract requirements and evaluate the often inconsistent bids transparently. On the supplier's side, it is essential for the respective workers engaged in the execution of the contract to have adequate skills, as well as for the entity as a whole to have the ability to achieve results. Entities with skills at their disposal have a considerable competitive advantage compared to other entities. The volume and quality of the capacities at the supplier's disposal directly affect its performance and the ability to deliver the subject of the tender in such a way that will fulfill its required function.

Another factor that needs to be taken into account are the capabilities of PPI participants. Hartl and Hartlová (2015) define capabilities as “the prerequisites, potential and dispositions for a certain skill or activity.” The higher the level of capabilities of individual PPI participants, the greater the chances of a successful implementation of PPI (Chicot & Matt, 2018; Erridge & Greer, 2002; Torvinen & Ulkuniemi, 2016). An important factor in this area are learning capabilities (Flynn & Davis, 2016; Rolfstam, 2016).

Legislation and the environment of PPI implementation

Based on the conducted literature review, legislation and the environment were found to be the source of the largest number of identified critical success factors for PPI. In absolute terms, it is not the largest area when it comes to the key factors identified. According to the authors, the large number of critical success factors is due to their heterogeneity, which prevents them from being easily combined.

The key success factors lie in the legislative regulations at all levels, i.e., the regional, national and supranational level (Karjalainen & Kempainen, 2008; Torvinen & Ulkuniemi, 2016). A flexible national legislation with a long-term orientation is ideal for the successful implementation of PPI (Lember et al., 2015; Suhonen et al., 2019), one with incentive policies focused on the support for innovativeness and under the umbrella of related international legislation (Lember et al., 2015; Rolfstam, 2012).

Given the relatively unclear boundary between PPI and PCP in the context of to what extent a particular contract is or is not innovative, there is a need for selected terms to be defined. Any ambiguity can lead to the ineffective use of PPI or wrongly defined contract goals and specifics (Obwegeser & Müller, 2018).

Transparency, including information symmetry, is another important prerequisite for the success of PPI (Aschhoff & Sofka, 2009; Bonaccorsi et al., 2012; Sánchez-Carreira et al., 2018). The successful implementation of any PPI project is contingent on the indiscriminate access of all participants to information and the selection process itself must be transparent and sufficiently justifiable based on the correctly chosen selection criteria (Chicot & Matt, 2018; Torvinen & Ulkuniemi, 2016).

Procurement practices should be appropriately set in order to support innovations so that, according to Uyarra et al. (2014) and Flynn et al. (2015), they do not discriminate against SMEs due to the size of the contracts put out to tender. According to Uyarra et al. (2016, 2017), they should also take into account regional specifics, i.e., the specific features of the environment in which the PPI contract is being implemented. This leads to additional key success factors, such as effective administration (Amann & Essig, 2015; Askfors & Fornstedt, 2018; Lember et al., 2015), the integration of public markets (Kalvet & Lember, 2010), adequate demand by the private sector (Kalvet & Lember, 2010; Uyarra et al., 2014), an environment conducive to R&D (Caloghirou et al., 2016; Uyarra et al., 2014), a sufficient number of companies with available resources to deliver innovations (Kalvet & Lember, 2010), professional procurers and procurement expertise (Georghiou et al., 2010; OECD, 2011; Uyarra, 2010), interactive learning space (Chicot & Matt, 2018), a sufficient amount of time for all the decision-making processes and contract delivery (Amann & Essig, 2015; Lember et al., 2015; Sánchez-Carreira et al., 2018).

In connection with the issue of key success factors in the area of legislation and the environment, there is one key success barrier worth mentioning, which is complexity. Complexity lies in the strict regulation of the public procurement process by national and even supranational legislation in combination with the interaction of the various parties engaged in the procurement process. On the one hand, each party to

the procurement process, according to Edler et al. (2015), brings certain value (i.e., contributes to the decision-making processes); however, on the other hand, an increasing number of parties involved increases the difficulty of coordinating the various participants.

Procurement procedure

In the area of procurement procedure, there are key success factors like communication and coordination between the respective participants, flexibility and risk management.

A significant aspect which contributes to the successful execution of a contract is strong coordination and open, direct communication between the various participants, including the provision of feedback (Amann & Essig, 2015; Georghiou et al., 2014; Uyarra et al., 2013). Without open and direct communication, there is a great risk of information discrepancies arising between the contracting authority and the supplier, which significantly threatens the success of the resulting product (Kalvet & Lember, 2010; Lember et al., 2015; Uyarra, 2016). Giving feedback significantly helps with the development of further cooperation between the interested parties, and improves their skills for participation in other PPI (Caloghirou et al., 2016; Erridge & Greer, 2002; Uyarra et al., 2014).

Another important feature is flexibility, which should be a quality possessed not only by the various participants in the given process, but also by the procurement procedure itself, so that it would be possible to make adjustments to current needs and requirements without this leading to a failure in the procurement procedure or contract execution. In this day and age, which is characterized by its global interconnection and significant technological advancement, flexibility is a necessary prerequisite for the successful functioning of private entities (Caloghirou et al., 2016).

Risk management also plays an important role, i.e., the approach of the respective PPI participants to risk, with risk aversion representing a barrier to innovation and finding an innovative solution (Erridge & Greer, 2002; Uyarra et al., 2014; Uyarra, 2016). Due to its nature, PPI is a much higher-risk contract than a regular public contract, which is why entities with a higher risk aversion prefer to choose a different form of conducting their business activity (Caloghirou et al., 2016; Lember et al., 2015; Suhonen et al., 2019).

1.3 Empirical study of critical factors in using PPI concept

The authors capitalized on their participation in two research projects on the topic of PPI: PPI2Innovate within Interreg Europe program and RI2Integrate within Interreg Danube program. Within these projects' teams of experts on PPI projects were formed. The authors addressed these expert teams regarding critical success factors.

Objective of PPI2Innovate project was to build regional capacities in PPI in Central Europe, to change attitude towards PPI, to strengthen linkages among relevant stakeholders in regional innovation systems and to finally boost usage of PPI. This change had been reached by delivering innovative outputs such as 3 thematic PPI2Innovate tools for SMART Health, SMART Energy and SMART ICT, all fully customized to the 6 national institutional frameworks and translated. In addition the project created 6 regional competence centres for PPI and their Central European network as well as 6 action plans to implement 8 PPI projects in each region. Four PPI pilots strengthened linkages to apply a trans-regional "learning by doing approach" and showed successful stories in 4 regions.

The duration of the project was 1. 6. 2016–31. 5. 2019. There were 10 partners from six countries participating at the project (PPI2Innovate, n.d.).

Objective of RI2Integrate project was to exploit the economic development potential in the EU and improve the integration of the EU's R&D Infrastructure investment projects operations through supporting the implementation of innovative tools for policy learning. The ultimate aim was to improve transfer of scientific results into the economy and develop 3 tools for macro-regional embeddedness of R&D Infrastructure investment – utilization guide for public procurement on innovation, guide for aiding the business ecosystems related to EU's R&D Infrastructure investment, roadmap for dissemination.

The RI2Integrate project started on 1. 1. 2017 and ended 30. 9. 2019. (RI2Integrate, c2023)

1.4 Methodology and research limitations

The research itself was carried out as an addition to two international projects – PPI2Innovate and RI2Integrate. The authors addressed

the expert teams formed within the aforementioned research projects to participate in Delphi method where each project partner expert group was represented as one panelist.

There were 11 expert groups respectively panelists from six countries participating at the research:

- Czech Republic: SIC – Central Bohemian Innovation Center;
- Czech Republic: DEX Innovation Centre;
- Hungary: Central Transdanubian Regional Innovation Agency Nonprofit Ltd.;
- Poland: Municipality of Lublin (local level);
- Italy: University of Turin;
- Italy: Piemonte Region (regional level);
- Slovenia: ICT Technology Network Institute;
- Slovenia: Ministry of Public Administration of the Republic of Slovenia (national level);
- Hungary: Somogy County Government (county level);
- Croatia: Croatian Agency for SMEs, Innovations and Investments;
- Poland: Rzeszow Regional Development Agency.

The authors of this article asked each team to create, using the three-round Delphi method, a list of ten critical success factors for PPI-type projects, of which the 14 most frequently recurring critical success factors were chosen for further evaluation. Subsequently, the expert groups evaluated the significance of the individual selected critical factors using the ten-point Likert scale. The outcome of the research is a set of 14 critical factors that have also been evaluated by all the expert groups in terms of their significance.

In the final part of the article, the authors discuss the results within the context of the available research literature and propose their own solution for supporting PPI-type projects.

2. Expert evaluation of critical success factors using Delphi method

In the first round of the Delphi method, each expert group described maximum of ten critical success factors for PPI projects which they are aware of. This was followed by the creation of a list of fourteen critical success factors, which in the next round was validated by the expert groups and subsequently evaluated on the Likert scale. The last round involved a discussion regarding how to strengthen the selected critical success factors.

For the sake of clear arrangement, the critical success factors were divided within this

research into the following categories, just as in the systematic literature review:

- Needs, requirements, goals;
- Personnel requirements;
- Legislation;
- Procurement process;
- Others.

Tab. 2 includes a list of individual critical success factors. The goal was to empirically verify the results of systematic literature review and evaluate the perception of identified critical success factors. How significant they are perceived on the scale 1–5 where 5 is highest importance. Due to the number of participants and the aim of the research, it was not relevant or possible to involve more sophisticated statistical methods. Based on the mean, median, and mode, the identified CSFs were divided into three groups as significant, highly significant, and critically significant. None of the identified CSFs was rated lower than 3 on the scale and was not marked as unimportant or insignificant.

3. Discussion of findings

When comparing the key success factors resulting from the literature review with those identified within the expert research, it is apparent that they are mostly the same, although there are slight differences. It is necessary to point out, that the key success factors in different categories as presented by the authors are closely related to each other, sometimes, the line that a given factor categorizes blurs as the factor is linked to and has a substantial impact on several areas of PPI. The highest average significance possible (5) was given to seven critical factors proposed by expert groups, identified within all presented categories. Sufficient financial resources were on the other hand perceived as least significant. Still, four respondents perceived the sufficient financial resources highly important. The issue here is that some of the public procurers are not limited by the costs.

In the Needs category, the empirical research came up with four critical success factors that more or less correspond to the literature review findings. According to the respondents, the key success factor in terms of needs is using the proper tools (such as policy objectives and strategic documents) for the need identification process. The respondents even see appropriate key means for need identification as slightly more important than identifying

Tab. 2: Critical success factors identified in research

Category	Description of critical factor	1	2	3	4	5	Mean	Median	Mode
Needs, requirements, goals	Use key policy objectives, strategic documents and priority tasks when identifying the need	0	0	0	1	10	4.9	5	5
	Proper identification of the need(s) for the implementation of PPI and a clear description of the subject of the contract; open consultation and dialog with the possible suppliers	0	0	0	3	8	4.7	5	5
	Involvement of stakeholders (trade association, practitioner, economic operators, academia) for the design of the best procurement strategy (e.g., preliminary market consultation/ technical dialogue)	0	1	1	4	5	4.2	4	5
	When describing the need, it is necessary to confront expectations and capabilities with each other in order to avoid receiving unrealistic ideas for technical, financial or even logistical reasons	0	0	4	3	4	4.0	4	3
Personnel requirements	Support of the decision maker and different relevant departments within the public procurer to conduct PPI	0	0	0	2	9	4.8	5	5
	Create a project team composed of people with appropriate competences including external experts in all affected areas (legal, procurement, technical, financial, health expert, etc.)	0	0	1	3	7	4.5	5	5
Legislation	Long-term supporting policies on innovation (at the European and/or national level) providing monitoring mechanisms and incentives to achieve innovation goals	0	0	0	3	8	4.7	5	5
	Convince decision-makers and internal units responsible for public procurement that it is worth investing more time and resources at the stage of preparing the proceedings to achieve better results	0	0	0	6	5	4.5	4	4
	Sufficient financial resources	0	2	5	0	4	3.5	3	3
Procurement procedure	Detailed planning and continual monitoring of projects	0	0	0	2	9	4.8	5	5
	Selection and award criteria must be clearly defined and result from the subject of the contract	0	0	0	0	11	5.0	5	5
	Anticipating and assessing the risks contribute to better managing of the PPI process; proper risk management, tenderers have to be asked to include an analysis of the risks in their proposals and how these can be mitigated	0	0	1	7	3	4.2	4	4
	Concentrate on construction and subsequent operation costs; not only the price of purchase of goods, services or construction works as the basic criterion for the selection of the offer and completely ignoring the aspect of the actual cost of the product life cycle	0	0	1	6	4	4.3	4	4
Others	Sharing best practices and model projects in the country	0	0	1	7	3	4.2	4	4

Source: own

the requisite need(s) as such. This may be because without using the right tools, it is impossible to work toward identifying the proper needs and clearly describing the requirements and subject of the contract. Need identification requires coherence in the perception of both the private and the public sectors' needs by contracting authorities as well as the participants themselves to ensure that the public contract requirements are realistic and the requirements of the PPI participants and the final product adequate (Askfors & Fornstedt, 2018; Bovaird, 2007; Uyarra, 2016). In this matter, Edler et al. (2012) mainly pointed out the lack of coherence in how the public sector's needs are translated to the market. The appropriate specification of requirements is vital not only in terms of the procurement process itself but also for the respective participants and the final product. As is pointed out in some papers analyzed in the literature review, tenders are often perceived as over-specified and burdensome, which risks locking out solutions that solve the problem in a different way from that anticipated by the procurers (Askfors & Fornstedt, 2018; Lember et al., 2015; Uyarra et al., 2016). Uyarra (2010) also expressed concerns about using rigid as opposed to outcome-based specifications in tenders, which may inter alia lead to the limitation of possible innovation.

The empirical research also revealed the need for the stakeholders' involvement in the design phase to define the best procurement strategy. In previous studies such as Georghiou et al. (2014) and Amann and Essig (2015), there is an emphasis on good communication with stakeholders and their involvement in each procurement process stage, not solely in defining the right strategy, as the procurement process is seen as very complex. Each barrier that might emerge should be addressed by matching policy instruments and the experiences of suppliers.

Lastly, empirical research presented the necessity of confrontation of expectations and capabilities to avoid receiving unrealistic ideas for technical, financial, or even logistical reasons when describing the needs as one of the critical success factors concerning PPI's needs, conditions, and goals. This factor is also consistent with the factors identified within the literature overview. For example, Yeow and Edler (2012) refer to the discrepancy between the capabilities held by procurers and the skills required for procuring innovative solutions, in general, as

a potential barrier to PPI. Kalvet and Lember (2010) highlight the importance of technological compatibility, which most probably leads to PPI failure when not taken into account.

The success factors identified within the literature overview align with those of empirical research in the Personnel requirements category. Nevertheless, the literature review resulted in more general categories that included more detailed key success factors found within the research area. These key success factors generally include all PPI participants' skills, capacities, and capabilities. As the significant barriers to PPI, Yeow and Edler (2012) state potential lack of leadership, Chicot and Matt (2018) draw attention to possible learning and capabilities failures among producers. Uyarra et al. (2014) highlight the importance of procurers' competencies and risk management. Several authors see the lack of appreciation of unsolicited ideas as a major issue as well (Georghiou et al., 2014; Uyarra et al., 2013). The team formed for PPI should comprise members with the appropriate competencies, knowledge, and experience in all the relevant fields to ensure a smooth, successful PPI process (Flynn et al., 2015; Rolfstam, 2016). According to OECD (2011), the need for more professional procurers and, therefore, the lack of skills for innovative purchasing becomes a significant challenge. Georghiou et al. (2010) also identified a lack of sufficient procurement expertise for complex purchases involving innovation as well as an absence of formal training for procurers. All the more so lack of experience in handling procurement of innovation could also be manifested in higher costs (Georghiou et al., 2014).

According to empirical research, public procurers should receive support from relevant resources in order to conduct PPI. The support of the decision maker and eligible departments within the public procurer was ranked by respondents as one of the essential success factors of all categories. Uyarra et al. (2014) support the importance of this factor by pointing out, that centralized procurement functions within organizations and a lack of cross-functional teams working in procurement can lead to a structural disconnect between potential suppliers, users, and buyers.

In the category of Legislation, the literature review identified a larger number of more detailed key success factors than the empirical research did. There are lots of authors

emphasizing the possible benefits of a correctly set legislation (meaning motivating and supporting the innovative potential of PPI). The issue of legislation being too strict or over-specified was discussed as a part of the Needs category. It is crucial to point out that strict national and EU-level regulation might result from the pursuance of equality and transparency in the procurement process (Torvinen & Ulkuniemi, 2016).

According to conducted research, the most important success factor concerning legislation is to have set long-term supporting policies on innovation (at the European, national, and/or regional level) that provide monitoring mechanisms and incentives to achieve innovation goals. It is consistent with the findings within the literature, as Edquist (2009) points out that stringent competition regulation across the EU has developed into a major obstacle to using PPI. The issue of the inability of innovation policy champions to trigger changes in line ministries is also regarded in this matter (Georgiou et al. 2014; Lember et al., 2015). Rolfstam (2012) talks about the inherent mismatch between intrinsic institutional motivation to procure innovations (e.g., in the case of existing long-term and irreversible investments) and externally imposed innovation goals in many sectors. According to Uyarra and Flanagan (2010), procurers are often faced with multiple demands beyond that of the procurement itself, and it is not an exceptional situation when the demands are contradicted. Cave and Frinking (2007) and Nyiri et al. (2007) add that there usually tend to be too many aims for a public administrator to achieve in such public procurement.

In the Procurement procedure category, two of the criteria were ranked as significantly as possible (by average significance equal to 5) – sufficient time, detailed planning and continual monitoring of projects at all stages and for conducting the procurement procedure, and a clear definition of selection criteria and award criteria as well as the results of the contract. Sufficient amount of time and detailed planning for implementing PPI at all its phases, which could positively impact the results achieved. While respondents prioritize the sufficiency of time available over financial and other resources (e.g., human and material), no such prioritizing in resource type is visible in the analyzed literature (Lember et al., 2015; Suhonen et al., 2019; Torvinen & Ulkuniemi, 2016). Flynn and Davis (2016) point out the importance of having

enough resources to compete for public tenders, as many SMEs are unable to participate due to the contract size in comparison to their resource capacity or because they do not meet the pre-qualification requirements. The time concerning key factor was also identified in the literature review; however, it was included in wider category – it was part of the category of Legislation, under the item “essence of time,” which, as previously stated, applies to all phases of PPI (Sánchez-Carreira et al., 2018).

Additionally, the literature review identified key factors concerning the need for a unified definition of basic terminology related to PPI (Obwegeser & Müller, 2018), effective administration (Amann & Essig, 2015), adequate demand by the private sector (Kalvet & Lember, 2010), taking into account the regional specifics in the procurement process and the execution of this type of contract (Uyarra, 2016), and transparency (Sánchez-Carreira et al., 2018).

The key success factors related to the procurement process were equally identified as strong communication and coordination of the respective PPI participants, including the giving of feedback (Lember et al., 2015; Uyarra, 2016), risk management (Suhonen et al., 2019) and flexibility on the part of the supplier (Caloghirou et al., 2016). Erridge and Greer (2002) warn of risk aversion or too rigid application of procurement procedures and practices, as it obstructs innovative thinking and PPI potential. Continuous dialog among all stakeholders, providing feedback, and project monitoring are necessary as they go hand in hand with transparency and process efficiency. Chicot and Matt (2018) moreover highlight the importance of information symmetry and interactive space learning.

The factor labeled as concentration on construction and subsequent operating costs had been ranked average significance four. Choosing appropriate criteria (not prioritizing the price criterion) in the evaluation of bids falls in the literature review under the category of Needs, specifically the items “goals” and “specification of requirements.” Not only the price of purchase of goods, services, or construction works should serve as the basic criterion for the selection of the offer, there are other as much important criteria (e.g., innovativeness; Caloghirou et al., 2016).

The expert research identified sharing best practices and model projects in the country

as key success factor. Given its nature, this critical success factor had been put into the Others category. Sharing know-how and best practices might positively impact not only innovation but also the skills and capabilities of project team members and all people involved in the sharing process. The competitiveness of SMEs could also be enhanced. This factor has not been recognized within the analyzed literature, therefore it is one of the article's contributions to the PPI key success factors presented in the current literature.

4. Recommendations

Based on the discussion with the respondents, the authors propose recommendations for each factor, where the authors found it relevant, on how to achieve a better result, or how to strengthen the particular factor.

Regarding the factors in the category of Needs, the general emphasis is on the necessity to correctly identify the needs within the PPI project, taking into account what is realistic and achievable. It is essential to involve the relevant stakeholders as early as in the need identification phase.

In the category of Personnel requirements, it is necessary to put together a team with a sufficient professional background capable of preparing a PPI project. PPI projects are much more demanding in terms of the expertise of personnel compared to regular public contracts. As part of several projects, a number of competency centers were established in the EU to provide support for public contracting authorities and the preparation of tenders using the PPI method. In this category, the experts agree that it is essential to motivate employees to prepare projects not using the conventional method (which is much easier and presents less risk for them) but using the PPI method. This is up to each public procurer to decide; however, pressure should be put on public contracting authorities by policy makers, who alone have sufficiently effective tools at their disposal to motivate contracting authorities to use PPI.

In terms of legislation, it is crucial to provide long-term support at all levels. Given the higher risk and higher costs, it is important to motivate, or compel, public contracting authorities to choose to conduct projects in the form of PPI. For this purpose, there is a host of tools, from subsidy programs contingent on the use of

the PPI concept to the directive requirement mandating that each procurer have a certain percentage of contracts carried out in the PPI system, depending on the type of procurer.

In the procurement process itself, the most significant success factor is a sufficient amount of time and the appropriate selection of evaluation criteria and the need for detailed planning and monitoring not only in the planning phase, but also in the subsequent implementation phases. The problem here is that the various bids must be clearly comparable. Unlike regular competitive bidding, it is necessary to define the evaluation criteria in terms of the requirements of the result rather than the way in which the result should be achieved.

Another important factor is the need for effective risk management throughout the project as due to their nature, PPI projects involve a higher degree of risk than regular projects. It is crucial for the public sector to guarantee to take on some of those risks.

The last important factor in this category is financial evaluation, where in PPI projects emphasis should be placed on the overall financial effectiveness of the solution. Rather than just the purchase price, what should be taken into account is the sum of the initial investment and operating costs over the lifetime of the solution, and possibly other parameters, such as the degree of innovation of the solution, environmental impacts, and social implications.

The expert groups also agreed on the need to support both public contracting authorities and private suppliers by sharing information on successful projects and best practices. Over the long term, suppliers have been put in a situation where they have to offer exactly what there is demand for at the lowest price possible. They have thus stopped showing initiative, as in the current system it would only result in a failure to win the contract. It is therefore absolutely necessary to raise awareness among suppliers and change the current standard, as experience with pilot runs or identified projects shows that suppliers are not interested in entering tenders conducted in the form of PPI as they do not have enough experience and are not ready for it.

Conclusions

The authors of this article as well as the authors identified in the literature review agree that PPI is a very powerful tool for supporting innovations

by the public sector. There is also a general consensus that a substantial role is played by policy makers, who must appropriately motivate public procurers to prioritize the PPI concept over conventional solutions, although its application poses greater demands for them.

The problem with monitoring the spread and application of the PPI concept is mainly that there is no clear attribute indicating that a particular public contract was handled as PPI, which makes it impossible to identify, monitor and evaluate PPI contracts, for example, using statistical office data.

In the authors' view, an important step is to raise awareness among all stakeholders, primarily policy makers and public procurers. Subsequent best practice and successful project sharing should attract innovative companies, who should find a system in which they can fully utilize their potential for innovation interesting.

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