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CHALLENGES IN USING PRE-COMMERCIAL PROCUREMENT (PCP) FOR ENHANCING INNOVATION FOR CITIES: RESULTS FROM AN EMPIRICAL STUDY ON SMART CITIES

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Abstract

The purpose of this study is to increase knowledge of the challenges in using pre-commercial procurement (PCP) for enhancing collaborative innovation with external actors in cities. PCP has not become a popular or widely known way to foster innovation for cities' needs –neither among cities nor among companies. The knowledge of using PCP for enhancing innovation in cities is almost non-existent. There is an evident need for increasing our understanding about the challenges in using PCP for collaborative innovation in cities. The present findings are based on an empirical study on open innovation platforms in Smart Cities. The research method is qualitative and draws on extensive data from in-depth interviews and co-creative multi-actor workshops. This study identifies and describes a large number of challenges in using PCP for enhancing innovation in cities.

Keywords Pre-commercial Procurement PCP, Collaborative innovation, Public innovation, Smart City, Innovation intermediary, Innovation platform, PPP public private partnership, University industry collaboration.

1 INTRODUCTION

PCP is the procurement of research and development of new innovative solutions before they are commercially available [1]. PCP refers to the procurement of (expected) research results and is a matter of direct public R&D investments, but no actual product development. Moreover, it does not involve the purchase of a (non-existing) product, and no buyer of such a product is therefore involved. This type of procurement may also be labelled “contract” research, and may include development of a product prototype [2]. The procurement is an R&D service contract, given to a future supplier in a multi-stage process, from exploration and feasibility to R&D up to prototyping, field tests with first batches and then, finally, commercialization [3]. PCP is an instrument for enabling and enhancing public innovation. This research includes also results dealing with Public Procurement of Innovation (PPI), because it is another approach for enhancing the innovation in the public sector –even though not the central theme of this article. PPI is an instrument and a procurement strategy by which a public agency places an order for a product or system that does not yet exist; innovation is necessary to make delivery possible [4].

PCP is also a clear opportunity to universities and research institutions for their applied research collaboration with industry partners and working life, because a large number of winning PCP-contracts (33%) have university center partner in consortium [5]. Winning SMEs are also often university start-ups. Moreover, Smart City research and related higher education in urban development is rapidly increasing due to the strong global urbanization development. Since cities are one of the main driving forces and enhancers of innovation in this field, there is a clear need to understand methods available for this purpose. PCP is one of the methods designed for enhancing the public sector's innovation.

Despite the various potential benefits of PCP for collaborative innovation in cities, it has not become a popular method to enhance collaborative innovation in cities. This empirical study aims at revealing reasons for this. First, this study briefly, based on the literature, explains the principle of PCP. After that, based on the empirical research, it describes a large number of challenges in using PCP for enhancing innovation in cities. After that, it draws the final conclusions.

2 PRE-COMMERCIAL PROCUREMENT

According to Edler and Georghiou [3], PCP is applicable for innovative products and services for which further R&D is required. The risk related to innovation process is shared between the company

and the city. Products and services are still in the pre-commercial phase, they are not “off the shelf”. The procurement is basically an R&D service contract, given to a future supplier in a multi-stage process, from exploration and feasibility to R&D up to prototyping, field tests with first batches and then, finally, commercialization. The rationale for this approach stems from the argument that R&D-intensive procurement needs more intensive interaction and cannot be judged on the basis of written specifications and proposals (ibid.).

According to Edquist and Zabala-Iturriagagoitia [2, see also 6], PCP does not involve the purchase of a (non-existing) product. And, no buyer of such a product is therefore involved. PCP may also be called “contract” research, and may include development of a product prototype. It is a matter of research and development (R&D) funding of a targeted kind, geared toward very specific goals and in a focused way.

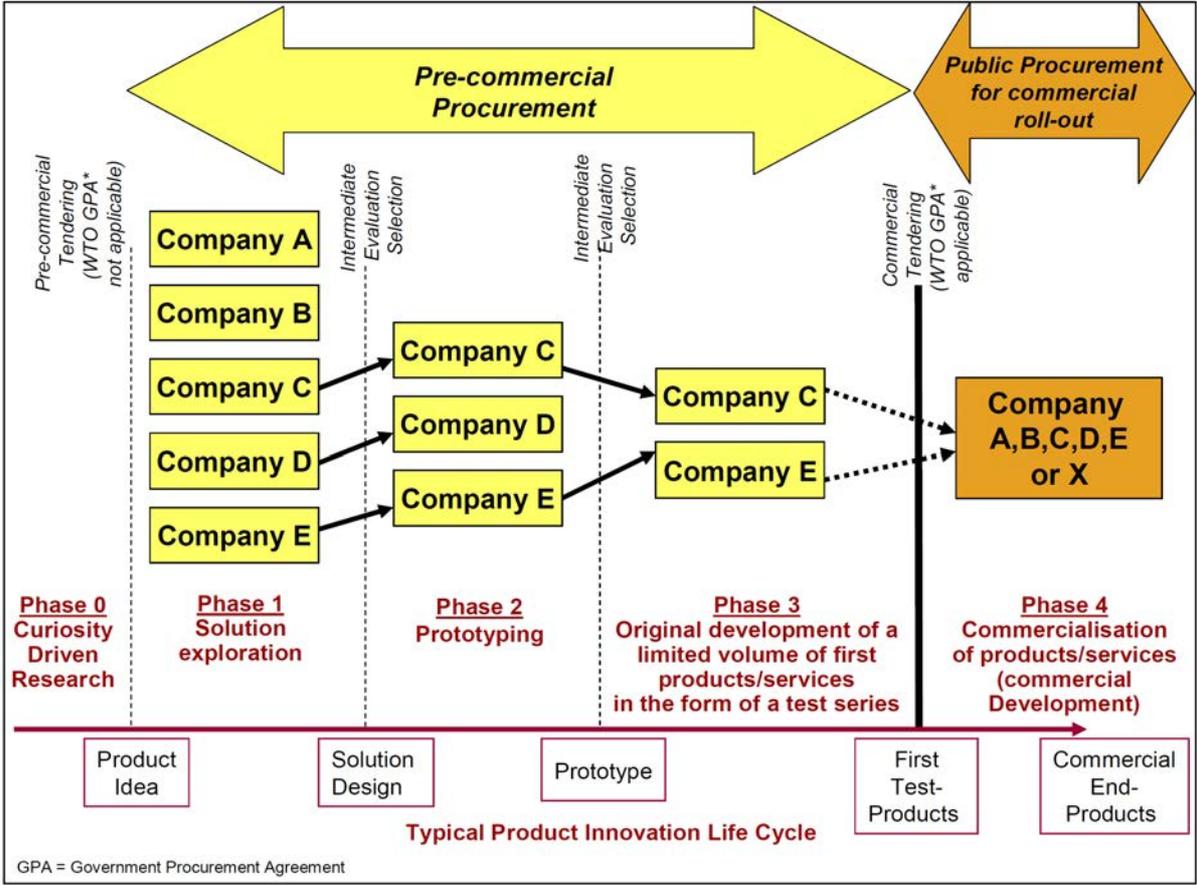


Figure 1. Example illustrating a phased pre-commercial procurement process [7, p. 8]

PCP and its phases are described by Decipher PCP project [8] based on EU Commission [7] as follows. PCP is an approach for acquiring R&D services which enable public procurers to (1) share the risks and benefits of designing, prototyping and testing of new products and services with the suppliers and other stake-holders such as the end-users, (2) create the optimum conditions for wide commercialization and take-up of R&D results through standardization and/or publication, and (3) pool the efforts of several procurers. PCP gives an opportunity to develop different ideas in parallel where one, or few of the initial ideas will eventually be selected for commercial public procurement in accordance with the Procurement Directives. It starts earlier in the innovation cycle of a product than a more conventional procurement project would do. Moreover, it is a competitive process where solutions are step by step selected or abandoned (Figure 1). It is attempt to highlight existing possibilities for public agencies to procure innovation within existing legal frameworks. The First phase in PCP may involve a pre-study or ‘solution exploration’ where several different solutions are explored. The second phase may include prototype development of the solutions that are considered most promising. This can be followed by the development of a small test-batch of some of the remaining solutions. Finally, one or few of the remaining solutions are selected for commercial roll-out [8].

3 METHOD

The present empirical findings are based on a larger study dealing with open innovation platforms in Smart Cities [9,10,11]. This larger research project addresses various aspects, and the central theme of this article -challenges in using PCP for enhancing innovation for cities- is one of them. The research method is qualitative based on in-depth interviews [12]. The data of this article include 65 in-depth interviews. The interviews were audio recorded. The interviewees also had a chance to make drawings during the interviews. The drawings were photographed, collected, and interpreted in the analysis. The informants of the in-depth interview come from Finland (49), Spain (5), Netherlands (2), China (3), Italy (2), Denmark (1), Australia (1) and USA (2). The interviews were audio recorded and transcribed for later analysis. However, most of the findings of this paper are based on the data from the Finnish informants. The informants were selected based on their expertise or experience in innovation in the cities, public procurement, Living Labs, or other type of innovation intermediaries in the city context. The interviewees include persons from the city administration, private companies, 3rd sector organizations, innovation intermediaries, as well as researchers. Interviewees selected from the city administration have experience or expertise on innovation, urban development, and collaboration with private/3rd sector organizations. Interviewees selected from private sector have experience or expertise on collaboration with the cities. Interviewees selected from 3rd sector have experience or expertise on collaboration with the cities. Interviewees from innovation intermediaries have experience or expertise on Living Labs or facilitation of collaborative innovation networks. Researchers are academics who have examined innovation intermediaries or urban development. Interviews took around 1-3 hours. In addition to in-depth interviews, the data of this article include material from 4 co-creative workshop addressing innovation collaboration between the cities and external actors. The data of the workshops include transcriptions of selected parts of the workshops, notes, photos on written and drawn material during the workshops, as well as written summaries of the main conclusions of the workshops. The data were analyzed by open coding and selective coding, in terms of the grounded theory method [13].

4 EMPIRICAL FINDINGS: CHALLENGES IN USING PRE-COMMERCIAL PROCUREMENT FOR ENHANCING INNOVATION FOR CITIES

This empirical study identifies several challenges in using PCP for enhancing collaborative innovation in cities. Figure 2 shows an overview of the challenges. It also shows by the colour whether a particular issue is perceived a challenge mostly by cities, external actors (companies, 3rd sector organizations, research institutions), or both.

4.1 Challenges to both cities and external actors

Ambiguity of the concept of PCP and application of Act on Public Contracts for it. The study showed that PCP and public procurement of innovation (PPI) are vague and ambiguous concepts. They have no commonly agreed precise definitions. In Finland, procurement can be defined as innovative procurement, either based on the procurement process or the innovative nature of procurement. In this case, the procurement process is either implemented in a new way or the subject of procurement is new or reformed. The challenge here is that the public sector with its traditional safety-oriented and risk-averse approach defines in excessive detail the subject of procurement based on limited knowledge of the market or on previously obtained solutions. In this case, the market cannot offer any new and more functional product or service solution for the needs of cities. The new Act on Public Contracts provides for innovation partnership for tendering research and development services if the product or service concept does not exist on the market. Procurement can be carried out with a partner selected through a competitive tender process if the final result meets the needs of the city. The challenge is that the scope of application of innovation partnership is unknown either.

The PCP process is less known as a concept. It is a less commonly used procurement method in Finland. This method has not been considered fully functional in the Finnish procurement culture. EU Commission-funded transnational PCPs have increased the awareness among city employees responsible for procurements and, to some extent, in companies. PCPs in the EU are intended to promote the recovery of the EU economy and develop its business sector. The object of procurement is research and development services. The purchase of R&D services is not yet properly recognized as procurement, but may even be perceived as the company's capitalization. It should also be noted that the purchase of R&D services is an activity regulated by contract law. This kind of activity is aimed at the development of an innovative product and service solution where both share risks. If the public

sector decides to acquire a developed innovation, such activity is subject to procurement legislation. Therefore, the challenge is to draw the line in the application of contract and procurement law.

Uncertainty of usefulness of PCP. Several interviews were suspicious about the PCP instrument's fitness for use and to stimulate the market. This is mainly because they know it is presently rather unknown, the process is long, includes several evaluation phases, and bureaucratic. For example, the EU Commission's PCP process includes three evaluation phases involving a number of external evaluators. Actors involved in PCP process may "run out of steam" during the project. This and several other challenges –discussed below- arouse suspiciousness and sceptic attitudes towards EU-commissions PCP instrument whether it creates new entrepreneurs spearhead products or services in Europe.



Figure 2. Challenges of pre-commercial procurement in enhancing collaborative innovation in cities

Decision makers in city departments lack support for interpreting Act of Public Contracts. The research material indicates that the current Act on Public Contracts offers a variety of methods to conduct innovative procurement and development work, but the cities do not take sufficient advantage of them to develop new solutions. Cities do not recognize the procurement process as a problem, but other actors find it limits the creation of new solutions. Decision-makers in different city departments have too little knowledge of procurement and legal matters, as well as the courage to carry out procurement in a new way. For this reason, many innovative procurements are not progressing because public procurement law is interpreted too literally, and the same practice continues. Procurement experts may not be sufficiently familiar with the problems of city departments. Experts in the departments do not feel adequately supported by procurement experts during the procurement planning and preparation phase or they try to consider the matter for too long with experts from the same department only. Neither do they always dare to ask. Cities' problems and challenges are still defined with too much emphasis on the procurer without sufficient knowledge of the supplier market and understanding of the customer.

Cities have poor knowledge of external actors. The study revealed that the cities' procurement experts and departments do not have sufficient knowledge of the external actors. Also, the available means and resources to adequately identify them are insufficient. This weakens the city's courage to use more innovative procurement methods and purchase R&D services. Cities shy away from external actors being given a freer hand to develop solutions for cities' problems. This is because the external actors are not sufficiently well known and their commitment is not trusted due to past experience. In addition, open dialogues with them are considered challenging due to a way of thinking based on public procurement law and competitive bidding. The mapping and identification of external actors in PCP is even more demanding than in traditional procurement. This is due to the fact that in the case of PCP the actors and the departments are often still in their infancy. Also, there is a tendency to form established procurement relationships between the city and external actors. For this reason, new alternatives and actors are not actively sought for product and service solutions.

Lack of knowledge of co-creative problem definition. The study shows that when defining a city's problem related to PCP, better expertise in co-creation is required. Cities alone are not able to solve and develop new operating models, but need more and more expertise from other actors already in the problem definition phase. This is often a challenge. Also, there is often a need for a professional external facilitator who is able to identify the problem and the associated needs together with the city's employees and other actors. Other parties to be involved in the co-creation are users, companies, third sector organizations, and research institutes. The problem definition stage also requires sufficient participation and expertise of procurement experts. This is important that it will later be possible to choose the most suitable procurement method to the problem behind the solution. Success in this will be of significant importance to the smoothness and cost-effectiveness of the procurement process. In addition, it will significantly affect the end result of procurement for both the city and the residents.

Lacking end-user and customer orientation. The research data shows that organizational, professional, and motivational factors prevent the adoption of a user and customer-oriented way of thinking in cities. The challenge lies in the co-creation of cross-administrative services and procurements in strong expert organizations. The challenge is to treat the customer as a subject, not an object of the activities. In order to define the city's problem to be solved, there is a need for experts working in the management of different city departments, persons working at the customer interface and in procurement. The challenge is that the current bureaucratic practices of organizations do not contribute to the creation of demand- and user-driven service solutions in conjunction with external actors. The innovative procurements were found to be the most successful as innovativeness is part of the basic functions of cities. Moreover, in terms of authorities' responsibilities, the new operating models and solutions are viewed as threatening if there is no certainty of their usability. The challenge is that cities fear that customers will not be treated equally.

Cities lack long-term procurement strategy. The challenge is that cities have not defined long-term procurement strategies that would be based on future societal problems and needs. Cities' administrations have too little time and resources to reflect on strategic renewal as well as to create new alternative development paths alongside the existing ones. The better cities are able to define key strategic priorities for development and to communicate them to external actors, the easier it will be for the cities to identify opportunities for PCPs and PPIs together with the external actors. In turn, it is difficult for external actors to invest in the development of their product and service concepts and to open a dialogue with cities if the cities do not communicate clearly and consistently future strategies

and problems. Another challenge is that cities are lacking systematic innovation activities aimed at finding new solutions with external actors.

Lack of trust between cities and companies. Co-creation is often hindered by a lack of confidence and transparency between the city and external actors, as well as by the diversity of values. Furthermore, cities are sceptical about companies' ability to understand their processes and objectives because companies operate on business principles. The challenge is to create a common understanding of R&D procurement and objectives as well as the distribution of risk together with external actors. The price-oriented approach of both parties makes it difficult for them to undertake PCPs and PPIs because they are unable to identify the long-term economic benefits of the projects. Purchasing R&D services from external actors requires building mutual trust and respect as well as understanding the nature and operational environment of each other's activities. It also requires the definition of common objectives on a customer-oriented and commercial orientation with external actors.

The changing role of the city as a procurer: from buyer into innovator. The investigation showed that the uncontrolled experimental culture is perceived as a threat because cities have limited time and human resources. Research and development requires the courage to open up the city's service production and environment for experimentation and evaluation. In particular, encountering external actors and considering their views and feedbacks are very challenging for cities. The adoption of new solutions is causing major challenges for cities if they have not been thought through during the procurement planning and preparation phase and tested under the right conditions, together with external actors.

The research data confirmed that completely new operating models and approaches are required to deal with external actors where PCP and other innovative (PPI) procurements are planned. The challenge is to extend the procurement expertise to the meanings of the various phases of the procurement process (planning and preparation, tendering, contract and cooperation during contract) as a whole. In this case, cities' service production can be reformed in an open-minded way and the relationship with external actors revived.

The research data shows that everyone who participates in pre-commercial and other innovative procurements can gain significant benefits and experience, even if the solutions have not been provided or the city decides not to procure them. In the new active role of a challenger, the city can act as an ecosystem builder as well as a catalyst of ideas, a valuable tester of the best solutions or the first buyer for external actors. Encouraged by the city, the external actors can find customers for solutions they have developed also outside the public sector because this sector is perceived as a demanding and credible testing environment for products and services. The research material shows that cities have an opportunity to reform themselves when a will and avenue are created to encounter external actors for the co-creation of both product and service concepts. This requires a flexible and structured operating model in order to identify opportunities for PCP and PPI procurements that are important to society.

Understanding lifetime cost and return of investment. The study shows that PCP and PPI procurements can be implemented if their costs are examined through the life-cycle costs and repayments. The challenge is to justify the investments to policy makers. Procurement processes require diverse economic and financial skills in order to reduce risks and ensure the end results. Cities lack investment programs for services. The challenge is to understand large volumes of service procurements and the economic importance of their development projects. The current investments are aimed at physical objects that are distributed over several years and do not burden the cities' finances in the same way as inefficiencies in service structures. The challenge is that PCP and PPI procurements are not seen as part of a cost effective procurement process and the benefits cannot be clearly specified to policy makers or the changes are opposed. They are perceived as additional costs and a communication problem, even though the aim of PCPs and PPIs is a more sustainable and more flexible service production as well as the development of the economy. The challenge is to use public tax funds in the research and development of services the results of which will not be seen until later.

Too few companies involved in PCP. The investigation revealed that there are relatively few Finnish companies involved in EU-funded transnational PCP projects. The challenge is to get external small and medium-sized actors interested in these projects and in gaining international experience. Multi-phase competitive EU-funded PCP projects may take several years. Not all external actors are able to commit to projects that last too long.

Small and medium-sized enterprises and third-sector actors are eager to solve cities' problems and, together with the cities, perform concrete development work to meet the identified needs if the R&D provides them with business opportunities or if the payments for the work performed are made quickly and regularly. The data indicate that large companies do not have a great interest in EU-funded PCP projects because they are already contractors of cities or do not cooperate with cities for some other reason, for example investments in their own product and service development.

The research data revealed that large companies are perceived as unwieldy and slow as public organizations. Cities experienced SMEs as flexible and customer-oriented co-creators. The challenge is that SMEs experience cities as inward-looking, bureaucratic and favouring large enterprises. For the above-mentioned reasons, all SMEs do not offer product and service concepts for public procurements, but instead they search for markets elsewhere. SMEs perceive public procurements as processes that are too lengthy and frustrating and involve a large amount of documentation and unprofitable contracts. In addition, they are afraid of their own ideas being used by other actors. Also, SMEs and the third sector find it challenging to invest in the development of new solutions if no remuneration is provided. The challenge is to strengthen the courage and confidence of external small and medium-sized enterprises in working on R&D with the city and other external actors.

Difficulties in need and goal definition of procurement. The research data show that challenges and problems are identified, but the greatest challenge for the public sector lies in acknowledging problems and defining needs as well as in agreeing on targets together with external actors. External actors feel that they have to participate already in the identification of the problem and not only in the definition of the need. In transnational EU-funded PCP projects, the mapping of supplier, product and service concepts is a challenging task because new external innovative actors are not necessarily reached by the current operating culture and model. The research data confirms that it is virtually impossible for a city alone to come up with innovative product and service concepts because its own operating environment sets mental limitations. Therefore, also external actors are required to solve the problem, alongside internal development and change agents.

The investigation revealed that the city organization is not tuned to face opportunities and surprises but instead preferably operates through an established model. The challenge is to change the current role of the city into more of an initiator, innovator and indicator of changes. The challenge is to proactively identify problems and solve them together with external actors. The current operating model of public sector procurements is still too closely linked to the traditional operating model where ready-made solutions are defined without involving, and hearing the views of, external actors. Officials are not used to define problems and needs so that the whole chain of needs is opened and discussed also with other city departments and external actors.

The role of planning and preparation increases in PCP. The planning and the preparation of procurements will require more vision, when the current operating model shifts towards demand- and user-driven innovative procurements. In this case, not only procurement law and price-oriented thinking but also the need, objective and outcomes of dialogues will determine a suitable procurement method when public agency decides to procure. According to the research data, needs are still defined in a too narrow-minded way from the perspective of one city department. This prevents the implementation of cross-departmental innovations and necessary R&D projects that also reduce the risks of the actual procurement.

Systematic mechanisms lack for dealing with external initiatives for innovation. The research data revealed that cities' procurement services are not sufficiently familiar with the existing product and service solutions of external actors. The research data also showed that it is difficult for external actors to find someone within the city organization to discuss new product and service solutions. The challenge lies in product and service concepts for which cities have existing contracts with external actors. Partly for this reason, new product and service solutions created by companies are not discussed and developed in good time before the old contracts expire and tendering begins.

The research data confirmed that cities must have employees to systematically coordinate enquiries from external actors and forward them to the right people as well as to arrange meetings. The challenge lies in the current operating model that does not treat all external actors fairly, and no uniform information resources are gathered for cities. The research data showed that external actors would like to offer, on their own initiative, R&D projects to solve the problems and challenges of cities, but there is no suitable channel for opening discussion or it is avoided. External actors prefer to undertake development projects together with other actors of their network because it is faster and more concrete than doing it with the city. The research data showed that some of the external actors,

especially SMEs which have new business ideas and suggest R&D collaboration to city authorities, feel they are treated indifferently by the city at times.

Difficulties in reaching common vision and goal between different actors. The research data showed that SMEs are happy to sell to cities, but the procurement criteria are not always attractive for them to make an offer. Cities perceive themselves as a significant buyer for the existing product and service solutions of external actors. The challenge for a city is that many external actors are not ready to invest in research and development, but rather demand free test platforms from cities' service production. Those responsible for procurements and service processes feel that some of external actors want to use the city's resources for their own benefit. The challenge is to get the external actors to understand the operations of a city organization and its objectives. External actors are otherwise not able to provide new and innovative solutions to cities' growing societal and social challenges. The research data confirms that external actors' outdated attitudes and practices slow down the transformation of their businesses because they focus only on protecting their own interests and competing with each other. SMEs and third-sector actors tuned for transformation feel that open communication and trust as well as the identification of the strengths of their own businesses lead to a more functional competitive co-creation and ecosystem in which there are more winners than losers.

According to the research data, SMEs are not always interested in R&D collaboration with cities because they are perceived as bureaucratic, slow and closed organizations. Access to R&D collaboration still appears to be a major effort for both cities and external actors. It requires of all parties dialogue, commitment, and the opening up of their own processes and calculations. The challenge for R&D is that it requires of all parties strategic thinking and the understanding of the nature and strengths of other actors' operations.

The research data shows that more information about PCP is required because cities and companies do not properly recognize the benefits in solving societal and social challenges. The establishment of a common view is challenging if the city and external players do not perceive co-creation as their strategic task and do not organize time and human resources for that. The challenge lies in the hierarchical administrative apparatus of a city and its established practices, which change slowly. The current economic situation and continuous sudden changes both locally and globally force cities to change their practices and procurement culture to become more flexible in the future.

Disagreements on IPRs. The research data shows that intellectual property rights give rise to intense discussions between companies and cities. In the current operating model cities are used to buy the ownership of products developed by other actors and do not consider further commercialization opportunities of the end solution from the companies' perspective. The challenge for PCP projects lies in the negotiations on intellectual property rights before the start of each process where the rights and objectives of the parties are evaluated before the final contract is signed. The challenge is to get a city used to traditional procurement practices to understand that the IPRs belong primarily to companies that are responsible for the further development of the developed solutions.

Structural and larger-scale radical changes related to service processes will not succeed using only quick experiments and digital applications. The challenge for a city is to perform long-term R&D together with several external actors. This will challenge the city and companies to understand the risks, benefits and relevance of the IPRs from the point of view of all contracting parties.

Risk of limited diffusion of new innovations. Based on the research data, it can be concluded that the commercialization and introduction of new solutions have not been systematized in cities, nor is it clear how they could be shared and spread to other cities. The competition between cities for vitality is a challenge in terms of the dissemination of ideas and best practices both domestically and internationally because spreading them depends too much on the networks of individuals. The move from the R&D phase to the actual procurement may fail if the real need has not been adequately determined in the preparation and planning phase. Both cities and external actors feel that outdated regulations impede R&D projects and the linkage of revised product and/or service concepts to the current service production.

Finnish cities insufficiently participate in co-creation, since they operate in a very self-centered way. They do not have sufficient systematic discussions on the national and international dissemination of new solutions with each other and with external partners, which means that the commercial benefits remain modest. The research data revealed that ministries should more actively promote the implementation of PCP projects and PPI strategies. According to the research data, the sharing and dissemination of new ideas, concepts and practices would, however, be easier to do in the public sector than in the private sector. This is due to the fact that cities do not compete with each other on

the principle of profit maximization. The challenge is to create a stronger common will between cities which requires strategic innovation management and less hierarchical organizational structures.

Weak knowledge or experience of public procurement and contracts among external actors.

The research data indicates that external actors perceive cities sometimes as difficult or less smart contracting parties. They appear to be unreasonable, inflexible and rigid before and after the contract is concluded. The challenge is to create an open negotiation and discussion culture as part of partnership and provide information about public procurement process. The challenge in PCPs is augmented by market analysis, market dialogue and the drawing up of contracts, which are an essential part in preparing the research and development process. Basic expertise in procurement alone is not enough – more sophisticated strategic management of the entire procurement process and negotiation skills are required when working with external actors. The challenge for a city is maintaining appropriate flexibility and strictness in contractual matters. According to the research data, the challenge for external actors is to understand the transparency of public sector activities, the monitoring of public finances and the requirement of productivity.

Lack of demand- and user- centric thinking. It is apparent from the research that demand-centric and user-centric innovative public procurements require a new kind of attitude and capability from both city purchasing officials and external actors. PCP is a challenging task for a city. In principle, cities undertake procurements because they cannot produce themselves, their own production is not profitable or they have no knowledge of the product and service concepts in question. Procurements are rarely guided by innovation or the development of the economy. Innovation is considered to belong to business services and not to the strategic management of procurement. Customer-oriented and centric thinking has not yet been realized in cities' processes because the customer is seen as an object rather than a subject and resource. Nor can external actors be seen as resources and partners. The challenge is to move from a formal hearing required by law to a genuine customer-oriented listening and the needs-based planning of services as well as production in which external actors will participate. The challenge for external actors is to understand the responsibility of city officials, the protection of customer privacy and the treatment in the phase of product and service concept testing, introduction and production.

Lack of collaboration between city departments. According to the research data, the co-creation of product and service concepts between city departments is insufficient because the value of interaction and co-creation across departmental borders is not recognized nor are the problems in processes opened up to external actors. A siloed operating model based on partial optimization prevents city departments from learning from each other because the department-specific operating models and attitudes are deeply rooted. The development of radical new product and service concepts requires more intense cross-administrative collaboration and open data, as well as collaboration with external actors.

Inability in recognizing business potential in the public sector services. The research data shows that cities' service production is perceived as a stable and long-term actor. It has a strong role as a welfare service provider. It is perceived, however, as cost-inefficient and slow to reform because of insufficient competition. The challenge is augmented by inability or unwillingness to recognize business opportunities because such authority has not been delegated to anyone in cities. For this reason, the use of PCP is low. Political decision-making does not encourage cities to undertake PCPs and PPIs.

4.2 Challenges mostly to cities

Long development and co-creation times during PCP processes. The study shows that a number of the EU Commission's transnational PCP processes are under way in Finland during this study. Some Finnish cities participating in these processes are seeking R&D experience as well as operating models for future procurements. The different procurement culture of other European cities, technical knowledge and the role of the public sector create their own challenges for transnational PCPs. Cities find PCP processes to be long and laborious, as the projects require a long-term commitment of resources. The evaluation phases, which are part of the EU Commission's PCP procedure, and the subsequent product development phases are found to be too lengthy and slowed down the commercialization of the solution. For example, the heavy use of external evaluators is considered as slowing down the process. The study showed the desire to give more responsibility for evaluation to the procurer, i.e. the city. On the other hand, the study revealed that, from the perspective of companies, 5 years is in some cases too short a period for product development that certain product and service solutions require. The study showed that PCP projects partly funded by the EU

Commission have been more about trying a new procurement system in which R&D services are purchased without the cities having a real and identified need or political objective.

PCP does not guarantee usable or commercial solution. The study showed that cities do not yet perceive the PCP method as useful because R&D is not seen as an investment. The challenge often lies in justifying and evaluating PCP and presenting the end result to the political decision makers. It is often about challenging external operators to create innovative product and service concepts for future problems for which there are no ready-made solutions or solutions might not be found during the process. The end result can also be a surprise when erratic and slow political decision making may prevent further measures. In PCP, experimenting, testing, and piloting are carried out under realistic conditions through the co-creation of solutions with external actors. The challenge is to accept the costs if the PCP is suspended under the terms stated in the contract. The challenge for cities is to understand that only actual demand motivates external actors to co-create new product and service concepts for the public sector. City purchasing officials are used to acquiring through an open procurement procedure large volumes at the lowest possible prices. The difficulty lies in giving an open challenge for external actors to solve, for example by using PCP.

Lack of incentives and metrics. The research data shows that PCP method and PPI strategies are introduced slowly or the city waits until other cities test them first. Procurement experts and city departments have to challenge themselves to try and learn other less-used dialogue procurement methods in order to create innovative service solutions. Strategic guidelines and support of the city's leadership encourage to undertake PCPs and PPIs in order to find new solutions by subjecting external actors to competition.

The challenge experienced is that cities' current enterprise resource planning systems do not provide comprehensive information on the costs of alternative solutions for the planning and preparation of innovative procurements. The incentives and metrics are lacking. The above-mentioned problem also prevents radical innovation between city departments. Another challenge lies in the identification of external actors, the fear of failure and the cost management, because external actors do not always understand the objective and the values of cities' activities. The fear is caused by the increase in the provision of services and the rise in prices in an uncontrolled manner later.

Budgeting constrained by organizational silos, fiscal years, and IT systems. The research data shows that cities' silo and annual budgeting and current information systems hamper radical innovations created across city departments. The challenge is to identify the potential objects and benefits of PCP and PPI with different city departments. Different city departments are not able to make use of each other's databases regarding clients and their needs in the procurement planning and preparation phases. The partial optimization of departments own operating models poses challenges for cities because none of the departments is able to manage the entire process. There is no separate budget or financing for R&D or co-creation projects involving external actors. According to the research data, some city departments are well ahead of others in the development of operating models while others are just beginning to open up their processes to external actors. The research data shows that the development of individual departments is not in the interest of the city, but is an impediment to comprehensive innovative development and procurement of services

Difficulties in establishing strategic innovation partnerships. The research data shows that the establishment of strategic partnerships is hindered by public procurement law issues and the difficulty to draw up development partnership agreements. This may reduce companies' interest in co-creation with cities because they do not have the time to wait for cities' decision and a final agreement. Co-creation is in the heart of PCP. The challenge lies in training procurement lawyers to understand the importance of innovative procurements when the city concludes PCP contracts and innovation partnership agreements. The challenge is also compounded by cost counting and clarifying concrete benefits for political decision makers.

4.3 Challenges mostly to external actors

Experience in and knowledge of PCP in cities is lacking. Cities have not actively used PCP. A challenge lies in the fact that PCP requires a new kind of knowledge and resources. Cities have less experience and expertise in project management and administration than many external actors, such as companies engaged in research and product development. For this reason, external expertise in managing PCP projects would be required. External expertise is, however, difficult to acquire due to cities' limited budgets and recruitment bans.

Our data shows that cities have inferior knowledge of PCP in general. Often even the term PCP is unknown, not to mention its application opportunities for stimulating the market by procuring R&D. Cities do not use PCP since they do not know it. In turn, they do not know PCC because they do not use it. Both the procurement as well as the lawyers working for the central government of cities have limited knowledge of PCP. Also, the city departments giving procurement requests to the procurement departments lack the knowledge of PCP. This is a major challenge while the city departments are the project owners and they have the responsibility to manage the PCP projects. PCP is not a matter of public procurement law, but instead the contract law. Cities are very familiar with the traditional public procurement law and related practices, since they are used to procure immediately usable solutions which are in the commercial phase. On the other hand, they have very little experience in buying innovation projects. Similarly, companies are also quite unaware of PCP. This is because PCP is so rarely used by the cities. Moreover, there are very few experts with solid experience of PCP available in the consulting community.

Many cities are too small units for using PCP in their procurement. It was found that a city is often too small a unit to be a PCP buyer. The study showed that it would be worthwhile for cities to perform PCPs jointly so that it is possible to share the costs and risks of R&D as well as experience. Also, product and service solutions that are to be developed can be tested under different conditions. This would particularly benefit smaller cities with fewer resources to purchase R&D services when searching for new solutions to societal and social problems.

Reluctance of opening up the cities' service processes. The study reveals that cities slowly open up their service production processes for examination by others. Cities are afraid of criticism, organizational changes and risk-taking. The opening up of processes would reveal that cities do not have a strategy to develop their services or that the strategy has not been integrated in the activities of the organization. Another challenge for cities is that the development in them often depends on certain individuals. They have to take a personal risk because they do not have management support. The study suggests, the development activities would require a clear operating model which can be implemented together with the staff. Cities would need an operational model for goal-oriented experimentation and learning whereby external actors will be able to integrate into the development of the city. The challenge is that the development of new services and business operations together with other actors will not succeed unless the city's service production model is transparently illustrated. The above-mentioned issues hold back the implementation of PCPs and innovative public procurements.

PCP not applicable for rapid life-cycle products and urgently needed solutions. Based on the study, the EU Commission's PCP process is not suitable for the development of product and service solutions with short life cycles. It is also not suitable for situations where the solution is needed quickly or the market solves the problems quickly.

Cities reluctant to make risk invests in innovation through PCP. The study shows that cities' decision-makers are reluctant to invest in R&D activities if the end result is uncertain. Furthermore, such projects are not necessarily of interest to the cities. They think that it is not enough if they only gain operating and user experience from new services innovations in real test environments. They would rather see also it leading to the actual tendering of ready commercial solutions under the Act on Public Contracts. The purchase of R&D services is not one of the cities' strengths, since they are accustomed to purchasing performances rather than effectiveness and results. The creation of new business activities sought through co-creation is also seen as a threat, because the result may cause changes to the current service production and the organization, and thus threaten existing "status quo". Taking research and development risks is not perceived as the city's responsibility.

Mindset overly procurement law centered. Based on the study, the procurement law centered mindset makes it more difficult to discuss the city's challenges and problems with external actors. The challenge is an important requirement set out in the Act on Public Contracts providing an equal, non-discriminatory and transparent treatment of all actors. Partly for this reason, the discussions on the problems and challenges are delayed or do not take place in time. Employees in city departments and procurement do not have enough courage to ask external actors open questions. Officials do not know how to deal with external actors' answers and solutions they propose because the experience and operating models are still insufficient.

The transformation of a city's service production will slow down if PCP instrument and PPI strategies are not used when suitable occasions arise. External actors do not dare to develop their own product and service offerings either, since the city does not communicate its problems and unable to clearly define its needs in its strategies. An encounter with new actors can be very random, in which case

many ideas in the development phase will remain undeveloped and important R&D projects unrealized. SMEs and third-sector actors are most affected by the current situation because they have less direct contact with the city's procurement decision-makers. A city purchasing official with the right to determine the object of procurement and its criteria and to select a supplier was considered to have too much power if only traditional procurement methods were used. According to the research data, listening to and engaging with external actors remain too insufficient in a culture centered on procurement law. In a mindset centered on procurement law and price, the purchase of R&D is shielded away from when the own definition of needs cannot be performed well and there is limited understanding of the business of external actors. In addition, cities are afraid of negative publicity and criticism caused by incorrect and cost increasing activities.

Too low risk-taking capacity of companies and cities. Based on the research data, it can be concluded that companies and cities avoid risks because innovation activities are not managed and coordinated. Enterprises are not very eager to take part in projects that do not generate business in the near future. SMEs and third-sector actors expect immediate business benefits and do not become interested in projects that are too long if the financing is not available or the demand is not certain. The challenge is the current economic situation in which cities and external actors have to find each other and share R&D risks together in the constructive spirit of co-creation.

It is apparent from the research that cities do not want to take too much risk due to the fear of failure since they are using public money and there is no separate budget for implementing R&D projects. The challenge is created by political decision-making and its slowness, which prevents the participation in medium-risk investments too. Another challenge is caused by situations in which SMEs expect that the city will purchase the end product and service concept created during the R&D process, without tendering. PCP contracts prevent the recurrence of the above-mentioned situations. Companies do not recognize the long-term benefits of competitive R&D which are offered to them by networking, learning and competition, among other things.

The research data indicate that companies' excessive emphasis on competition is detrimental to the creation of new innovative solutions and networks among different external actors. The PCP method offers one option to share R&D risks in the co-creation of innovative products and service concepts. In the structured operating models of PCP projects funded by the EU Commission the best factors should be used and applied to cities' own projects.

Market dialogue between cities and companies too formal and scarce. The research data indicates that market dialogue on, PCPs requires, among other things, strong commercial, procurement, technical, financial and legal expertise. The challenge experienced is that there are not yet enough skills and expertise to initiate market dialogue, even though it is recommended for wider use in the preparation of public procurements. This has given only limited experiences. The challenge is procurement preparation and planning that are started too late, leaving too little time for proactive market dialogue with external actors. External actors often perceive market dialogue as formal sessions where open discussion and innovation do not take place among the actors and no co-creation is possible. The challenge is to improve the dialogue and co-creation competence of the city and external actors through more structured market dialogue processes in order to renew the procurement culture.

5 CONCLUSIONS

The purpose of this study is to increase knowledge of the challenges in using pre-commercial procurement for enhancing collaborative innovation with external actors in cities. The present research was based on an empirical study on open innovation platforms in Smart Cities. The method was qualitative, and based on extensive data from in-depth interviews and co-creative multi-actor workshops. This study identified and described a large number of challenges in using PCP for enhancing innovation in cities. It also brought forward which challenges were emphasized by cities, external actors, or both of them.

The following suggestions stem from the present study to officials in city governments and urban policy makers. Cities should have clear long-term procurement strategies which are based on cities' overall strategies and needs for new innovations. Cities should actively use their procurement to foster the development of new user oriented solutions, implementation of co-creative problem definition at grass roots level, establishment of multi-stakeholder innovation networks [14,15], and use of new open-minded and innovative procurement methods. Moreover, cities should change their mindset and

processes, as well as increase their knowledge base to transform themselves from buyer to innovator and innovation enhancer.

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